Table 8-1-7 Estimated Cargo Volume of Calcutta/Haldia by Macroscopic forecast.

(Unit: '000 tonnes)

	1995	2000	2005
Medium Case	20,000	27,200	36,990
High Case	21,700	31,030	44,370
Low Case	18,390	23,470	29,960

(Base year: 1988, 13,071 thousand tonnes)

8-1-2 Forecast by Major Commodity Group

(1) Import Cargo

(a) P.O.L. (Crude)

The refining capacity of Indian Oil Corporation (I.O.C.), Haldia, is 2,750 thousand tonnes per year. For this refining capacity Oil Corporation Committee (O.C.C.) estimates the Haldia P.O.L. (crude) traffic as follows:

Table 8-1-8 Projection of Haldia P.O.L (crude) Port Traffic by O.C.C.

(Unit: '000 tonnes)

	1990/91	1994-95	1999-2000
O.C.C.	2,610	2,610	2,610

We assume that the present capacity of Haldia Refinery will remain unchanged up to the year 2005. Therefore we estimate the import of P.O.L. (crude) handling at Haldia as follows:

Table 8-1-9 Estimated Import of P.O.L. (crude) handling at Haldia

(Unit: '000 tonnes)

Year	P.O.L. (crude)
1995	2,610
2000	2,610
2005	2,610

(b) P.O.L.(Products)

(Haldia)

According to O.C.C. projections of Haldia P.O.L. (products) Port Traffic (see Appendix 8-1-1), port traffic including export and import is shown as Table 8-1-10.

Table 8-1-10 Projection of Haldia P.O.L.(Products) Port Traffic by O.C.C.

(Unit: million tonnes)

	1990/91	1991/92	1992/93	1993/94	1994/95	1999/2000
P. O. L. (Products)	3.84	4.48	5.88	5.17	5.42	6.39

O.C.C. estimates that 94.4 percent of Haldia P.O.L. (products) port traffic is import cargo and 5.6 percent is exports (see Appendix 8-1-2). Therefore we estimate the import of P.O.L. (products) using the share of import (94.4 percent) up to the year 2000. For the year 2005, we extrapolate from the figures in 1995 and 2000.

Table 8-1-11 Estimated Import of P.O.L.(Products) Handling at Haldia

(Unit: '000 tonnes)

Year	P.O.L. (Products)
1995	5,120
2000	6,030
2005	7,100

(Calcutta)

The forecast volume of P.O.L. (products) handled at Calcutta by O.C.C. and C.P.T is shown as follows:

Table 8-1-12 Forecast of P.O.L.(products) by O.C.C. and C.P.T

(Unit: '000 tonnes)

	1990/91	1991/92	1992/93	1993/94	1994/95	1999/2000
O.C.C.	659	713	772	832	903	-
C.P.T.	-	-	-	-	1,162	1,485

For 1995 we adopt the prediction by O.C.C.. As there is no prediction for 2000 or 2005, we extrapolate from the figures for 1990/91 and 1994/95 for the low case. However, C.P.T. does forecast the volume of P.O.L. (products) handling at Calcutta in 1995 and 2000. So we use C.P.T. predictions in 1995 and 2000, and extrapolate the estimate for 2005 from the figures for 1995 and 2000 as the high case. The medium case is the middle value between the high case and the low case.

Table 8-1-13 Estimated Import of P.O.L. (products) handling at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	900	1,160	-
2000	1,420	1,490	1,340
2005	1,945	1,895	1,995

(c) Foodgrains

In Seventh Five Year Plan (1985-90) the government target for the agriculture sector is to maintain self-sufficiency in foodgrains. There is no plan to import food grains in principle except in bad harvest years due to adverse natural conditions such as droughts, floods and so on.

Table 8-1-14 Production and Net Import of Foodgrains

(Unit: million tonnes)

Year	Production	Net Import
1980/81	129.59	0.66
81/82	133.30	1.58
82/83	129.52	4.07
83/84	152.37	2.37
84/85	145.54	(-) 0.35
85/86	150.43	(-) 0.06
86/87	144.07	(-) 0.29

Source: Economic Survey 1987-88

Imports of limited quantities were resorted to, mainly to maintain the level of buffer stocks, and may not take place every year. From Table 5-3-2 around 1 million tonnes of foodgrains were imported in 1976/77 and in 1983/84 but imports were very low in other years at Calcutta. Considering higher productivity and improved storage in the future, there will probably be no large-scale imports at Calcutta in the future. Therefore we assume that Calcutta may import 200 thousand tonnes in 1995, which is the approximate average annual import volume since 1976/77, and 400 thousand tonnes in 2000 and 2005, which is approximately the largest import volume except for 1976/77 and 1983/84.

(d) Finished Fertilizer

India is now in the process of attaining self-sufficiency in finished fertilizer. We assume that the policy aiming at self-sufficiency in finished fertilizer will be attained by 1995 and therefore there will be no importation of finished fertilizer after 1995. However, Calcutta will continue to import finished fertilizer for Nepal. Thus we only consider the projection of finished fertilizer imports for Nepal. The volume of finished fertilizer to Nepal through Calcutta was 31.4 thousand tonnes in 1986/87 and 31.7 thousand tonnes in 1987/88. We adopt the projected annual growth rate of GDP from 1985 to 1990 in Nepal (4.5 percent) as the traffic projection for finished fertilizer to Nepal. Thus the cargo volume of finished fertilizer to Nepal is estimated as follows:

1995	45	thousand tonnes
2000	55	"

2005 65 "

According to the information obtained, Nepal would prefer to import finished fertilizer through Haldia, though the time of shifting from Calcutta to Haldia has not been fixed (it may be considered as originating around 1990 - 91). CPT projects the shares of finished fertilizer handled at Calcutta and Haldia as 47 percent at Calcutta and 53 percent at Haldia in 1995 and 45 percent at Calcutta and 55 percent at Haldia in 2000. So we assume that the shares by CPT projection will be realized in 1995 and 2000 and that the shares in 2005 will be the same as in 2000.

Table 8-1-15 Estimated Import of Finished Fertilizer at Calcutta and Haldia

(Unit: '000 tonnes)

Year	Calcutta	Haldia
1995	20	25
2000	25	30
2005	30	35

Note: According to CPT information, India still need to continue importing finished fertilizer which is no indigenous production in the country. CPT predicts import of finished fertilizer under the assumptions that finished fertilizer will be imported at annual growth rate of 7.34 % for Calcutta and 11.74 % for Haldia based upon the projections of 80 thousand tonnes for Calcutta and 155 thousand tonnes for Haldia in 1989-90 by MOST.

Final CPT projection of finished fertilizer including Nepal Cargo in 1994/95, 1999/2000 and 2004/05 are as follows:

(Unit: ,000 tonnes)

	Calcutta	Haldia
1994/95	170	340
1999/2000	307	307
2004/05	369	369

Therefore there is a possibility of a increase of the cargo handling of finished fertilizer.

(e) Raw Materials for Fertilizer

According to the Seventh Five Year Plan 1985-90, the projected fertilizer production is 8,750 thousand tonnes in 1990 and 15,580 thousand tonnes in 2000. We used an annual growth rate of 5.9 percent during 1990 to 2000 in order to estimate the production of fertilizer in 1995 and 2005.

Table 8-1-16 Projection of Fertilizer Production

(Unit: '000 tonnes)

Year	Production
1990	8,750
1995	11,675
2000	15,580
2005	20,790

Fertilizer production in the hinterland is 915 thousand tonnes in 1985/86 and 1,062 thousand tonnes in 1986/87. The share of fertilizer production in the hinterland in the national total is approximately 15.5 percent (15.9 percent in 1985/86 and 15.0 percent in 1986/87).

Table 8-1-17 shows the projection of fertilizer production in the hinterland.

Table 8-1-17 Projection of Fertilizer Production in the Hinterland

(Unit: '000 tonnes)

Year	Production
1995	1,810
2000	2,415
2005	3,220

The proportion of nitrogenous and phosphetic fertilizers in India is shown as follows:

Table 8-1-18 Proportion of Nitrogenous and Phosphetic Fertilizer Produciton (National Base)

(Unit: '000 tonnes, %)

Year	Nitrogenous		Phosphetic	
	Volume	Share	Volume	Share
1981/82	3,144	76.8	949	23.2
82/82	3,424	77.7	980	22.3
83/84	3,485	76.9	1,048	23.1
84/85	3,917	75.6	1,263	24.4
85/86	4,328	75.2	1,428	24.8
86/87	5,410	76.5	1,660	23.5

Source: Economic Survey 1987-88

The proportion of nitrogenous and phosphetic fertilizer production in the hinterland is follows:

Table 8-1-19 Proportion of Nitrogenous and Phosphetic Fertilizer Production (Hinterland)

(Unit: '000 tonnes, %)

Year	Nitrogenous		Phosphetic	
	Volume	Share	Volume	Share
1985/86	841	92.0	74	8.0
86/87	950	89.5	112	10.5

Source: ebc's Comprehensive Guide to Fertilizer Industry

The main raw materials for fertilizer in India are rock phosphate and sulphur for phosphetic fertilizer. The sources of nitrogen for nitrogenous fertilizer are mostly indigenous. From the above two tables (Table 8-1-18 and 8-1-19), the proportion of phosphetic fertilizer production in the hinterland is less than half of the national average. We assume that the proportion of phosphetic fertilizer production in the hinterland in 1995 will remain the same as in 1986/87, but that the proportion in 2000 and

2005 will increase to 15 percent, approaching the national average.

With regard to the import of Rock Phosphate, we assume that 3.5 tonnes of Rock Phosphate will be imported for every ton of phosphetic fertilizer produced. We also assume the sulphur requirements for fertilizer at the rate of 1.56 tonnes per ton of phosphetic fertilizer.

Thus from Table 8-1-19, production of phosphetic fertilizer in the hinterland is approximately 180 thousand tonnes in 1995, 360 thousand tonnes in 2000 and 480 thousand tonnes in 2005.

Therefore the import of Rock Phosphate and Sulphur at Calcutta/Haldia is estimated as follows:

Table 8-1-20 Raw Materials for Fertilizer Handled at Calcutta/Haldia

(Unit: '000 tonnes)

Year	Rock Phosphate	Sulphur	Total	Production of fertilizer
1995	630	280	910	180
2000	1,260	560	1,820	360
2005	1,680	750	2,430	480

CPT projects the shares of raw materials for fertilizer handled at Calcutta and Haldia as 42 percent at Calcutta and 58 percent at Haldia in 1995 and 26 percent at Calcutta and 74 percent at Haldia in 2000. So we assume that these shares will be realized in 1995 and 2000 and we also assume that the shares in 2005 will remain at the same level as in the year 2000.

Table 8-1-21 Estimated Import of Raw materials for Fertilizer at Calcutta and Haldia

(Unit: '000 tonnes)

Year	Calcutta	Haldia
1995	380	530
2000	470	1,350
2005	630	1,800

Note: According to CPT information, CPT faces a reduction of allocation of finished fertilizer traffic and raw materials for fertilizer traffic during 1988/89 compared to the previous year (Finished fertilizer traffic to Calcutta Port for the first 8 months of the current year was only 37.7 percent and raw materials traffic was 60.1 percent).

The ports of Calcutta/Haldia have the problems of draft limitation and inefficiency by slow discharge.

As for raw material for fertilizer, it is definitely important that the manufacturers be supplied with the required quantities of essential raw materials in a timely manner in order to maintain their fertilizer production.

It is sometimes difficult at Calcutta/Haldia to fulfil this condition because of slow discharge. Therefore there is a possibility of a decrease of the cargo handling of raw materials for fertilizer.

(f) Iron, Steel and Machinery

(1) Iron and Steel

(Consumption)

Table 8-1-22 shows the trend of per capita consumption of iron and steel. From this table, we can estimate future per capita consumption of iron and steel using a time series correlation.

Table 8-1-22 Per Capita Consumption of Iron and Steel

(Unit: kg)

	Per Capita Consumption of Iron and Steel
1972/73	14
73/74	15
74/75	14
75/76	13
76/77	15
77/78	16
78/79	18
79/80	17
80/81	19
81/82	19
82/83	16
83/84	17

Table 8-1-23 Estimated Per Capita Consumption
of Iron and Steel

(Unit: kg)

	Per Capita Consumption of Iron and Steel
1995	23
2000	25
2005	27

$Y = 13.5 + 0.4t$ $(r = 0.834)$

t: Year (1972/73: t=1)
Y: Per Capita Consumption of Iron and Steel

From Table 8-1-2 (Projected Population), we can estimate total consumption of iron and steel as follows.

Table 8-1-24 Consumption of Iron and Steel

(Unit: '000 tonnes)

	Medium	High	Low
1995	20,630	21,210	20,330
2000	24,300	25,750	23,530
2005	28,400	31,080	27,050

(Production)

By the data from SAIL, production of finished steel is estimated as 20,437 thousand tonnes in 1995 and 24,591 thousand tonnes in 2000. We extrapolate from the figures in 1995 and 2000 for the year 2005. Thus the estimated finished steel production is as follows:

Year	Production
1995	20,440 thousand tonnes
2000	24,590
2005	29,580

(Import)

From the consumption and production figures of iron and steel, we can estimate the required imports of iron and steel as follows:

Table 8-1-25 Required Imports of Iron and Steel

(Unit: '000 tonnes)

	Medium	High	Low
1995	190	770	0
2000	0	1,160	0
2005	0	1,500	0

The ratio of iron and steel handled at Calcutta is approximately 17 percent during 1983/84 to 1985/86. Therefore the iron and steel handled at Calcutta is estimated as follows:

Table 8-1-26 Iron and Steel handled at Calcutta

(Unit: '000 tonnes)

	Medium	High	Low
1995	30	130	0
2000	0	195	0
2005	0	255	0

(2) Machinery

For the estimation of the import of machinery at Calcutta we use the annual growth rate of GDP(Industry) from Table 8-1-1 and the volume of imported machinery handled at Calcutta, 146 thousand tonnes in 1987/88.

Table 8-1-27 Machinery handled at Calcutta

(Unit: '000 tonnes)

	Medium	High	Low
1995	230	240	220
2000	325	350	285
2005	465	525	385

Thus the total cargo of iron, steel and machinery handled at Calcutta is as follows:

Table 8-1-28 Iron, Steel and Machinery handled at Calcutta

(Unit: '000 tonnes)

	Medium	High	Low
1995	260	370	220
2000	325	545	285
2005	465	780	385

Note: According to CPT information, project cargo and high rate of consumption of steel in the eastern region is likely to increase iron, steel and machinery traffic. Expansion/modernization programmes of steel plants, fertilizer plants and other plants at Durgapur, Namrup, Brauni, etc. will lead to more importation of iron, steel and machinery. CPT forecast the import of iron, steel and machinery in 1994/95, 1999/2000 and 2004/05 are as follows:

(Unit: ,000 tonnes)

	Calcutta	Haldia
1994/95	315	169
1999/2000	427	107
2004/05	443	147

Therefore there is a possibility of an increase of the cargo handling of iron, steel and machinery through not only Calcutta Dock but also Haldia Dock.

(g) Coking Coal

At present there are six integrated steel plants in the country. These are Bhilai, Durgapur, Rourkela, Bokaro, IISCO (Burnpur) and Tata Steel (Jamshedpur). In addition to these six integrated steel plants, Visakhapatnum Steel Plant will be operating at full capacity by 1990. Durgapur, Bokaro and IISCO are importing coking coal through Haldia while Bhilai, Roukela and Tata Steel are importing coking coal through Visakhapatnum and Paradip for the steel plants.

According to the "Master Plan Study" of Visakhapatnum Port by Indian Ports Association, the availability of finished steel is estimated by plant as shown in Table 8-1-29.

Table 8-1-29 Availability of Finished Steel by Plant

(Unit; In million tonnes)

Steel Plant	1989/90	1994/95	1999/2000	Port used for coking coal
Durgapur	0.573	0.745	0.745	Haldia
Bokaro	2.998	2.998	2.998	
IISCO	0.452	0.665	0.665	
Bhilai	2.470	2.470	2.470	Vizag/Paradip
Rourkela	1.164	1.721	1.721	
Visakhapatnum	0.797	2.169	2.169	
Tata Steel	1.297	1.691	2.147	
Total	9.751	12.459	12.915	

Source: Visakhapatnum "Master Plan Study" by India Ports Association.
June 1988

According to SAIL (Steel Authority of India Limited), SAIL is currently importing about 1.1 million tonnes of coking coal for the above three steel plants located in the hinterland of Haldia. The requirements of these three plants are likely to increase to 1.73 million tonnes within the next 3-4 years. From this information we assume that 1.73 million tonnes of coking coal will be required in 1992/93 and that the requirement of coking coal will increase in proportion to the total production of Durgapur, Bokaro and IISCO. This production is slated to increase from 4.023 million tonnes in 1989/90 to 4,408 million tonnes in 1994/95, with a annual growth rate of approximately 1.8 percent. Therefore we project the demand for coking coal through Haldia as 1.8 million tonnes in 1995 and 2000. After 2000 a new steel plant will be constructed at a coastal region such as the Visakhapatnum Steel Plant, if necessary. Japanese steel experts has such idea of steel plant at coastal region. Thus we assume that the production of Durgapur, Bokaro and IISCO in 2005 will remain at the same level as in 1995, which means the requirement of coking coal for the above three plants will remain around 1.8 million tonnes in 2005.

According to CPT information, SAIL recently appreciated that it is losing to the tune of Rs. 56 million per annum by routing coking coal via Paradeep and Vizag. SAIL agreed to consider on an immediate basis routing of 1.5 million tonnes through Haldia provided the limitations of draft at the Port are removed. CPT considers that it is possible to handle 2.0 million tonnes of coking coal at 1994/95 because of easily attainment of annual traffic of 1.5 million tonnes in the near future.

Tata Iron & Steel Co. (TISCO) are currently importing around 0.61 million tonnes of coking coal through Paradeep and are losing Rs. 34.2 million per annum for not moving cargo through Haldia. CPT expects 0.5 million tonnes of coking coal will be handled at Haldia in 1994/95.

Therefore the prediction of coking coal handled at Haldia is totally 2.5 million tonnes in 1994/95. We accept the coking coal handling 2.5 million tonnes in 1994/95, 1999/2000 and 2004/05 respectively by CPT prediction as a high case.

(h) Cement

India is now in the process of attaining self-sufficiency in cement production. We assume that this goal of self-sufficiency in cement will be attained by 1995 and therefore there will be no importation of cement after 1995 though there may be a few cases of imports of special quality cement. However, Calcutta will continue to import cement for Nepal. Thus in our study we only consider the projection of cement imports for Nepal.

Cement to Nepal through Calcutta was 73.6 thousand tonnes in 1986/87 and 150.1 thousand tonnes in 1987/88. We adopt the projected annual growth rate of GDP from 1985 to 1990 in Nepal (4.5 percent) for the traffic projection of cement to Nepal. As the cargo volume of cement in the base year (1988), we use the average cargo volume (110 thousand tonnes) in 1986/87 (73.6 thousand tonnes) and 1987/88 (150.1 thousand tonnes) because the cargo volumes are rather different between the two years. Thus the cargo volume of cement to Nepal through Calcutta is estimated as follows:

1995	150 thousand tonnes
2000	185 thousand tonnes
2005	230 thousand tonnes

Note: According to CPT information, Calcutta Port may have a chance to export cement to Bangladesh. CPT says that annual requirement of cement in Bangladesh is estimated at 2 million tonnes while the domestic production of Bangladesh will hardly be in the level of 300 thousand tonnes. It is not difficult for India to export cement to Bangladesh as there is a capacity of over 60 million tonnes of cement. CPT expects the cargo will be routed through Calcutta. Thus CPT may handle 1 million tonne of cement export to Bangladesh in 1994/95, though no projection was made by CPT, ADB, Planning Commission and JICA.

(i) Edible Oil

The per capita consumption of edible oil is shown in Table 8-1-30.

Table 8-1-30 Per Capita Consumption of Edible Oil

(Unit: kgs)

Year	Per Capita Consumption of Edible Oil
1974/75	3.3
79/80	3.7
80/81	3.8
81/82	5.1
82/83	4.5
83/84	5.8
84/85	5.5
85/86	5.0
86/87	5.9

Source: Economic Survey 1987-88

A time series correlation for the per capita consumption of edible oil is shown as follows:

$$Y = 2.73 + 0.24t \quad (r=0.864)$$

t: Year (1974/75: t=1)

Y: Per capita consumption of edible oil

Therefore the estimated per capita consumption of edible oil is estimated as follows:

Table 8-1-31 Estimated Per Capita Consumption of Edible Oil

(Unit: kgs)

Year	Estimate
1995	7.8
2000	9.0
2005	10.2

The hinterland for consumption of edible oil is West Bengal. The population of West Bengal is estimated as follows:

Table 8-1-32 Estimated Population of West Bengal

(Unit: million)

Year	Population of West Bengal
1995	70.2
2000	74.9
2005	79.9

The Population in 2005 is estimated from the annual growth rate of 1.3 percent during 1995 to 2000.

Therefore the consumption of edible oil is estimated as shown in Table 8-1-33.

Table 8-1-33 Estimated Consumption of Edible Oil in the Hinterland

(Unit: '000 tonnes)

Year	Consumption of Edible Oil
1995	547.6
2000	674.1
2005	815.0

In 1985/86, edible oil handled at Calcutta comprises about 35 percent of consumption. We assume that this ratio will continue up to 2005.

Table 8-1-34 Edible Oil handled at Calcutta

(Unit: '000 tonnes)

Year	Edible Oil handled at Calcutta
1995	190
2000	235
2005	285

(j) Other Liquid Cargo

(Calcutta)

Main other liquid cargoes are Methanol, Mono Ethyel Glycol and Benzene.

From CPT data the share of other liquid cargo in total liquid cargo is approximately 3 percent.

Table 8-1-35 Share of Other Liquid Cargo

(Unit: '000 tonnes)

	1986/87	1987/88	1989/89
POL*	732	906	477
Edible Oil	122	124	63
Other liquid	34	31	19
Total	888	1,061	559
Share of other liquid cargo	3.8%	2.9%	3.4%

* POL = POL (Import) + POL (Export)

Therefore we assume that the share of other liquid cargo will continue up to 2005.

Table 8-1-36 Estimated POL and Edible Oil in 1995, 2000 and 2005

(Unit: '000 tonnes)

	1995	2000	2005
POL	990	1,560	2,140
Edible Oil	190	235	285
Total	1,180	1,795	2,425

From Table 8-1-36 and the share of other liquid cargo we estimate other liquid cargo as 30 thousand tonnes in 1995, 50 thousand tonnes in 2000 and 70 thousand tonnes in 2005.

(Haldia)

The main other liquid cargoes are phosphoric acid, liquid NH3 and benzene. According to the information from CPT, there is a demand for LPG (Liquid Petroleum Gas) because of the shortage of the gas in the eastern region.

101 thousand tonnes of other liquid cargo was imported in 1986/97 and 116 thousand tonnes in 1987/88. The annual growth rate from 1986/87 to 1987/88 is 14.8 percent. We assume that this annual growth rate will continue up to 1995 and we estimate the other liquid cargo as 280 thousand tonnes in 1995 using the average import volume during two years as base data. This figure is the same as the CPT projection in 1995. Therefore we assume that the annual growth rate of importation of other liquid cargo after 1995 is the same as the CPT projection, that is around 12 percent.

(i) Other Cargo

The correlation between GDP in India and the other cargo (import) handled at Calcutta/Haldia is shown as Table 8-1-37.

Table 8-1-37 GDP in India and Other Cargo (import) handled at Calcutta/Haldia

(Unit: '000 tonnes & Rs. crores)

Year	Other Cargo (Import)	GDP
1977/78	527	45,566
78/79	583	47,910
79/80	663	49,144
80/81	826	50,521
81/82	977	53,267
82/83	1,019	56,327
83/84	984	58,975
84/85	1,040	62,047
85/86	1,251	64,523

Note (1): Figures of other cargo (import) and GDP are 3-year moving averages.

(2): GDP: At 1970-71 prices

$Y = 0.14 (X - 46,566)^{0.87} + 527 \quad (r = 0.950)$

r : Correlation coefficient

Y : Other cargo (import)

X : GDP in India

From Table 8-1-1 other cargo (import) handled at Calcutta/Haldia is estimated as follows:

Table 8-1-38 Estimated Other Cargo Handled at Calcutta/Haldia

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	2,360	2,500	2,220
2000	3,160	2,820	3,510
2005	4,120	3,530	4,780

CPT projects the shares of other cargo handled at Calcutta and Haldia as 82.8 percent at Calcutta and 17.2 percent at Haldia in 1995 and as 78.6 percent at Calcutta and 21.4 percent at Haldia in 2000. Therefore we used these shares for 1995 and 2000 and assumed that the shares in 2005 are the same as in the year 2000.

Table 8-1-39 Estimated Import of Other Cargo handled at Calcutta and Haldia

(Unit: '000 tonnes)

Year	Calcutta			Haldia		
	Medium	High	Low	Medium	High	Low
1995	1,950	2,070	1,840	410	430	380
2000	2,480	2,760	2,220	680	750	600
2005	3,240	3,760	2,770	880	1,020	760

(2) Export Cargo

(a) P.O.L.(Products)

(Haldia)

From Appendix 8-1-1 P.O.L. (products) handled at Haldia including imports and exports are estimated as shown in Table 8-1-10. Appendix 8-1-2 shows the share for exports of P.O.L. (products) as 5.6 percent. Therefore P.O.L. (products) handled at Haldia in 1995 and 2000 are estimated by Table 8-1-10 and the share for exports. The figures for 2005 are extrapolated from the figures in 1995 and 2000.

Table 8-1-40 Estimated Export of P.O.L. (products)

(Unit: '000 tonnes)

Year	P.O.L. (products)
1995	300
2000	360
2005	430

According to CPT information, significant quantity of P.O.L. are exported by barges also. CPT estimates the export of P.O.L. at Haldia based upon the cargo carried by vessel as well as by barges as follows:

Year	Haldia
1994/95	705
1999/2000	751
2004/05	788

Therefore we accept the P.O.L.(Products) Projections by CPT as high case.

(Calcutta)

From the past record the ratio of exports to imports of P.O.L. (products) handled at Calcutta is approximately 10 percent. (From Table 5-3-2 and 5-3-3 the ratio during 1976/77 to 1987/88 is 9.9 percent.)

Thus from Table 8-1-13 the import of P.O.L. (products) at Calcutta is estimated as follows:

Table 8-1-41 Estimated Export of P.O.L. (products) at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	90	-	-
2000	140	150	135
2005	195	190	200

(b) Coal

According to the "Master Plan Study" of Tuticorin Port by Indian Ports Association, the main importer of coal is Tuticorin Thermal Power Station (TTPS). The present installed capacity of TTPS is 3 x 210 MW. As for the annual requirement of coal for the existing three units, the TTPS authorities have decided their requirement is 2.46 million tonnes per annum considering the lower calorific value of the coal. It is proposed to augment the present installed capacity by the addition of two more 210 MW units. The requirement of coal for all five units is estimated as 4.15 million tonnes per annum by the TTPS authority.

At present the entire requirement of coal of TTPS is imported from Haldia and the export of coal from Haldia is only to Tuticorin. Therefore we project the volume of coal to be handled at Haldia as 4.15 million tonnes in 1995, 2000 and 2005. This volume of coal handled at Haldia corresponds to the approximate 4.00 million tonnes mentioned in the interview with the Department of Coal, Ministry of Energy.

There are plans for thermal power plants behind Madras (Ennor, North Madras and Mettur) and there will be a substantial coal requirement for these plants. But the primary source of coal supply for these thermal power plants is identified as the Talcher Coalfields in Orrisa. From the location of Talcher Coalfields, there is no chance for transport of this coal via Haldia.

As for Assam coal, according to Department of coal, Ministry of Energy, production of coal is at most 500 thousand tonnes per year and this is used for local cement plants, etc.

According to CPT information, however, CPT estimates the possibility of cargo handling of coal, 5 million tonnes in 1994/95, 5.5 million tonnes in 1999/2000 and 6 million tonnes in 2004/05 respectively at Haldia Dock Complex from the following reasons:

1) Present capacity of Haldia Dock Complex (HDC) for coal handling is 3.5 million tonnes at one coal berth. This will increase to 5 million tonnes when the iron ore berth will be converted to a coal berth in 1989/90. The capacity will further increase to more than 6 million tonnes from 1991/92 with the introduction of a crusher. Paradeep and Vizag are reaching capacity saturation and these ports require considerable additional investment for creation of port facilities.
2) The coal reserves of India by state show that the share of Bihar and West Bengal to total coal reserves is more than 50 per cent (coal reserve of Bihar is 57,571 million tonnes and that of West Bengal is 30,022 million tonnes to the total coal reserve of 170,461 million tonnes). The Coals of Bihar and West Bengal are likely to be routed through Haldia because of the lowest cost of transportation as compared with Paradeep or Vizag.
3) South Eastern Railways indicates that they do not have any problems in moving up to 5 million tonnes of coal for Haldia from the collieries. Utilization of facilities at Haldia therefore does not require additional investment by Railways while such is not the case for the port of Paradeep.
4) Paradeep is expected to handle 3.35 million tonnes of coal in 1994/95 increasing an additional 2.35 million tonnes from the present level. In order to handle 3.35 million tonnes of coal, Paradeep require 499.54 ship days at berth as against only 246.75 ship days at berth at Haldia, even after taking into account possible different parcel sizes of 35,000 tons at Paradeep and 26,000 tons at Haldia. If one ship day is assumed to represent an additional cost of Rs. 60,000 par day it permits a saving of Rs. 1.52 crores per annum.

CPT also forecasts that coal over the export from Haldia to TTPS will be used to meet the demand from the cement and paper industries.

Therefore, as mentioned above, we estimate the volume of coal to be handled at 4.15 million tonnes per year up to 2005 but we accept the possibility of coal handling of 5.0 million tonnes in 1994/95, 5.5 million tonnes in 1999/2000 and 6.0 million tonnes in 2004/05 respectively by CPT estimates as a high case.

Therefore, as mentioned above, we estimate the volume of coal to be handled at Haldia as 4.15 million tonnes per year up to 2005.

(c) Iron, Steel and Machinery (Export)

(1) Iron and Steel

It is estimated that exports of iron and steel including cast iron goods will increase from 150 thousand tonnes in 1984/85 to 380 thousand tonnes by the Seventh Five Year Plan 1985-90. So we may use the annual growth rate of this estimation, that is 20 percent, for the estimation of exports of iron and steel handled at Calcutta from 1987/88 to 1989/90. But this annual growth rate is very high for a long-term projection. Therefore we use the annual growth rate of finished steel production from 1990 to 2005 for the long-term estimation of exports of iron and steel including cast iron goods handled at Calcutta.

Table 8-1-42 Estimated Annual Growth Rate of the Export of Iron and Steel Including Cast Iron Goods

(Unit: %)

Year	Medium	High	Low
1988-1990	20	20	20
1990-1995	2.1	2.6	1.7
1995-2000	5.0	5.8	4.2
2000-2005	5.7	6.7	4.8

The export of iron and steel including cast iron goods handled at Calcutta is shown as follows:

Table 8-1-43 Export of Iron and Steel Including Cast Iron Goods Handled at Calcutta during 1983/84 - 1987/88

(Unit: '000 tonnes)

Year	Iron and Steel	Cast Iron Goods	Total
1983/84	13	56	69
84/85	58	58	116
85/86	53	53	106
86/87	15	64	79
87/88	36	71	107

From Table 8-1-43 future exports of iron and steel including cast iron goods are estimated as follows:

Table 8-1-44 Estimated Exports of Iron and Steel Including Cast Iron Goods Handled at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	170	175	165
2000	215	230	200
2005	285	320	250

The annual growth rate of production of cast iron goods is approximately 7 percent during 1981 to 1987 and the share of exports of cast iron goods handled at Calcutta is around 65 percent. For the export projection of cast iron goods we assume that annual growth rate (7 percent) and the share of exports of cast iron goods handled at Calcutta (65 percent) will continue up to the year 2005. Thus the estimated export of cast iron goods handled at Calcutta is shown as follows.

Table 8-1-45 Cast Iron Goods

(Unit: '000 tonnes, %)

Year	Production	CIG handled at Calcutta	Share
1980/81	71		
81/82	83		
82/83	88		
83/84	87	56	64.3
84/85	87	58	66.7
85/86	93	53	57.0
86/87	104	64	61.5

Source: Economic Survey 1987-88

Table 8-1-46 Estimated Export of CIG Handled at Calcutta

(Unit: '000 tonnes)

Year	Exports of CIG
1995	125
2000	175
2005	245

From Table 8-1-44 and 8-1-46, exports of iron and steel handled at Calcutta are estimated as follows.

Table 8-1-47 Exports of Iron and Steel Handled at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	45	50	40
2000	40	55	25
2005	40	75	5

(2) Machinery

For the estimation of exports of machinery handled at Calcutta we use the annual growth rate of GDP (Industry) from Table 8-1-1 and the volume of imported machinery handled at Calcutta, 14 thousand tonnes in 1987/88.

Table 8-1-48 Machinery Handled at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	20	23	20
2000	30	35	25
2005	40	50	35

Thus the total cargo of iron, steel and machinery handled at Calcutta is projected as follows:

Table 8-1-49 Estimated Exports of Iron, Steel and Machinery Handled at Calcutta

(Unit: '000 tonnes)

Year	Iron Steel & Machinery excluding CIG			CIG
	Medium	High	Low	
1995	65	75	60	125
2000	70	90	50	175
2005	80	125	40	245

(d) Jute and Jute Products

Trends in jute production, exports and consumption are shown in Table 8-1-50.

Table 8-1-50 Production of Jute and Jute Products, exports and consumption.

(Unit: '000 tonnes)

	Production		Exports		Domestic Consumption	
	Volume	Share	Volume	Share	Volume	Share
1960-61	1,097	100.0	-	-	-	-
70-71	1,060	100.0	-	-	-	-
80-81	1,392	100.0	570	40.9	822	59.1
82-83	1,338	100.0	360	26.9	978	73.1
83-84	1,095	100.0	200	18.3	895	81.7
84-85	1,367	100.0	280	20.5	1,087	79.5
85-86	1,350	100.0	290	21.5	1,060	78.5
86-87	1,394	100.0	350	25.1	1,044	74.2

According to the data from India Jute Mills Association, the export of jute and jute products in 2000 will be 175 thousand tonnes for the lower case and 280 thousand tonnes for higher case. The lower case assumes that substitution by synthetic packing materials will increase and the higher case assumes that the demand for jute packing materials will continue.

For the estimation of the export of jute and jute products in 1995 and 2005, we used the annual growth rate of (-) 5.2 percent for the lower case and (-) 1.7 percent for the higher case during 1986/87 to 2000.

Therefore the export of jute an jute products is estimated as follows:

Table 8-1-51 Estimated Export of Jute and Jute Products Handling at Calcutta

(Unit: '000 tonnes)

Year	Medium	High	Low
1995	265	305	225
2000	230	280	175
2005	195	255	135

(e) TEA

(Production)

Tea production by major state is shown in Table 8-1-52. For the future projection of tea production, the Consulative Committee of Plantation Associations, Calcutta estimates tea production by state at the years 1995 and 2000. From this data we estimate the tea production at the year 2005 by using the same annual growth rate of 4.1 percent during 1995 to 2000 and also assuming the same share of production by state.

Table 8-1-52 Tea Production and Future Projection of Tea Production

(Unit: '000 tonnes)

	North India						South India				Total	
	Assam		West Bengal		Others							
1960	157	48.9	81	25.2	6	1.9	244	76.0	77	24.0	321	100.0
65	181	49.5	86	23.5	6	1.6	273	74.6	93	25.4	366	100.0
70	212	50.7	101	24.2	4	0.9	317	75.8	101	21.8	418	100.0
75	265	54.4	111	22.8	5	1.0	381	78.2	106	21.8	487	100.0
80	301	52.9	133	23.4	4	0.7	438	77.0	131	23.0	569	100.0
81	305	54.5	128	22.8	5	0.9	438	78.2	122	21.8	560	100.0
82	299	53.3	133	23.7	5	0.9	437	77.9	124	22.1	561	100.0
83	322	55.4	140	24.1	4	0.7	466	80.2	115	19.8	581	100.0
84	339	53.0	148	23.1	4	0.6	491	76.2	149	23.3	640	100.0
85	353	53.8	157	23.9	4	0.6	514	78.3	142	21.7	656	100.0
86	336	53.8	143	22.9	6	1.0	485	77.7	139	22.3	624	100.0
87	369	54.7	152	22.6	6	0.9	527	78.2	147	21.8	674	100.0
95	483	53.9	210	23.4	8	0.9	701	78.2	195	21.8	896	100.0
2000	591	54.0	256	23.4	9	0.8	856	78.2	239	21.8	1,095	100.0
05	723	54.0	313	23.4	10	0.6	1,046	78.2	292	21.8	1,338	100.0

(Consumption)

The trend of tea consumption is shown in Table 8-1-53. From this table, the share of tea exports is gradually decreasing while the share of tea consumption is increasing. The future share of tea exports is estimated by a time series correlation.

$$Y = 61.07 - 1{,}057t \quad (r = 0.980)$$

Y: Share of tea exports

t: Year (1960/61: t=1)

We assume a continued decreasing share of tea exports for the low case of tea export. We assume that the share of tea exports maintains the same level as in 1987/88, that is, approximately 31 percent, for the high case.

Table 8-1-53 Trend in Tea Consumption

(Unit: '000 tonnes)

Year	Production		Exports		Domestic Consmption	
	Volume	Share	Volume	Share	Volume	Share
1960-61	321	100	193	60.1	128	39.9
65-66	366	100	199	54.4	167	45.6
70-71	418	100	202	48.3	216	51.7
75-76	487	100	218	44.8	269	55.2
80-81	569	100	224	39.4	345	60.6
81-82	560	100	241	43.0	319	57.0
82-83	561	100	190	33.9	371	66.1
83-84	581	100	208	35.8	373	64.2
84-85	640	100	217	33.9	423	66.1
85-86	656	100	214	32.6	442	67.4
86-87	624	100	203	32.5	421	67.5
87-88	674	100	209	31.0	465	69.0

The medium case is estimated as the middle value between the high case and the low case.

From Table 8-1-55 we can estimate the share of tea cargo volume handled at Calcutta/Haldia from a logistic curve as follows:

$$Y = \frac{0.80}{1 + 0.80^{(T-1975)}}$$

Y: Share of tea cargo volume handled at Calcutta/Haldia

T: Year

Table 8-1-54 Projection of Tea Exports and Tea Consumption

(Unit: '000 tonnes, %)

	Production (Volume)	Exports						Consumption					
		Medium		High		Low		Medium		High		Low	
		Volume	Share	Volume	Share	Volume	Share	Volume	Share	Volume	Share	Volume	Share
1995	896	247	27.6	278	31	216	24.1	649	72.4	618	69	680	75.9
2000	1,095	273	24.9	340	31	206	18.8	822	75.1	755	69	889	81.2
2005	1,338	298	22.3	415	31	181	13.5	1,040	77.7	923	69	1,157	86.5

Table 8-1-55 Estimated Share of Tea Cargo Volume handled at Calcutta/Haldia

(Unit: '000 tonnes, %)

	Calcutta/Haldia		Other Ports		Total Exports	
	Volume	Share	Volume	Share	Volume	Share
1979/80	121.0	58.1	87.4	41.9	208.4	100
80/81	148.2	64.0	83.5	36.0	231.7	100
81/82	150.0	66.9	74.1	33.1	224.1	100
82/83	138.2	71.2	55.8	28.8	194.0	100
83/84	135.0		N.A		N.A	
84/85	153.0		N.A		N.A	
85/86	169.0		N.A		N.A	
86/87	154.0		N.A		N.A	
1995	175-225	80	41-53	20	216-278	100
2000	165-270	80	41-70	20	206-340	100
2005	145-330	80	36-85	20	181-415	100

The share of tea cargo handled at Haldia in the total cargo handled at Calcutta and Haldia was 18.2 percent in 1986/87 and 39.1 percent in 1987/88. This rapid increase of share at Haldia was based upon the establishment of the ICD at Guwahati. As the utilization ratio of the ICD at Guwahati is still not 100 percent, we assume that the share of tea cargo handled at Haldia will increase up to 50 percent in the future. Thus, the future tea cargo handled at Calcutta and Haldia is shown as Table 8-1-56.

Table 8-1-56 Estimated Export of Tea Handled at Calcutta and Haldia

(Unit: '000 tonnes)

	Calcutta			Haldia		
	Medium	high	Low	Medium	high	Low
1995	100	110	85	100	115	90
2000	105	135	80	105	135	85
2005	120	165	70	120	165	75

(f) Other Cargo (Export)

For the estimation of exports of other cargo handled at Calcutta we use the annual growth rate of GDP (Industry) from Table 8-1-1 and the volume of exported cargo handled at Calcutta, 419 thousand tonnes in 1987/88.

Table 8-1-57 Other Cargo handled at Calcutta

(Unit '000 tonnes)

Year	Medium	High	Low
1995	600	645	560
2000	775	875	690
2005	1,000	1,185	850

The shares of other cargo handled at Calcutta and Haldia are approximately 90 percent at Calcutta and 10 percent at Haldia during 1977/78 to 1987/88. It is estimated that about 25 percent of other cargo handled at Calcutta is long-distance cargo which tends to be handled at Haldia. Therefore we assume that most of this long-distance cargo will be transferred from Calcutta to Haldia. Thus the share of other cargo handled at Calcutta and Haldia are 67.5 percent at Calcutta and 32.5 percent at haldia in 1995. According to the CPT projections, the shares of other cargo handled at Calcutta and Haldia are 67.8 percent at Calcutta and 32.2 percent at haldia in 1995 and 57.3 percent at Calcutta and 42.7 percent at Haldia in 2000. Therefore we assume that the shares of other cargo handled at Calcutta and Haldia are 57.3 percent at Calcutta and 42.7 percent at haldia in 2000 and 2005.

Table 8-1-58 Estimated Export of Other Cargo at Calcutta and Haldia

(Unit: '000 tonnes)

Year	Calcutta			Haldia		
	Medium	High	Low	Medium	High	Low
1995	405	435	380	195	205	180
2000	445	500	395	330	370	295
2005	570	675	485	430	505	365

(3) Forecast of Container Cargo

In India cargoes are roughly classified into the following four packing types: loose (break bulk), containerized, dry bulk and liquid, as follows.

Loose (break bulk):	Cement, Sugar, Iron and Steel, Machinery, Tea, Jute and Jute Products, Other Cargo
Containerizable :	Tea, Jute and Jute Products, Iron and Steel, Machinery and Other Cargo in break bulk
Dry bulk :	Foodgrain, Fertilizer, Raw Materials for Fertilizer, Coal, Coking Coal, Salt
Liquid bulk :	P.O.L.(Crude), P.O.L.(Products), Edible Oil, Other liquid cargo

Table 8-1-59 shows the cargo volume by packing type at Calcutta and Haldia from 1983/84 to 1987/88.

Table 8-1-59 Cargo Volume by Packing Type

(Calcutta) (Unit:'000 tonnes)

Year	Break Bulk		Dry Bulk	Liquid	Total
		of which containerizable			
1983/84	2,050	1,497	1,476	562	4,088
84/85	2,377	1,721	843	768	3,988
85/86	2,609	1,772	702	852	4,163
86/87	2,648	1,680	511	888	4,047
87/88	2,910	1,874	422	1,061	4,393

(Haldia) (Unit:'000 tonnes)

Year	Break Bulk		Dry Bulk	Liquid	Total
		of which containerizable			
1983/84	169	149	1,932	4,279	6,380
84/85	194	147	1,909	4,433	6,536
85/86	257	167	2,420	5,287	7,964
86/87	271	205	2,663	5,091	8,025
87/88	275	259	3,271	5,132	8,678

From Administration Report 1986-87 by CPT, there is no container cargo in coastal cargo. So we exclude coastal cargo from containerizable cargo in order to estimate the containerizable cargo. There is also no containerization of export iron, steel and machinery cargo. Table 8-1-60 shows the container cargo handled at Calcutta and Haldia.

Table 8-1-60 Container Cargo

(Calcutta) (Unit: '000 tonnes, %)

Year		1983/84	1984/85	1985/86	1986/87	1987/88
Import	Container cargo	60	83	134	146	207
	Containerizable cargo except iron, steel & machinery	680	757	890	883	1,188
	Containerized ratio	8.8	11.0	15.1	16.5	17.2
Export	Container cargo	115	140	190	223	206
	Containerizable cargo export iron, steel & machinery	678	810	733	666	528
	Containerized ratio	17.0	17.3	25.9	34.1	39.0

Iron, Steel and Machinery (Unit: '000 tonnes, %)

Year		1983/84	1984/85	1985/86	1986/87	1987/88
Import	Container cargo	5	6	28	37	11
	Iron, Steel, & Machinery	310	355	392	403	370
	Containerized ratio	1.6	1.7	7.1	9.2	3.0
Export	Container cargo	14	19	44	60	63
	Iron, Steel, & Machinery	75	126	118	91	120
	Containerized ratio	18.7	15.1	37.3	65.9	52.9

(Haldia) (Unit: '000 tonnes, %)

Year		1983/84	1984/85	1985/86	1986/87	1987/88
Import	Container cargo	13	21	22	40	37
	Containerizable cargo except iron, steel & machinery	79	75	131	130	147
	Containerized ratio	16.5	28.0	16.8	30.8	25.2
Export	Container cargo	33	43	21	47	86
	Containerizable cargo except iron, steel & machinery	69	72	33	68	111
	Containerized ratio	47.8	59.7	63.6	69.1	77.5

Iron, Steel and Machinery (Unit: '000 tonnes, %)

Year		1983/84	1984/85	1985/86	1986/87	1987/88
Import	Container cargo	1	2	16	30	9
	Iron, Steel, & Machinery	1	4	16	30	9
	Containerized ratio	100	50	100	100	100

The containerized ratios in 1995, 2000 and 2005 are estimated based on a growth curve (logistic curve) as shown below:

(Calcutta)

Import:

Containerizable cargo except iron, steel and machinery

$$Y= \frac{0.55}{1 + 0.75^{(t-1993)}}$$

Iron, steel and machinery

$$Y= \frac{0.15}{1 + 0.75^{(t-1990)}}$$

Export:

Jute and jute products

$$Y= \frac{0.65}{1 + 0.75^{(t-1990)}}$$

Tea

$$Y= \frac{0.80}{1 + 0.75^{(t-1990)}}$$

Containerizable cargo except iron, steel and machinery

$$Y= \frac{0.80}{1 + 0.75^{(t-1983)}}$$

Iron, steel and machinery

$$Y= \frac{0.70}{1 + 0.75^{(t-1990)}}$$

(Haldia)

Import:

Containerizable cargo except iron, steel and machinery

$$Y= \frac{0.60}{1 + 0.75^{(t-1990)}}$$

Export:

Containerizable cargo except iron, steel and machinery

$$Y= \frac{0.70}{1 + 0.75^{(t-1990)}}$$

Thus, the future container cargo volume is forecast based on the containerized ratio in 1995, 2000 and 2005 as shown in Table 8-1-61 and Table 8-1-62.

Table 8-1-61 (1) Future Container Cargo at Calcutta

(Unit: '000 tonnes)

		1995	2000	2005
Import	Container cargo	520-590 (550)	865-1,070 (965)	1,190-1,615 (1,390)
	Cargo except iron, steel & Machinery	1,490-1,680 (1,580)	1,800-2,235 (2,010)	2,245-3,045 (2,625)
	Containerized ratio	35	48	53
Export	(Jute and jute products)			
	Container cargo	115-160 (135)	110-175 (145)	85-165 (125)
	Jute and Jute products	225-305 (265)	175-280 (230)	135-255 (195)
	Containerized ratio	52	62	64
	(Tea)			
	Container cargo	55- 70 (65)	60-105 (80)	55-130 (95)
	Tea	85-110 (100)	80-135 (105)	70-165 (120)
	Containerized ratio	64	77	79
	(Other cargo)			
	Container cargo	210-240 (225)	225-285 (255)	280-390 (330)
	Other cargo	275-315 (295)	285-360 (325)	350-490 (410)
	Containerized ratio	77	79	80

Other cargo: Containerized cargo except jute and jute products, Tea and iron, steel and machinery

Iron, Steel and Machinery

		1995	2000	2005
Import	Container cargo	25- 45 (30)	40- 75 (45)	55-115 (70)
	Contaienrized cargo	220-370 (260)	285-545 (325)	385-780 (465)
	Containerized ratio	12	14	15
Export	Container cargo	100-110 (105)	150-175 (160)	195-255 (225)
	Containerized cargo	185-200 (190)	225-265 (245)	285-370 (325)
	Containerized ratio	56	66	69

Table 8-1-61 (2) Future Container Cargo at Haldia

(Unit: '000 tonnes)

		1995	2000	2005
Import	Container Cargo	180-205(195)	340-536(390)	445-600(520)
	Containerizable Cargo	380-430(410)	600-750(680)	760-1,020(880)
	Containerized ratio	48	57	59
Export	(Tea)			
	Container Cargo	90-115(100)	85-135(105)	75-165(120)
	Tea	90-115(100)	85-135(105)	75-165(120)
	Containerized ratio	100	100	100
	(Other)			
	Container Cargo	100-115(110)	195-245(215)	250-345(295)
	Other Cargo	180-205(195)	295-370(330)	365-505(430)
	Containerized ratio	56	66	69

Therefore the future container traffic (TEUs) at Calcutta and Haldia is estimated in Table 8-1-62.

Table 8-1-62 The Future Containers Traffic (TEUs)

(Calcutta)

(Unit: '000 tonnes, '000 TEUs)

		IMPORT			EXPORT		
		Medium	High	Low	Medium	High	Low
1995	Cargo (Tonnage)	580	635	545	530	550	480
	Containers (TEUs)	55	59	50	55	59	50
	of which Loaded	45	49	42	42	44	38
	Empty	10	10	8	13	15	12
2000	Cargo (Tonnage)	1,010	1,145	905	640	685	600
	Containers (TEUs)	92	103	84	92	103	84
	of which Loaded	78	89	70	51	55	48
	Empty	14	14	14	41	48	36
2005	Cargo (Tonnage)	1,460	1,730	1,245	775	865	695
	Containers (TEUs)	134	155	117	134	155	117
	of which Loaded	113	134	97	62	69	56
	Empty	21	21	20	72	86	61

Average loaded weight : Import 12,9 tonnes/TEU
of last 5 years Export 12,5 tonnes/TEU

(Haldia)

(Unit: '000 tonnes, '000 TEUs)

		IMPORT			EXPORT		
		Medium	High	Low	Medium	High	Low
1995	Cargo (Tonnage)	195	205	180	210	230	190
	Containers (TEUs)	28	31	26	28	31	26
	of which Loaded	17	18	16	19	21	17
	Empty	11	13	10	9	10	9
2000	Cargo (Tonnage)	390	425	340	320	380	280
	Containers (TEUs)	50	56	43	50	56	43
	of which Loaded	34	37	29	29	34	25
	Empty	16	19	14	21	22	18
2005	Cargo (Tonnage)	520	600	445	415	510	325
	Containers (TEUs)	65	73	53	65	73	53
	of which Loaded	45	52	38	37	45	30
	Empty	20	21	15	28	28	23

Average loaded weight : Import 11.6 tonnes/TEU
of last 5 years Export 11.1 tonnes/TEU

(4) Summary

As a conclusion, Table 8-1-63 shows a summary of the cargo forecast. The table is a comparison of the total cargo volumes obtained by the macro and micro forecast methods.

Herein, the future cargo volumes to be handled at Calcutta/Haldia in the target years are assumed equal to those forecast in the medium case of the forecast by commodity group, that is the micro forecast.

Table 8-1-63 Comparison of Cargo Forecasts

(Unit: '000 tonnes)

	Case	1995	2000	2005
Macro forecast	Medium	20,000	27,200	36,990
	High	21,700	31,030	44,370
	Low	18,390	23,470	29,960
Micro forecast	Medium	20,660	24,710	28,955
	High	21,025	25,585	30,360
	Low	20,370	24,040	27,885

Table 8-1-64 Summary of Cargo Forecast (Unit:'000 tonnes)

		1995			2000			2005		
		Calcutta	Haldia	Total	Calcutta	Haldia	Total	Calcutta	Haldia	Total
IMPORT	POL(Crude)	-	2,610	2,610	-	2,610	2,610	-	2,610	2,610
	POL(Products)	900	5,120	6,020	1,420 (1,340- 1,490)	6,030	7,450 (7,370- 7,520)	1,945 (1,895- 1,995)	7,100	9,045 (8,995- 9,095)
	Foodgrain	200	-	200	400	-	400	400	-	400
	Finished Fertilizer	20	25	45	25	30	55	30	35	65
	Raw Materials for Fertilizer	380	530	910	470	1,350	1,820	630	1,800	2,430
	Iron, Steel & Machinery	260 (220- 370)	-	260 (220- 370)	325 (285- 545)	-	325 (285- 545)	465 (385- 780)	-	465 (385- 780)
	Coking Coal	-	1,800 (2,500 as high case)	1,800 (2,500)	-	1,800 (2,500 as high case)	1,800 (2,500)	-	1,800 (2,500 as high case)	1,800 (2,500)
	Cement	150	-	150	185	-	185	230	-	230
	Edible Oil	190	-	190	235	-	235	285	-	285
	Other Liquid Cargo	30	280	310	50	500	550	70	890	960
	Salt	10	-	10	10		10	10		10
	Other Cargo	1,950 (1,840- 2,070)	410 (380- 430)	2,360 (2,220- 2,500)	2,480 (2,220- 2,760)	680 (600- 750)	3,160 (2,820- 3,510)	3,240 (2,770- 3,760)	880 (760- 1,020)	4,120 (3,530- 4,780)
	Total	4,090 (3,940- 4,320)	10,775 (10,745-10,795)	14,865 (14,685-15,115)	5,600 (5,220- 6,170)	13,000 (12,920-13,070)	18,600 (18,140-19,240)	7,305 (6,705- 8,190)	15,115 (14,995-15,255)	22,420 (21,700-23,445)
EXPORT	POL (Product)	90	300 (705 as high case)	390	140 (135- 150)	360 (751 as high case)	500	195 (190- 200)	430 (788 as high case)	625
	Coal	-	4,150	4,150	-	4,150	4,150	-	4,150	4,150
	Iron, Steel & Machinery	65 (60- 75)	-	65 (60- 75)	70 (50- 90)	-	70 (50- 90)	80 (40- 125)	-	80 (40- 125)
	Jute & jute Products	265 (225- 305)	-	265 (225- 305)	230 (175- 280)	-	230 (175- 280)	195 (135- 255)	-	195 (135- 255)
	Tea	100 (85- 110)	100 (90- 115)	200 (175- 225)	105 (80- 135)	105 (85- 135)	210 (165- 270)	120 (70- 165)	120 (75- 165)	240 (145- 330)
	Cast Iron Goods	125	-	125	175	-	175	245	-	245
	Other Cargo	405 (380- 435)	195 (180- 205)	600 (560- 640)	445 (395- 500)	330 (295- 370)	775 (690- 870)	570 (485- 675)	430 (365- 505)	1,000 (850- 1,180)
	Total	1,050 (965- 1,140)	4,745 (4,720- 4,770)	5,795 (5,685- 5,910)	1,165 (1,010- 1,330)	4,945 (4,890- 5,015)	6,110 (5,900- 6,345)	1,405 (1,165- 1,665)	5,130 (5,020- 5,250)	6,535 (6,185- 6,915)
Grand Total		5,140 (4,905- 5,460)	15,520 (15,465-15,565)	20,660 (20,370-21,025)	6,765 (6,230- 7,500)	17,945 (17,810-18,085)	24,710 (24,040-25,585)	8,710 (7,870- 9,855)	20,245 (20,015-20,505)	28,955 (27,885-30,360)
CONTAINER	Import('000 tonnes)	580 (545- 635)	195 (180- 205)	775 (725- 840)	1,010 (905- 1,145)	390 (340- 425)	1,400 (1,245- 1,570)	1,460 (1,245- 1,730)	520 (445- 600)	1,980 (1,690- 2,330)
	No.of TEU's	55 (50- 59)	28 (26- 31)	83 (76- 90)	92 (84- 103)	50 (43- 56)	142 (127- 159)	134 (117- 155)	65 (53- 73)	199 (170- 228)
	of which Loaded	45 (42- 49)	17 (16- 18)	62 (58- 67)	78 (70- 89)	34 (29- 37)	112 (99- 126)	113 (97- 134)	45 (38- 52)	158 (135- 186)
	of which Empty	10 (8- 10)	11 (10- 13)	21 (18- 23)	14 (14- 14)	16 (14- 19)	30 (28- 33)	21 (20- 21)	20 (15- 21)	41 (25- 42)
	Export('000 tonnes)	530 (480- 550)	210 (190- 230)	740 (670- 780)	640 (600- 685)	320 (280- 380)	960 (880- 1,065)	775 (695- 865)	415 (325- 510)	1,190 (1,020- 1,375)
	No. of TEU's	55 (50- 59)	28 (26- 31)	83 (76- 90)	92 (85- 103)	50 (43- 56)	142 (128- 159)	134 (117- 155)	65 (53- 73)	199 (170- 228)
	of which Loaded	42 (38- 44)	19 (17- 21)	61 (55- 65)	51 (48- 55)	29 (25- 34)	80 (73- 89)	62 (56- 69)	37 (30- 45)	99 (86- 114)
	Empty	13 (12- 15)	9 (9- 10)	22 (21- 25)	41 (37- 48)	21 (18- 22)	62 (55- 70)	72 (61- 86)	28 (23- 28)	100 (84- 114)

8-2 Calling Vessel Traffic Forecast

(1) Calcutta Dock System

The current average vessel size of respective cargo types is as follows, as presented in Appendix 11-1-1.

① Liquid Bulk Carriers	6,717 GRT ≑ 10,258 DWT
② Dry Bulk Carriers	6,917 GRT ≑ 10,288 DWT
③ Container Vessels	3,786 GRT ≑ 5,560 DWT
④ General Cargo Vessels	5,961 GRT ≑ 9,361 DWT

According to the comprehensive river training scheme for improvement of the draft in the River Hooghly, the allowable draft will be expected to be improved up to the following values.

ⓐ Present	6.8 m
ⓑ in 1995	7.4 m
ⓒ in 2005	7.9 m

The maximum vessel size in full load conditions which will be accessible in respective years is as follow as presented in Appendix 11-1-8.

	ⓐ Present	ⓑ in 1995	ⓒ in 2005
① Liquid Bulk Carriers	5,884 DWT	8,077 DWT	10,318 DWT
② Dry Bulk Carriers	5,428 DWT	7,686 DWT	10,060 DWT
③ Container Vessels	7,083 DWT	9,130 DWT	11,110 DWT
④ General Cargo Vessels	5,648 DWT	7,743 DWT	9,883 DWT

At present, the average vessel size of liquid bulk carriers, dry bulk carriers and general cargo vessels is larger than the vessel size which is restricted by the allowable full load draft. Accordingly, most of these vessels call at Calcutta Dock System is partially laden conditions. Even after improving the allowable draft up to 7.9m in 2005, the vessel size which is restricted by the allowable full load draft is almost same as the current average vessel size, so the average vessel size for these cargoes seems not to change even in 2005.

On the other hand, the current average vessel size of container vessels is less than the vessel size which is restricted by the allowable full load draft, so the maximum vessel size of container vessel seems to be defined by the allowable full load draft. From the relationship between DWT and container carrying capacity, the container vessels of 7,000 DWT have the capacity of 350 TEUs and the container vessels of 11,000 DWT have the capacity of 500 TEUs. So in 2005, more 500 TEU container vessel will be expected in Calcutta Dock System. If the average vessel size is assumed to be 80% of the maximum vessel size, the average vessel size of container vessels will be as follows;

	ⓐ Present	ⓑ in 1995	ⓒ in 2005
Container Vessels	5,560 DWT	7,300 DWT	8,900 DWT

Therefore, the projected vessel size of respective cargoes can be summerized as follows.

	ⓐ Present	ⓑ in 1995	ⓒ in 2005
① Liquid Bulk Carriers	10,300 DWT	10,300 DWT	10,300 DWT
② Dry Bulk Carriers	10.300 DWT	10,300 DWT	10,300 DWT
③ Container Vessels	5,600 DWT	7,300 DWT	8,900 DWT
④ General Cargo Vessels	9,400 DWT	9,400 DWT	9,400 DWT

The parcel size per ship is as presented in Appendix 11-1-10 as follows.

	in 1994/95	in 2004/04
① Liquid Bulk Carriers	6,405 tons	7,905 tons
② Dry Bulk Carriers	8,024	9,259
③ Container Vessels	3,885 (385 TEUs)	4,835 (580 TEUs)
④ General Cargo Vessels	4,785	5,735

The projected number of calling vessels is as presented in Appendix 11-1-11 as follows.

	in 1994/95	in 2004/04
① Liquid Bulk Carriers	170	300
② Dry Bulk Carriers	76	116
③ Container Vessels	286	(190) 462
④ General Cargo Vessels	462	507

Note: The number of container vessels for the rather radical alternative is presented in the parentheses.

Accordingly, the estimated number of vessels calling at Calcutta can be summarized as follows.

Table 8-2-1 Estimated Number of Vessels Calling at Calcutta

Ship Type	Ship Size	Average Handling Volume		Number of Calling Vessels	
		in 1995	in 2005	in 1995	in 2005
Liquid Bulk Carriers	10,300 DWT	6,405 tons	7,905 tons	170	300
Dry Bulk Carriers	10,300 DWT	8,024 tons	9,259 tons	76	116
Container Vessels	(7,300 DWT in 1995) 8,900 DWT	3,885 tons 385 TEUs	4,835 tons 580 TEUs	286	190
General Cargo Vessels	9,400 DWT	4,785 tons	5,735 tons	462	507

(2) Haldia Dock System

The estimated number of vessels calling at Haldia can be summarized as follows.

Table 8-2-2 Estimated Number of Vessels Calling at Haldia

Ship Type	Ship Size	Average Handling Volume		Number of Calling Vessels	
		1995	2005	1995	2005
Crude Tanker	87,400 DWT 144,000	50,000 tons 63,000	-- 75,000 tons	26 21	-- 35
Product Tanker	35,000	28,000	32,000	194	235
Other Liquid Tanker	12,000 - 25,000	11,000 - 23,000	11,000 - 23,000	17	52
Ore Carrier (Coal)	35,000	29,500	32,500	141	131
Dry Bulk Carrier (Fertilizer/Material)	20,000 - 30,000	10,000	23,000	54	79
Ore Carrier (Coking Coal)	30,000 - 40,000	29,500	32,000	61	56
Conventional Carrier (General Cargo) (Bagged Fertilizer)	5,000 - 20,000 GRT	5,000 11,000	5,000 11,000	60 1	99 2
Container Ships	300/400 TEUs 500 TEUs over	250 TEUs --	-- TEUs 600	224 --	-- 480

8-3 IWT Traffic Forecast

8-3-1 Demand Forecast for Loading/Unloading Containers at Calcutta/Haldia

The following table is the extraction from container of Table 8-1-64.

Table 8-3-1 Demand Forecast for Loading/Unloading Containers at Calcutta/Haldia

(Unit: TEUs)

Dock Systm	Actual	Forecast	
	1987/88	1995	2005
Calcutta	47,635	110,000	268,000
Haldia	18,842	56,000	130,000
Total	66,477	166,000	398,000

8-3-2 IWT Traffic Estimate

(1) IWT share in container transport between Haldia and Culcatta

1) Dutch Report on IWT (May 1987) adopted 25 - 40 percent in 1995 and 35 percent in 2005 as the modal share of IWT between Haldia and Calcutta. Also the ratio of the container cargoes with the inland origins/ destinations in Calcutta and its vicinity is assumed as 70 percent based on the industry share (This figure is compatible with the figures found in Traffic Management Study for Calcutta Port, 1983 and RITES' Report on Containerisation, 1987 and O/D analysis).

2) IWT share in the Rhein container transport through Rotterdam Port is as follows (Containerisation International 1987).

	1980 Rotterdam	1986 Rotterdam	1986 Delta Terminal
IWT	4 %	15 %	26 %
Rail	19	11	20
Road	77	74	54

3) IWT transport will be still less costly than road transport even after the development of the efficient road transportation system as suggested in the section of container traffic allocation. However the difference is not so significant (around $ 10 per TEU).

4) Based on the above, the modal share of IWT between Haldia and Calcutta will be assumed as 25% in the future container transport. This presupposes the sufficient policy support to promote IWT transportation.

(2) IWT container throughput forecast at Calcutta and Haldia

Adopting the same traffic to/from Assam and FEPZ as estimated in the Dutch Report on IWT,

In 1995:

Haldia (1995) : (Unit: TEU)
to/from Calcutta 56,000 x 0.7 x 0.25 = 9,800
to/from Assam 3,100 = 3,100
to/from FEPZ 1,500 = 1,500
Total throughput at Haldia = 14,400

Calcutta (1995):
to/from Haldia = 9,800
to/from Assam = 6,400
Total at Calcutta = 16,200

In 2005:

<u>(Case 1) Trend case in terms of functional allocation</u>

Haldia (2005):
to/from Calcutta 130,000 x 0.7 x 0.25 = 22,800
to/from Assam = 11,600
to/from FEPZ = 8,400
Total at Haldia = 42,800

Calcutta (2005):
to/from Haldia = 22,800
to/from Assam = 21,900
Total at Calcutta = 44,700

(Case 2) Shifting to Haldia case in terms of functional allocation

In this case, container throughputs at Haldia/Calcutta are:

	2005
Calcutta	110,000 TEUs
Haldia	288,000
Total	398,000

Therefore,

Haldia (2005):

to/from Calcutta 288,000 x 0.7 x 0.25 = 50,400

to/from Assam/FEPZ 20,000

Total 70,400

Calcutta (2005):

to/from Haldia = 50,400

to/from Assam = 21,900

Total 72,300

(3) Comparison with Dutch Report and Determination of Throughputs

(Unit: TEUs)

Year	Case No.	Dock System	Our Estimate	Dutch Estimate	Mean Value
1995	-	Calcutta	16,200	24,200	20,200
		Haldia	14,400	22,440	18,400
2005	AI-1	Calcutta	44,700	-	44,700
		Haldia	42,800	-	42,800
	AI-2	Calcutta	72,300	51,600	62,000
		Haldia	70,400	49,680	60,000

Note: TEU/Box No. = 1.1 in 1995
1.2 in 2005

Mean value will be adopted here for the future IWT traffic.

There is no major difference between the estimate by the IWT Report and our estimate.

8-4 Port Traffic Forecast (Railway, Road)

8-4-1 General

In this section, we forecast the future port traffic volume in each mode based on the present modal split and the cargo volume forecast in the previous section.

Actual modal split is determined not only by the transportation cost and transportation time, but also by the user's choice based on the maximum utility. Considering Calcutta port, it seems abnormal that consignors have switched their cargo to road from railway due to the heavy demurrage for the delay in loading caused by the inefficient port operation. In some cases, terminal charges become higher than the transportation cost. As mentioned in Chapter 3, at Calcutta port, the modal share of rail and road in terms of tonnage is 5% and 95% respectively. Even in the case of bulky cargoes, the split is 25% and 75%, although for the entire nation the railway share is 51% in terms of tonnage, and 64% in terms of tonne-km.

At Calcutta port, the cargo volume transported by trucks is increasing. This is also due to the increase of general cargoes which are handled in small volume, the value of time and the demand for door to door service and just in time transport. Most export cargoes and imported general cargoes are carried by trucks at present. This trend seems likely to continue through 2005.

The main role of railways is to transport a few kind of cargoes in large volume and cargoes from terminal point to terminal point. Accordingly, it is desirable that railways carry cargoes over a long distance by block rake. Cargoes suitable for railway transportation are bulky cargoes viz. cement, fertiliser, oil products, coal, etc.

The volume of cargoes to/from sidings by rail increase slightly. However, due to the lack of storage space in the port area and users' intentions to use other terminals which are now under construction or proposed near Howrah viz. the Dankuni terminal of Eastern Railway and the Sankrail terminal of South Eastern Railway, the future volume of these cargoes will likely be 2.4 million tonnes in 1990 as forecast by CPT and this volume seems likely to remain stable through 2005.

The volume of cargoes which are transported by rail after being carried by road from Calcutta port seems likely to increase and cause congestion at nearby stations in the future. Therefore, the construction of a new loading terminal for block rakes seems necessary.

Most cargoes handled at Haldia port are bulky cargo and are delivered by railway. Especially coal and coking coal are transported by railway only. This trend shall continue through 2005.

8-4-2 Bulky Cargo at Calcutta

Considering the future modal split of imported bulky cargoes at Calcutta port, three scenarios are envisaged as follows.

Scenario-1 Present modal share will continue

(Fertiliser)

Railway : All cargoes are for Nepal. The shares of railway and road of Nepal cargo will be the same as at present, that is 40% and 60% respectively.

Road : All cargoes excluding Nepal cargo by rail including cargoes being taken to nearby stations after delivery by road from the docks, which comprise around 20% of the cargo volume excluding Nepal cargo.

(Cement)

Railway : All cargoes are for Nepal. The shares of railway and road will be the same as at present, viz. 30% and 60% respectively.

Road : Same as Fertiliser

(Raw Materials for Fertiliser, Machinery and Others)

Railway : 17% of cargo will be by rail

Road : 83% of cargo will be by road, including cargoes being taken to nearby stations after delivery by road from the docks, which comprise around 20% of the cargo volume.

Scenario-2 Road cargo being taken to nearby stations will be shifted to railway after completion of a new loading terminal for block rakes.

(Fertiliser)

Railway : In addition to Scenario-1, the 20% of the cargoes excluding

Nepal cargo will shift to rail from road. The modal share of Nepal cargo will be the same as under Scenario-1.

Road : *Cargo excluding railway cargoes.*

(Cement)

Railway : In addition to Scenario-1, the 20% of the cargoes excluding Nepal cargo will shift to rail from road. The modal share of Nepal cargo will be the same as under Scenario-1.

Road : Cargoes excluding railway cargoes.

(Raw Materials for Fertiliser, Machinery and Others)

Railway : 34% of cargo will be by rail.

Road : 66% of cargo will be by road.

Scenario-3 Modal share for Nepal cargo will change as follows. Other conditions will be the same as under Scenario-2.

(Fertiliser) Rail : Road = 55 : 45

(Cement) Rail : Road = 50 : 50

* *25% of road traffic to Nepal will shift to railways.*

Scenario-4 Modal share for Nepal cargo will change as follows. Other situations will be the same as under Scenario-2.

(Fertiliser) Rail : Road = 70 : 30

(Cement) Rail : Road = 65 : 35

* 50% of road traffic to Nepal will shift to railways.

The cargo volumes in 1994/95 and 2004/2005 estimated by each scenario are summarized in Table 8-4-1. In this table, the average volume in 1986/87 and 1987/88 are also presented for reference.

Considering the cargo volume, especially of railway cargo, it seems reasonable to forecast the future cargo movement as follows.

In 1994/95 : The modal split follows Scenario-2.

In 2004/05 : The modal split *follows Scenario-3 or Scenario-4.*

Accordingly, the railborne traffic volume in 1994/95 will be around 250 thousand tonnes and 80% of this will be handled at the new loading terminal. The balance will be handled at the quay side tracks behind the sheds.

Table 8-4-1 Estimated Imported Bulky Cargo Volume at Calcutta Port by Mode

(.000 tonnes)

Commodity		Volume (Nepal cargo)	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
			Rail	Road	Rail	Road	Rail	Road	Rail	Road
Fertiliser	1986/87 1987/88 Average	224 (32)	13 (6%)	211 (94%)	52 (23%)	172 (77%)	←	←	←	←
	1994/95	20 (20)	8 (40%)	12 (60%)	8 (40%)	12 (60%)	11 (55%)	9 (45%)	14 (70%)	6 (30%)
	2004/05	30 (30)	12 (40%)	18 (60%)	12 (40%)	18 (60%)	17 (55%)	13 (45%)	21 (70%)	9 (30%)
Cement	1986/87 1987/88 Average	156 (112)	31 (20%)	125 (80%)	43 (27%)	113 (73%)	←	←	←	←
	1994/95	150 (150)	45 (30%)	105 (70%)	45 (30%)	105 (70%)	75 (50%)	75 (50%)	98 (65%)	52 (35%)
	2004/05	230 (230)	69 (30%)	161 (70%)	69 (30%)	161 (70%)	115 (50%)	115 (50%)	150 (65%)	80 (35%)
Raw material for Fertilizer Machinary & Others	1986/87 1987/88 Average	330	56 (17%)	232 (83%)	94 (34%)	186 (66%)	←	←	←	←
	1994/95	564	96 (17%)	468 (83%)	192 (34%)	372 (66%)	192	372	192	372
	2004/05	1025	174 (17%)	851 (83%)	349 (34%)	676 (66%)	349	676	349	676
Total	1986/87 1987/88 Average	660	100 (15%)	568 (85%)	189 (29%)	471 (71%)	←	←	←	←
	1994/95	734	149	585	245	489	278	456	304	430
	2004/05	1,285	255	1,030	430	855	481	804	520	765

In 2004/05, the railborne traffic volume will increase up to 500 thousand tonnes and most of this will be handled at a new loading terminal to be located at the EJC yard.

8-4-3 Bulky Cargo at Haldia

Coal and coking coal are transported by railway only at Haldia.

As for P.O.L, the modal split of P.O.L at Haldia at present is estimated as follows.

Road : 10%, waterway : 10%, pipeline 55%, Railway 25%

Assuming the present modal share will not change through 2005, the future P.O.L traffic volume by rail is forecast as shown in Table 8-4-2.

Table 8-4-2 Estimated Bulky Cargo Volume by Rail at Haldia Port

		('000 tonne) Volume	Rail
COAL	1987/88	2,624	2,540
	1994/95	4,150	4,150
	2004/05	4,150	4,150
C/COAL	1987/88	500	510
	1994/95	1,800	1,800
	2004/05	1,800	1,800
P.O.L	1987/88	4,302	860
	1994/95	5,120	1,280
	2004/05	7,100	1,775

8-4-4 General Cargoes and Containers at Calcutta/Haldia

General cargoes including containers will be transported in six modes as shown below.

For long distance

1 by railway in container
2 by road in break bulk
3 by IWT in container

For short distance in/around Calcutta

1 by road in container
2 by road in break bulk
3 by IWT between Calcutta/Haldia in container

At present railborne container movement between major ports and ICDs is very small. It is estimated as under 10% of the total container volume handled at major ports. As far as Calcutta port is concerned, it is only 5%. In India, around 80% of containers are stuffed/unstuffed in the ports. However, 60 - 70% of these seem to be full container load (FCL) shipments, which should have moved "door to door," and it is estimated that the FCL ratio will increase to 80% in future. The share of containers which will not be stuffed/unstuffed in the port and will move door to door is estimated as follows.

In 1995	50%
In 2005	80%

So, the number of TEUs moving inland from and to the ICDs is estimated as 23% of the total anticipated throughput of containers by 1990, and 40% by 2000.

As far as Calcutta/Haldia port is concerned, 30% of the total container throughput is delivered to/from the inland by truck in break bulk at present. It is estimated that 20% of the total containers will be delivered as FCL by railway by 1995 and 30% by rail and IWT by 2005.

Considering the above and the IWT demand forecast in Section 8-2, the future general cargo volume via each mode is estimated as shown in Table 8-4-3 (1995), 8-4-4 (2005 Alternative 1), and 8-4-5 (2005 Alternative 2).

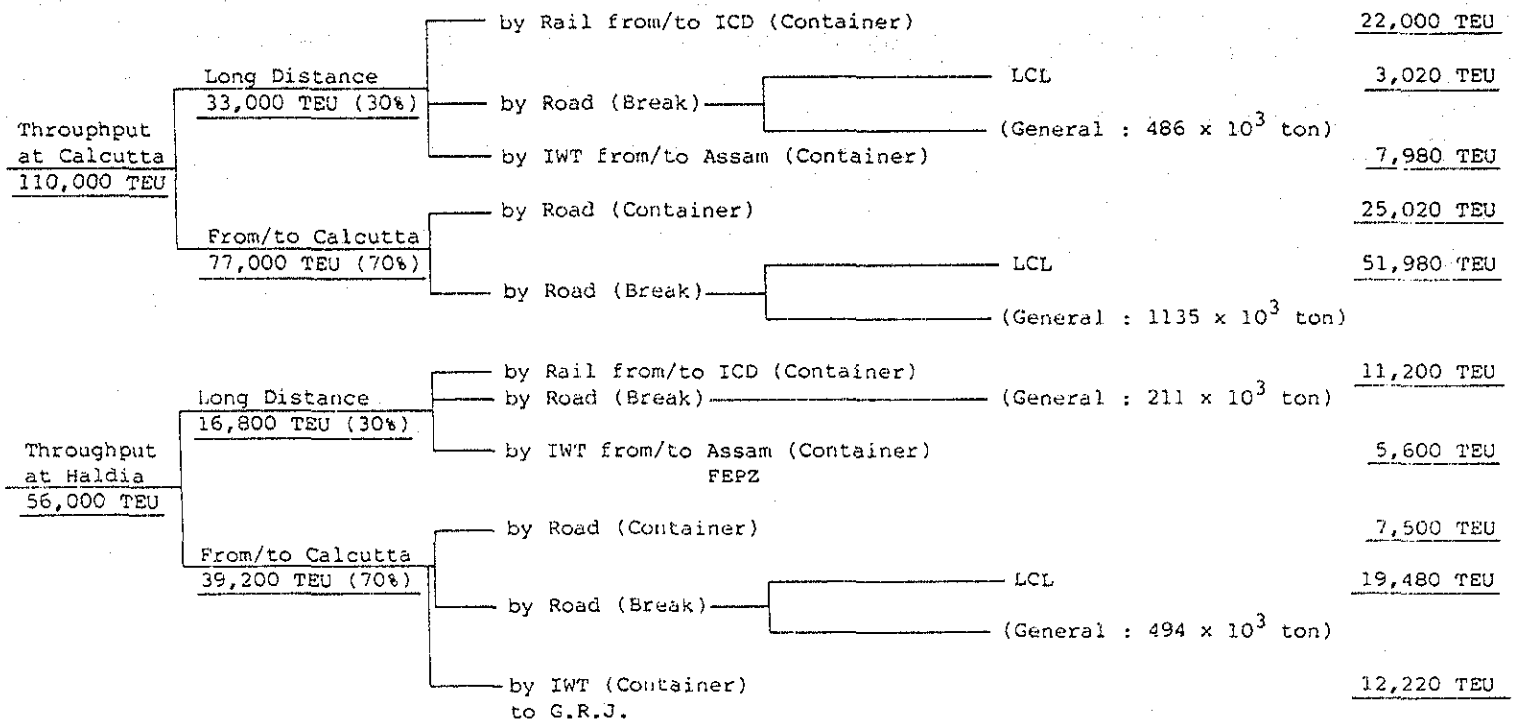


Table 8-4-3 Container/(General) Cargo Movement in 1995

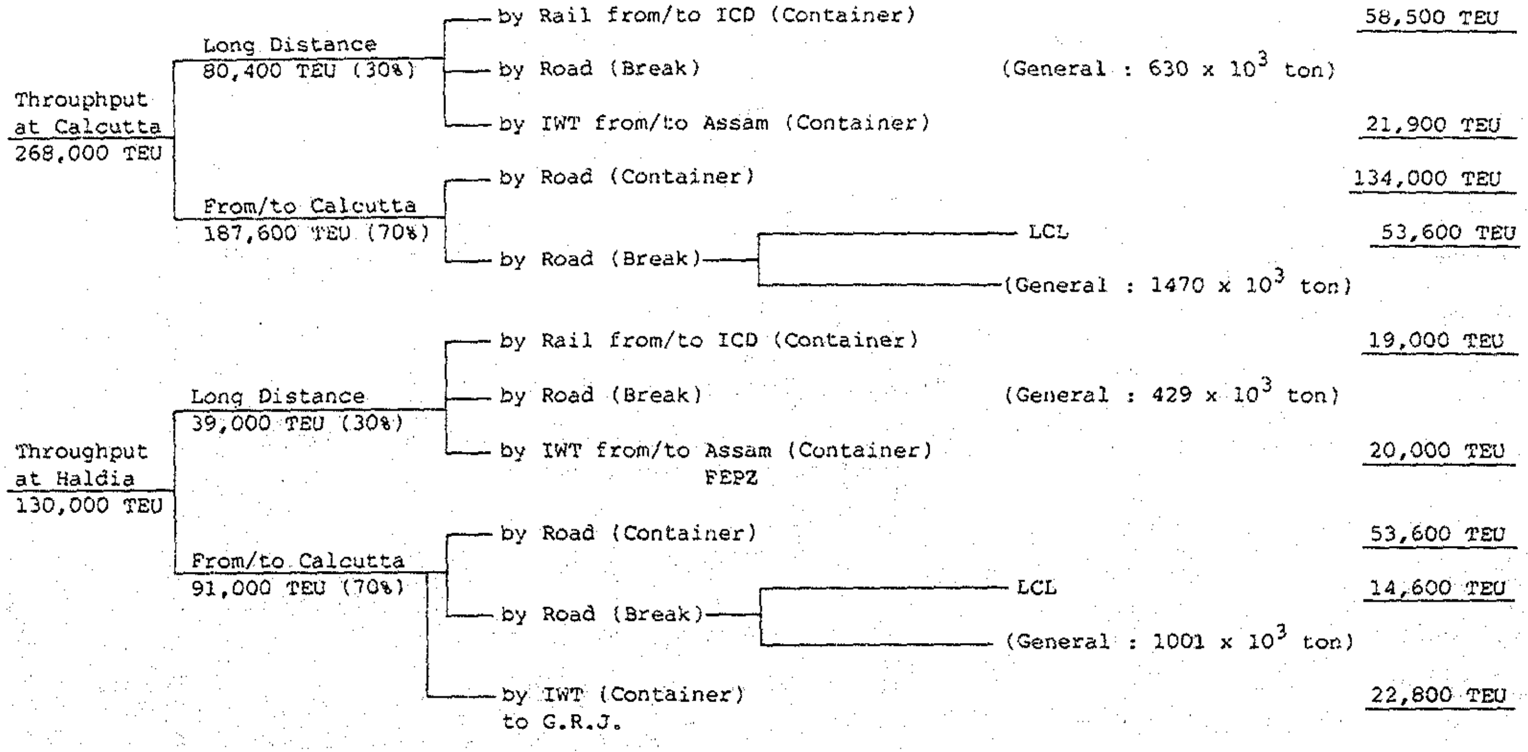


Table 8-4-4 Container/(General) Cargo Movement in 2005 (Alternative-1)

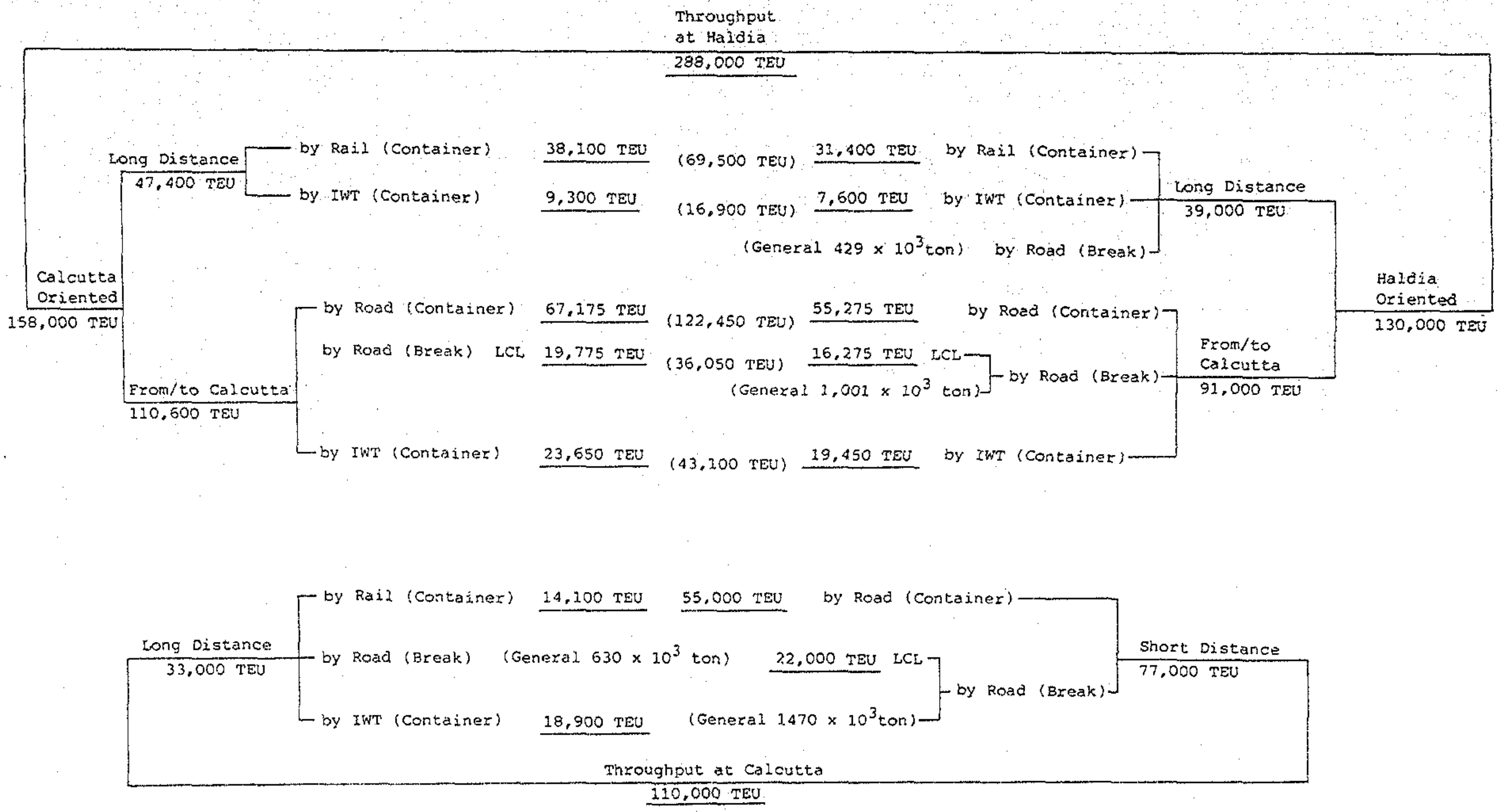


Table 8-4-5 Container/(General) Cargo Movement in 2005 (Alternative-2)

Chapter 9 Port Development Policy

9-1 Allocation of Functions between the Ports

9-1-1 General Concepts of Functional Allocation

The Calcutta Dock System is a very old port as KPD1 and KPD2 were opened to traffic in 1893 and NSD in 1928. In order to receive the deep draft vessels that cannot use the Calcutta Dock System, the Haldia Dock System began operations in 1977, as a complimentary port to the Calcutta Dock System.

As for liquid bulk cargo, separate oil jetties have been constructed since 1886 at Budge Budge, 13 miles below KPD. At Haldia one oil jetty was opened in 1968 in order to accommodate super-tankers.

and dry bulk cargo have been transferred from the Calcutta Dock System and the facilities at Budge Budge to the Haldia Dock System and the oil jetty.

As the following table shows, the share of P.O.L (Products) at the Haldia Dock System has been gradually increasing over 11 years, but the cargo volume handled at the Calcutta Dock System and at Budge Budge has also been slightly increasing. Edible oil has been handled at the Calcutta Dock System and at Budge Budge, P.O.L (Crude) has been handled solely at Haldia.

		1976-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87
POL(Products)	Import											
	Calcutta	357	395	569	420	676	482	474	412	597	737	655
	Haldia	363	500	657	1,019	1,839	1,272	965	1,080	1,385	1,653	1,604
	Share of Ha	50.4%	55.9	53.6	70.8	73.1	72.5	67.1	71.2	69.9	69.2	71.0
	Export											
	Calcutta	82	43	37	33	18	34	43	63	67	35	77
	Haldia	364	573	467	182	286	444	618	676	642	789	686
	Share of Ha	81.6%	93.0	92.7	78.4	94.1	92.9	93.5	91.5	90.6	95.8	89.9
Edible Oil	Import											
	Calcutta	29	63	100	93	108	105	75	87	104	80	122
	Haldia	-	-	-	-	4	-	-	-	5	-	-
	Share of Ha	0%	0	0	0	3.6	0	0	0	4.6	0	0
Crude POL	Import											
	Calcutta	-	-	-	-	-	-	-	-	-	-	-
	Haldia	1,900	1,899	2,187	2,528	2,335	2,313	2,495	2,583	2,401	2,845	2,700
	Share of Ha	100%	100	100	100	100	100	100	100	100	100	100

The main port of liquid bulk cargo is surelly Haldia, but some firms with production facilities near the port will continue to handle liquid bulk cargo at Calcutta at the target year of the Master Plan.

		1976-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87
Food Grants Import	Calcutta	1,026	109	56	-	68	172	423	922	188	2	9
	Haldia	-	-	3	-	-	-	-	16	16	-	-
	Total	1,026	109	59	-	68	172	423	938	204	2	9
	Share of Ha	0	0	5.1	0	0	0	0	1.7	7.8	0	0
Salt Import	Calcutta	241	143	217	179	214	52	148	102	36	30	18
	Haldia	-	-	-	-	-	-	-	-	-	-	1
	Total	241	143	217	179	214	52	148	102	36	30	19
	Share of Ha	0	0	0	0	0	0	0	0	0	0	5.3
Coking Coal Import	Calcutta	-	-	-	-	-	-	-	-	-	-	-
	Haldia	-	-	40	212	17	42	245	62	46	470	422
	Total	-	-	40	212	17	42	245	62	46	470	422
	Share of Ha	-	-	100%	100	100	100	100	100	100	100	100
Coal Export	Calcutta	790	686	525	164	219	339	378	262	94	65	62
	Haldia	18	350	271	457	648	1,042	1,506	1,623	1,568	1,784	2,059
	Total	808	1,036	796	621	867	1,381	1,884	1,885	1,662	1,849	2,121
	Share of Ha	2.2%	33.8	34.0	73.6	74.7	75.5	79.9	86.1	94.3	96.5	97.1
Fertilizer Import	Calcutta	353	289	523	279	512	339	145	111	401	391	293
	Haldia	-	-	41	45	47	30	28	96	159	80	78
	Total	353	289	564	324	559	364	173	207	560	471	371
	Share of Ha	0	0	7.3	13.9	8.4	8.2	16.2	46.4	28.4	17.0	21.0
Raw Materials Import	Calcutta	80	109	122	90	77	129	107	79	124	214	129
	Haldia	-	-	-	26	39	60	66	115	114	86	103
	Total	80	109	122	116	116	189	173	194	238	300	232
	Share of Ha	0	0	0	22.4	33.6	31.7	38.2	59.3	47.9	28.7	44.4
Fertilizer Raw Materials	Calcutta	433	398	645	369	589	463	252	190	525	605	422
	Haldia	-	-	41	71	86	90	94	211	273	166	181
	Total	433	398	686	440	675	553	346	401	798	771	703
	Share of Ha	0	0	6.0	16.1	12.7	16.3	27.2	52.6	34.2	21.5	25.7

At present, salt, food grains, fertilizer and raw materials for fertilizer are handled as dry bulk cargoes at the Calcutta Dock System, and coal, coking coal, fertilizer and raw materials for fertilizer are handled at the Haldia Dock System.

The cargo volume of food grain imports varies year by year. The policy of the Indian Government emphasizes self-sufficiency in food grains, but under certain conditions such as drought India imports food grains, mainly through the Calcutta Dock System. Currently the food grain berth at the Calcutta Dock System is used for handling general cargo, because the present demand for food grain imports is very small. In the long run, the chance for India to become a net exporter of food grains is small. India will likely continue to import food grains as an emergency measure. The berth to handle food grains should, therefore be maintained at the Calcutta

Dock System.

The import of salt will decrease in the future.

The import of coking coal will continue at the Haldia Dock System.

The import of fertilizer and raw materials for fertilizer is gradually being transferred to the Haldia Dock System, but most of this cargo is still handled at the Calcutta Dock System. Then we assume fertilizer and raw materials for fertilizer will continue to be handled at the Calcutta Dock System.

In conclusion, fertilizer and raw materials for fertilizer will be the only dry bulk cargoes to be handled at the Calcutta Dock System in the future. The facility to handle food grains will be maintained as an emergency berth.

At present, passenger liners from the Calcutta Dock System to the Andaman Islands carry passengers 2 times per month. The following table shows passenger traffic between Andaman and Calcutta. This trend will continue in the future.

	1982-83	83-84	84-85	85-86	86-87	87-88
Embarkation	20,437	17,080	16,039	25,722	24,428	27,257
Disembarkation	16,938	15,099	11,487	22,594	22,226	21,118
Total	37,375	32,179	27,526	48,316	46,654	48,375

Route: Andaman to Calcutta

The historical trend of the "other cargo", that is other than the liquid bulk cargo and the dry bulk cargo, is as follows.

	1976-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87
Calcutta Import	531	478	634	757	745	1,116	1,189	923	1,016	1,316	1,349
Calcutta Export	2,073	1,927	1,432	1,414	1,176	1,199	1,009	812	1,006	901	930
Calcutta Total	2,604	2,405	2,066	2,171	1,921	2,315	2,198	1,735	2,022	2,217	2,279
Haldia Import	-	0.3	70	61	164	223	140	100	121	224	304
Haldia Export	-	0.9	15	34	54	39	43	69	73	33	69
Haldia Total	-	1.2	85	95	218	262	183	169	194	257	373
Import Total	531	478	704	818	909	1,339	1,329	1,023	1,137	1,540	1,653
Export Total	2,073	1,928	1,447	1,448	1,230	1,238	1,052	881	1,079	934	999
Grand Total	2,604	2,406	2,151	2,266	2,139	2,577	2,381	1,904	2,216	2,474	2,652
Share of Ha (Im)	0	0	9.9	7.5	18.0	16.7	10.5	9.8	10.6	14.5	18.4
Share of Ha (Ex)	0	0	10.4	2.3	4.4	3.2	4.1	7.8	6.8	3.5	6.7
Share of Ha (To)	0	0	4.0	4.2	10.2	10.2	7.7	8.9	8.8	10.4	14.1

As mentioned in Chapter 7, the table volume of general cargo will increase in the future. Also more of the general cargo will be containerized. The total volume of other cargo had fluctuated around 2.5 million tonnes, but has recently increased since 1983-84. The share of the Haldia Dock System has recently increased also since 1983-84 according to the increase of container cargo. The allocation of container traffic should be fully taken into consideration in the cargo projection.

9-1-2 Container Traffic Allocation

(1) Analysis on the functional allocation

As analysed in Chapter 8, the potential demand for container throughput at Calcutta/Haldia is as follows.

(unit:TEUs)

	1987/88	1995	2005
Calcutta	47,635	110,000	268,000
Haldia	18,842	56,000	130,000
Total	66,477	166,000	398,000

This estimate assumes that the past trend of container throughput at Calcutta/Haldia Dock Systems continues in the future, and no appreciable policy initiatives are taken to to make Haldia more attractive and thereby influence the allocation of container throughput between these two dock systems.

However, considering the excessive traffic congestion prevailing in the inner city of Calcutta and the needs for the dispersal of population and the economic activities from the Calcutta Area on the onehand and the future development of the inland transport links on the other, it is necessary to re-examine the allocation of container throughput as indicated above from the viewpoint of regional policy perspective and the changing transport economy.

(i) Constraints on ship size at the Calcutta Dock System

The dimensions of the dock at Calcutta are as under.

	Length	Width	Depth
KPD	157m	21.9m	9.15m
NSD	172m	24.4m	9.15m

However, navigability at Calcutta is more severely constrained by the bends and available draft in the River Hooghly.

The available draft in the future is projected by CPT as follows.

6.8m	at present
7.4m	in 1995
7.9m	in 2005

On the other hand, the drafts of the full container vessels are shown as follows.

Cargo Carrying Capacity (TEUs)	Range (TEUs)	Sample Number	Mean(m) Draft(m) (m)	Standard Deviation (σ) (m)	m - σ/2 (m)	m + σ/2 (m)
300	100 - 500	270	6.42	0.88	5.98	6.86
350	150 - 550	266	6.76	0.87	6.33	7.20
500	300 - 700	241	7.79	0.98	7.30	8.28
700	500 - 900	177	8.81	0.99	8.32	9.31
1,000	500 - 1,000	403	9.67	0.91	9.22	10.13
1,400	900 - 1,900	344	10.59	0.97	10.11	11.08

Source: Analysis by Ports and Harbour Research Institute of Japan based on Lloyd's Register)

Due to the above navigational constraints, the container vessels calling at Calcutta at present are restricted to 300/400 TEUs loaders in the main. With the dredging up to 7.9 m, they can increase up to around 500 TEU loaders. Considering the secular trend of the increase of vessel size arising from the need to maximize the scale economy of maritime container transport, the role of Haldia Dock System in container transport seems to increase its importance as against the Calcutta Dock System.

(ii) Regional planning perspective

The development of Haldia Dock System was conceived not only to accommodate larger vessels to overcome the navigational bottlenecks at Calcutta but also to foster the development of Haldia district as a growth center to enable the dispersal of demographic and economic activities from the over-congested Calcutta Area. With the intensification of external diseconomies and environmental nuisances arising from over-congestion of traffic, population and economy in Calcutta, the development of Haldia Dock

System as the catalyst for growth center is becoming more and more important to facilitate the balanced regional development as well as to relieve the over-concentration of the Calcutta Area. In this connection, shifting of container throughput from Calcutta to Haldia should be pursued to the greatest possible extent and sufficient policy support is required to realise this goal. The attractiveness of Haldia in container transport needs to be increased both in terms of hardware and software through policy initiatives to overcome various obstacles.

(iii) Utilisation of existing port assets at Calcutta

As analysed in Section 11-1-3-(5), the container handling capacity at Calcutta is estimated as per 110,000 TEUs provided that the break-bulk general cargo is catered to at Calcutta in preference to container transport and provided that the existing berths are modernised and no new berth constructed.

This implies the excess potential throughput beyond 110,000 TEUs, i, e, 158,000 TEUs will spill over from Calcutta to other ports. In the environment of inter-port competition, it should be stressed that Haldia must be improved sufficiently to attract the spill-over container cargo from Calcutta.

(iv) O/D of containers

The inland origins and destinations of the containerisable cargo through Calcutta Dock System were analysed utilizing the available data, viz data provided by CPT, the information provided through major forwarders and the Engineering Export Promotion Council at Calcutta, RITES' Report on the Perspective Plan for the Development of Containerisation in India (1987), etc. The followings were identified through this analysis.

ⓐ the inland origins and destinations of the containerisable cargo through Calcutta Dock System are located in a wide area including West Bengal, Orissa, Bihar, U.P., M.P., Delhi, Punjab, Assam, Nepal and Bhutan and others.

ⓑ Around 70% of the total containerisable cargo through Calcutta Dock System flows to/from West Bengal while around 30% flows to/from states other than West Bengal.

ⓒ Calcutta and the Haora/Hughli Area which are closely connected with Calcutta Dock System in terms of socio-economy and geographical contiguity account for around 40% of the total containerisable cargo through Calcutta.

It is not always realistic to delineate the hinterlands between Calcutta/Haldia Dock System for the purpose of determining the allocation of the container throughput. This is because the commodity flow is the outcome of the economic activities of the free private sector where the existing commercial links between the private agents involved has a crucial influence, and therefore it would be difficult to ensure the realisation of such an arbitrary delineation.

However, the allocation of the future container throughput to Calcutta based upon the concept of hinterland delineation seems to be useful as one indicator for the limit setting of the future container handling capacity at Calcutta.

Taking into consideration the geographical contiguity, socio-economic linkages and available inland transport infrastructure, it seems reasonable to assume all the containerisable cargo with inland origins/destinations on the east bank of the Hooghly (Calcutta, etc) and 50% of that to/from the Haora/Hughli Area as the primary hinterland of the Calcutta Dock System in the future.

Then, the containerisable cargo to be catered to at Calcutta Dock System will be around 30% of the total.

Thus, the container handling capacity at Calcutta is,

398000 TEU x 0.3 = 106,000TEUs   110,000TEUs.

This is in accordance with the handling capacity determined by the full utilisation of existing port assets at Calcutta in and after 1995.

(v) Measures to make Haldia more attractive in container transport

The existing container terminal at Haldia seems far less attractive to shippers/consignees/shipping lines than that at Calcutta in a variety of aspects and sufficient improvements are required to attract more container traffic.

Based upon the comments presented by the Shipping Wing of MOST, India and the discussions with shippers/consignees and CPT as well as the observation of the existing situation of Haldia, the Team identifies the following ways to increase the attractiveness of Haldia.

ⓐ Modernization and augmentation of container handling facilities at Haldia

To cope with full containerization, it is necessary to construct container terminals equipped with sufficiently deep berths, gantry cranes with sufficient handling capacity and out-reach, sufficient container yard space for container stacking, container freight stations, efficient maintenance and repair shops, cargo handling equipment and other ancillary facilities in marine terminals.

However, the container terminal at Haldia is sub-standard and hinders the efficient container flow.

Specifically, Haldia suffers from the following problems.

- terminal layout unsuitable for efficient container flow
- shortage of container marshaling/stacking space
- shortage of equipment for quay and land side operation
- shortage of berthing facilities

The modernization and augmentation of these basic facilities should be carried out in a timely and orderly manner in line with the future traffic demand. Even temporary excess capacity accompanying long-range investment may well be permissible to provide Haldia with advantages as against Calcutta.

ⓑ Improvement of inland transport links

Haldia is located far from the inland origins and destinations of the traffic demand. Therefore it is indispensable to provide efficient inland transport links connecting to the port terminal.

The development or redevelopment of inland transport infrastructure such as roads and railways as well as inland container depots is required to accommodate heavy-load traffic and to achieve efficient inter-modality and door-to-door service, which is the ultimate goal of containerization.

In addition, the provision of IWT container transport links will diversify the available transport links with Haldia, and therefore increase the attractiveness of Haldia.

The planned track terminals and railway goods terminals in Haora/Hughli Area will also be effective in shifting container cargo from Calcutta to Haldia, particularly when they assume the function of bonded inland container depots.

ⓒ Improvement of software

The shortage of appropriate software required for container handling at Haldia was also stressed by the shipping Wing.

The problems include:

- lack of infrastructure and logistic support for shippers and clearing agents at Haldia
- poor communication facilities between Calcutta and Haldia
- poor road transport network leading to difficult communication within Haldia township

  The development of the Haldia township and other facilities have also been very slow in coming.

These problems are mostly outside the control of the port trust and requires the efforts of the state/municipal governments as well as of their subsidiary organizations such as Haldia Development Corporation.

Considering the close linkage between the regional development as a whole and the development of Haldia Dock Complex, the rewards of the efforts to resolve these problems will be tremendous. In this regard, the coordination between the port sector and local governments/related organizations is crucial, and an institutional framework to ensure effective coordination such as the set-up of a joint committee on the infrastructural development might be useful.

Thus,the following measures would help to make Haldia more attractive in container transport vis-a-vis. Calcutta.

(a) Establishment of efficient modern container terminals at Haldia which are more competitive than those at other ports

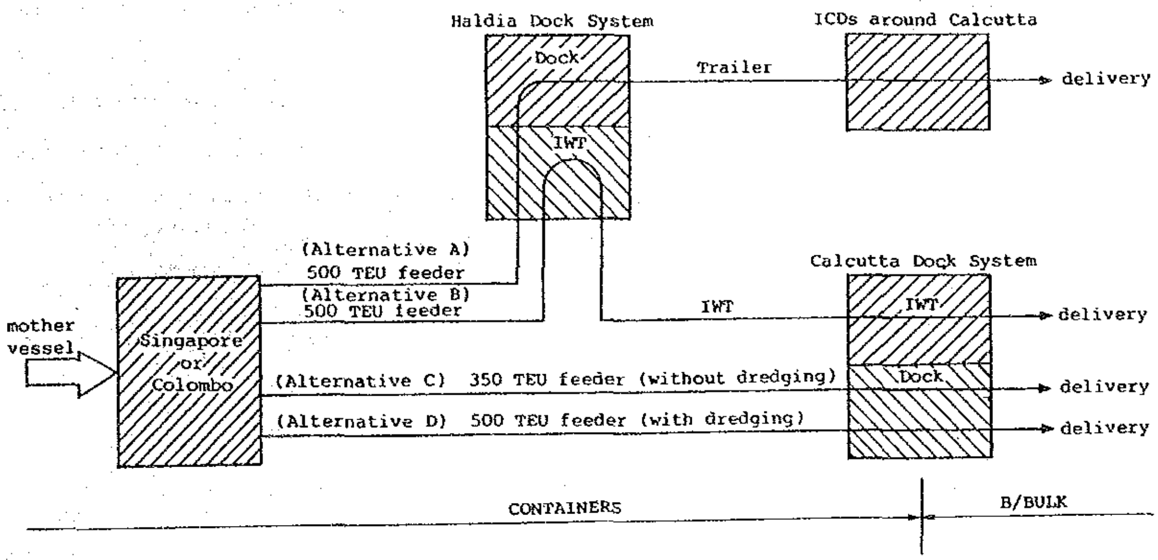
(b) Establishment of the efficient multiple inland transport links connecting the Haldia marine terminals with the hinterland

(c) Improvement of related software infrastructure such as discussed above. In addition, the following items seem also be required to increase the attractiveness of Haldia.

(d) Modernization and the restructuring of port operation systems to ensure efficient handling of container flow including computerized documentation processing, skill development programmes, etc.

(vi) Analysis on Transport Economy

Based upon the analyses above, 4 representative alternatives can be formulated for transporting containers by feeder vessels in 2004/2005 as follow.



Transport cost per TEU for each alternative scheme is estimated as follows.

Port of transhipment / Alternative	Shingapore	Colombo	Remarks
(Alternative A)	272 US$	250 US$	1) Transport Cost per import TEU from Singapore/Colombo up to before delivery to Calcutta Area. 2) Assumptions are indicated below. 3) Excludes transhipment cost at Singapore/Colombo.
(Alternative B)	263	241	
(Alternative C)	293	267	
(Alternative D)	286	267	

The above transport cost estimate indicates that shifting container transport to Haldia will be more economical and beneficial to users in the future (2005) than the calling of feeder vessels to Calcutta Dock System, provided that the required measures are effectively taken to make Haldia move attractive as discussed above (V), including provision of efficient inland transport infrastructure between Calcutta and Haldia such as IWT and road improvement/ICDs near Calcutta, and provided that the pricing is properly determined on the basis of the costs.

It is also noteworthy that invisible costs are not included in the cost estimate such as the externalities, e.g. congestion and environmental cost as well as the possible increase of dredging cost between Calcutta and Haldia. If these are taken into account, shifting to Haldia of container transport will be more economically beneficial from the viewpoint of the socio-economy as a whole. Furthermore, when the door-to-door service of containers are developed sufficiently, the transport cost by road decreases more remarkably whereby furtherly increasing the attractiveness of Haldia.

The major assumptions of the estimate are as follows.

(a) service life of capital = 30 years for civil works
15 years for equipment

(b) opportunity cost of capital = calculated based on a repayment period of 25 years with a grace period of 5 years and an interest rate of 10.75 % p.a.

(c) container handling cost at Haldia marine terminal
= ship to quay + quay to yard + yard to trailer = 1,400 Rs
(present, for Alternative A)

(d) IWT transport cost = 872 Rs (IWT Report, Alternative B)

(e) Alternatives C and D include the port traffic facility improvement cost based on the traffic share.

(f) Alternative D includes the draft improvement cost (dredging etc.) based on the traffic share.

(g) container handling cost at Calcutta marine terminal
= ship to quay (container) + cargo handling + yard handling + ship side handling cost = 1,790 Rs.

(2) Proposed alternatives for container traffic allocation between Calcutta/Haldia

Based upon the analysis of the previous section, two different alternatives are formulated.

(Alternative-1)

This alternative allocates the container traffic according to the potential throughput demand for each Dock System as estimated in Chapter 8. In this regard, this alternative will be called the "trend case".

The allocation between Calcutta/Haldia under this case is indicated as under.

(unit:TEUs)

	(Year 1987/88)	(1995)	(2005)
Calcutta	47,635	110,000	268,000
Haldia	18,842	56,000	130,000
Total	66,477	166,000	398,000

(Alternative-2)

This alternative assumes that container handling capacity at Calcutta is restricted to 110,000TEUs and the rest will spill over to Haldia Dock System.

In this regard, this alternative will be called "the shifting to Haldia case"

The allocation between Calcutta/Haldia under this case is indicated as under.

(unit:TEUs)

	(Year 1987/88)	(1995)	(2005)
Calcutta	47,635	110,000	110,000
Haldia	18,842	56,000	288,000
Total	66,477	166,000	398,000

Both these alternatives require IWT container transport links between Haldia and Calcutta as analyzed in Chapter 8.

Among these two alternatives, Alternative-2 (Shifting to Haldia case) seems more desirable than Alternative-1 (Trend case) from the viewpoint of regional policy perspective and transport economy as analysed in the previous section. However, the realization of Alternative-2 presumes policy initiatives or incentives to users which are reiterated as follows.

(a) Development of efficient container transport links

Above all, it is crucial to modernize the existing sub-standard container terminal and establish efficient marine terminals as well as port operation systems at Haldia so as to ensure efficient handling of container flow. Additionally, the development of efficient inter-modal inland transport links comprised of road plus ICDs and IWT between Haldia and Calcutta Area are also crucial to exploit the potential advantages in transport economy. In contrast, the present inland transport link is sub-standard and insufficient for ensuring the shift of containers to Haldia in that the available inland transport mode is only the road transport by a monopolized trucking company at a high tariff and cargoes are subject to contamination and pilfrage during transportation. When the efficient inter-modal inland transport links are established, all these problems will be resolved or diminished through competition between modes and introduction of FCL container transport.

(b) Tariff differentiation

Given the above development of inland container transport links no major arbitrary tariff differentiation between Calcutta and Haldia Dock system as is set at present (Tariff at Calcutta almost doubles Haldia) would be required. It is fair to expect container transport to gradually shift to Haldia from Calcutta led by the invisible hand, i.e. the profit motive of users if the tariffs are determined based on the cost. However, some policy initiatives might be required particularly in the transient period to overcome the various inertia acting against the shift and to facilitate the shift. In that situation, tariff differentiation will be effective as a price incentive to the users. Even in this case, a small differentiation will be sufficient judging from the inherent comparative cost advantage of handling at Haldia compared to that at Calcutta.

(c) Improvement of communication system between Calcutta and Haldia Dock Systems

It is fair to expect that the ancillary supporting facilities such as banking and clearance facilities will follow without any major difficulties, following the trend of increased throughput at Haldia. Communication systems linking Haldia and Calcutta/ICDs/IWT terminal at Calcutta should be improved so as to ensure efficient bonded transport between them, so that the requirement of the shift of banking/clearance facilities may be minimized.

(d) The preferential use or entrusting of terminal operation of some of the container berths at Haldia to particular shipping lines, etc. while Calcutta is restricted to common use might also be effective, with the increase of container throughput and ship waiting time at Calcutta.

In conclusion, the Team recommends Alternative-2 (Shifting to Haldia Case) as the proper functional allocation because this is justifiable from the economic and social viewpoint as discussed above and also because it seems feasible provided that the policy initiatives or incentives to users as discussed in this section are provided in an appropriate manner. However, the realization of Alternative-2 presumes the timely and orderly development of efficient container transport links to ensure efficient intermodality which involves various related agencies including the public as well as the private transport sector, so the choice between these two alternatives might be reviewed as necessary taking into consideration the progress of the development of inland transport links and the trend of seaborne traffic, for example when the 9 th plan is formulated.

9-2 Need for a Deep Seaport

9-2-1 Requirement for Further Improvement of Draft of the Approach Channel to Haldia

From the analysis of the future trends of the shipping technology presented on section 7-1, the future vessel size, commodity wise, can be summarized as follows.

(a) Liquid Bulk Carriers

At present, the major vessel size range is 25,000 to 40,000 DWT on the number basis and 250,000 to 320,000 DWT on the freight space basis. The excess capacity of oil tankers is estimated as 20 % of the total tanker capacity and will be diminished by scrapping VLCC at the early 1990s. On the other hand, the vessel size range of 25,000 to 40,000 DWT will be staying at the same level as at present. The vessel size range of 80,000 to 100,000 DWT or 60,000 to 100,000 DWT, the so-called Suez-max tankers will expand its share in the total oil tanker capacity.

(b) Dry Bulk Carriers

At present, the major vessel size range is 25,000 to 40,000 DWT on the number basis as well as on the freight space basis. The total freight space of dry bulk carriers is expected to increase from 197.4 million DWT in 1986 to 284.9 million DWT in 2000, so the freight space of each vessel size is estimated to increase. The share of 10,000 to 40,000 DWT is expected to increase from 45.6 % in 1986 to 48.9 % in 2000.

The share of 40,000 to 80,000 DWT is prospected to decrease from 32.6 % in 1986 to 29.8 % in 2000.

(c) Fully Cellular Container Vessels

At present, the major vessel size range is less than 500 TEU Type on the number basis and over 2,500 TEU Type on the freight space basis. Already the fourth generation container vessels with the capacity of over 4,000 TEUs has deployed and the share of over 2,500 TEU type will expect to be increase although other vessel size rang will also continue to be ordered.

(d) General Cargo Vessels

At present, the major vessel size range is 5,000 to 10,000 DWT in the number basis, and 15,000 to 30,000 DWT on the freight space basis. In the future, the total freight space is expected to increase from 132.9 million DWT in 1986 to 152.9 million DWT in 2000. The average vessel size of general cargo vessels has been stable since 1979, so the drastic change of vessel sizes will not be expected in the future.

The full load drafts of the expected vessels are as follows.

		Vessel Size	Full Load Draft
(a)	Liquid Bulk Carriers	40,000 DWT	11.3 m
		100,000 DWT	14.5 m
(b)	Dry Bulk Carriers	40,000 DWT	11.0 m
(c)	Container Vessels	Over 2,500 TEU Type	12.4 m
(d)	General Cargo Vessels	10,000 DWT	7.9 m

The following table shows the vessel size distribution of food grain carriers by age.

(Unit: %)

DWT / Age	15,000 - 30,000		30,000 - 50,000		50,000 - 90,000		Total	
0 - 10	20.3	39.4	23.4	45.4	7.8	15.2	51.6	100.0
11 - 20	25.0	51.6	12.5	25.8	11.0	22.6	48.4	100.0
Total	45.3		35.8		18.8		100.0	

The proportion of 15,000 to 30,000 DWT on the number basis is 45.3 % of the total existing food grain carriers. The share of the age 0 to 10 years is 51.6 %, almost half of the total existing food grain carriers. The proportion of 30,000 to 50,000 DWT to the existing food grain carriers of the age 11 to 20 years is 25.8 %, but the proportion of the same vessel size of the age 0 to 10 years is 45.4 %. Accordingly, newly constructed vessel size tends to be 30,000 to 50,000 DWT. The sare of 50,000 to 90,000 DWT to the respective agewise vessel numbers is 15.2 % for 0 to 10 year vessels and 22.6 % for 11 to 20 year vessels. So this range vessel does not expand its share during these 10 years.

The full load draft of 30,000 to 50,000 DWT vessels is as follows.

30,000 DWT : 10.5m
50,000 DWT : 12.0m

The following table shows the vessel size distribution of ore carriers by age.

(Unit: %)

DWT Age	0 ~ 5,000		5,000 ~ 10,000		10,000 ~ 15,000		15,000 ~ 30,000		30,000 ~ 60,000		60,000 ~ 100,000		100,000 ~		Total	
0 - 10	0.1	0.3			0.8	1.4	20.1	34.5	15.6	26.8	10.2	17.5	10.9	18.7	58.3	100.0
11 - 20					2.6	6.7	20.6	53.5	6.2	16.2	5.6	14.6	3.5	9.1	38.4	100.0
20 ~					0.1	2.8	1.6	47.2	1.6	47.2	0.1	2.8			3.3	100.0
Total	0.1				3.5		42.2		23.4		16.3		14.4		100.0	

The major vessel size range of over 20 year old is between 15,000 and 60,000 DWT. The major vessel size range of 0 to 10 year old is still 15,000 to 30,000 DWT but the share of larger vessels than 60,000 DWT increased greatly. The full load drafts over 60,000 DWT vessels are as follows.

60,000 DWT : 12.9m
100,000 DWT : 15.0m
150,000 DWT : 16.9m

Presently the objective allowable draft from the comprehensive river training scheme for improvement of the draft in the Hooghly Estuary seems to be 10.67 m. Judging from the future trend of vessel size, this allowable draft seems to be sufficient for the full load draft of general cargo vessels, but not sufficient for liquid bulk carriers, dry bulk carriers and fully cellular container vessels. The futer trend of liquid bulk carriers, especially crude oil tankers, will be expected the expansion of the so-called Suez-max tankers (100,000 to 150,000 DWT) or 60,000/80,000 to 100,000 DWT tankers. The full load draft of these tankers are respectively between 14.5 m and 17.0 m or 12.6/13.7 m and 14.5m. And the products tankers will be expected the expansion of 25,000 to 40,000 DWT, and the full load draft of this tanker range is between 10.0 and 11.3m. If the maximum allowable draft is defined by the full load draft of crude oil tankers, there will exist the need for a deep seaport. If the maximum allowable draft is defined by the full load draft of products tankers and it is possible to improve the allowable draft over 11.3 m by the comprehensive river training sheme, there will not exist the need for a new deep seaport.

The future trend of dry bulk carriers will be the expansion of less than 40,000 DWT, and the full load draft of these dry bulk carriers is less than 11.0 m. The trend of ore carriers will be the expansion of over 60,000 DWT vessels. The full load draft of these vessels is over 12.9 m.

The trend of food grain carriers will be the expansion of 30,000 to 50,000 DWT. The full load draft of these vessels is between 10.5 m and 12.0 m. The trend of fertilizer and raw material for fertilizer carriers and coking coal carriers is not so clear. But the maximum vessel size of coal carriers is 45,000 DWT at present and the major vessels belong to the vessel range of 15,000 to 30,000 DWT. And the fertilizer carriers do not occupy the position of main dry bulk carriers. So the trend of these carriers seems to be similar to the trend of overall dry bulk carriers, i.e. the expansion of less than 40,000 DWT. Accordingly, if it is possible to improve the allowable draft up to 11.0 m by the river training scheme, it will not necessary to explore the possibility of a new deep seaport.

The future trend of container vessels will be the expansion of over 2,500 TEU container vessels, but this type of vessels is used and will be used for mother vessels in main lines. So the likely calling vessels to Haldia is less than 1,000 TEU container vessels as stated in other section, therefore it will not necessary to explore the possibility of a new deep seaport.

Then conclusions regarding need for a new deep seaport from the point of view of future trends of vessel size are as follows.

① If the future allowable draft is 10.67 m, then it will be necessary to explore the possibility of a new deep seaport over 10.67 m.

② If the future allowable draft is expected to be 12.00 m, then it will not be necessary to explore the possibility of a new deep seaport excluding the consideration of crude oil tankers.

According to the result of interviews with the user Ministries, Canalizing Agencies and other parties concerned, the required vessel size by commodity is as follows.

	Present	Future	Full Load Draft
1. Grain :	(5-6,000 tons)*	15-20,000 DWT (Break Bulk Vessel)	10.3 m
		50,000 DWT (Dry Bulk)	11.7 m
2. Fertilizer & Raw Materials :	(5-6,000 tons)	20-30,000 DWT	10.3 m
3. Coking Coal :	30-40,000 DWT	65,000 DWT	11.0 m
4. Crude Oil :	87,000 DWT (30-35,000 tons)	150,000 DWT	17.0 m
5. POL Products :		20,000 DWT	9.5 m
6. LPG :	5,000 DWT	7-10,000 DWT	
7. Edible Oil :	(5,000 DWT)	20,000 DWT	9.5 m

* Note: Presently handled volume per ship due to draft restriction.

Compared the above result of interviews with the future trends of vessel size, the above result seems to be reasonable. If the vessels calling at Haldia will be partially-laden, all of the desired vessels will be use Haldia Port. It seems to be very difficult to achieve a further expansion of the draft up to over 12 m, but a more detailed study to explore the possibility of improving the draft limitations by hydraulic engineer and siltation problem experts is recommended.

Chapter 10 Navigation Safety and Navigation Aids

10-1 Initial Analysis and Recommendations

10-1-1 The Basic Policy of the New Pilotage System

Like the port of Calcutta, there are many riverine ports in the United States such as New York, Portland, Philadelphia and so forth.

The pilot boarding points of those ports are generally designated at the river mouth and masters of the inbound vessels command the vessels themselves along the buoyed channel from the open sea to the pilot station.

In the estuary of the River Hooghly, though there are some hazardous sands and bars, circumstances are similar to those of American ports and the navigable channel from Sandheads through Upper Gasper Lightship is wide enough and almost straight.

The results of our first field survey show that traffic in this area is rather light, especially crossing vessels are very rare.

Consequently, it is possible for the vessels to navigate safely from Sandheads through upper Gasper Lightship under command of their masters, provided that navigation aids are improved and well-maintained.

Furthermore, if a widened fairway, navigation aids complying with international standards and an appropriate traffic control system are established and well-maintained, masters of the vessels will be able to pass the Middleton Channel without the assistance of pilots and reach the pilot boarding point at Sagar Roads.

At the time of the first field survey, questionnaires were delivered to captains and pilots of inbound and outbound vessels asking about the possibility of passing Middleton Channel without the assistance of pilots.

In total, 37 answers were returned and 65% of the captains and pilots indicated the possibility of safe transit of the channel under certain conditions, mainly improvement of the navigation aids.

Fundamentally, the realization of the following items will be effective in improving the efficiency of pilotage and the pilots' working conditions.

(1) Set the pilot boarding point as close to Sagar Roads as possible.
(2) Abolish the existing station vessels with expensive operating costs.

(3) Set up a shore pilot station with the necessary facilities.

(4) Utilize smaller motorboats between the shore pilot station and the pilot boarding point.

Navigation from Sandheads through Sagar Roads should be studied dividing the route into two parts according to the degree of difficulty of navigation. One is the part below Middleton Channel and the other is Middleton Channel and the upper part.

The lower part, the channel from Sandheads through Upper Gasper Lightship, is wide enough and almost straight, so it is not difficult for masters of the vessels to navigate this part along the lightships provided that light buoys are properly laid on both sides to indicate the limit of the channel.

However the upper part, because of the narrow width and strong tidal current at Middleton Channel, is dangerous for masters to navigate without the assistance of pilots.

To secure safe navigation in this part, it is necessary to widen the navigable waterway at Middleton Channel, and new traffic lanes with navigation aids which comply with international standards must be established.

On top of this, a proper traffic control system using radar and communication devices must also be set up.

Based on the above-mentioned views, the following three kinds of new pilotage systems are proposed.

(1) Plan-1 : System with newly-built station pilot vessels.
("Station vessels system")

(2) Plan-2 : System of pilots boarding at Sagar Roads with a shore pilot station.
("Sagar Roads system")

(3) Plan-3 : System of pilots boarding at Gasper Lightships with a shore pilot station.
("Lower Middleton Channel system")

These systems are explained below.

Any new system will require a large initial investment and also considerable running expenses, and safety must be given top priority.

Therefore, it is important to carry out thorough investigations and examinations before the introduction of a new system.

Since navigation aids are strongly connected with each of the proposed new pilotage systems, they are considered in detail in each plan.

10-1-2 New Pilotage System

Plan-1 : Station vessel system

(A) Outline of the plan

This is fundamentally a revision of the current system replacing the old station vessels with new automated, reduced-crew vessels.

New traffic lanes between Sandheads and Gasper Lightships must be established in order to make it possible to transfer the pilot boarding point upward. With adoption of this system, the pilotage distance to Calcutta will be reduced to 95 miles, which is about 31 miles shorter than the current system.

(B) Pilot boarding point

An area between Gasper Lightships, centering 21-25.6N, 88-09.1E approximately, will be designated as the new pilot boarding point.

A considerable maneuvering area should be reserved so that the masters of the vessels are able to make good lee at the time of pilot embarking/ disembarking in rough weather, especially during the southwest monsoon season.

(Refer to Fig.-1 : Lower Traffic Lanes)

(C) Pilot vessels

The new pilot vessels will be about 1,000 gross tonnes, which is the maximum size of pilot vessels at foreign ports using similar systems.

The vessels will be highly automated in order to reduce the number of the crew as much as practicable.

Operation of pilot vessels is basically the same as under the current system. One pilot vessel on duty around Gasper Lightships either cruises or stays at anchor depending on weather conditions.

Pilots embark or disembark using a high-speed motor-boat mounted on the station vessel.

(Refer to Table-1 : Principal Particulars of Pilot Vessel/Boat)

(D) Traffic lanes

An approach channel about 3-4 miles wide and 28 miles long will be established from Sandheads to the pilot boarding point.

This channel, hereinafter called the lower traffic lanes, consists of an inbound lane, an outbound lane and the separation zone. One way traffic must be observed in each lane.

Navigation aids will be properly laid as described below, and all obstructions in the channel such as wrecks and shallow spots must be removed.

As for the appropriate depth of water, this should be studied and determined in relation to the depth of the upper route and the docks.

(Refer to Fig. 10-1-1)

(E) Navigation aids

(1) Light buoys

10 buoys will be laid at the boundaries of the traffic lanes and the pilot boarding area.

2 buoys will be laid on the center line of the separation zone.

These buoys must comply with IALA's buoyage system.

They should be not only be highly reliable and easy to maintain, but they must also be able to bear strong winds and high waves during cyclones and in the southwest monsoon season.

All buoys should be equipped with radar reflectors.

(2) Light ships

Eastern Channel Lightship will be kept at the current position and will be utilized as the target by inbound vessels.

Intermediate and Lower Gasper Lightships will be transferred to the center line of the separation zone as indicated in Fig. 10-1-1.

All lightships including Upper Gasper Lightship should be equipped with Racons and radar reflectors.

(F) Anchorage

An anchorage (about 3 miles x 2 miles) will be set up at Sandheads for vessels that are unable to proceed to the ports directly.

Four lightbuoys will be laid to mark the boundaries of the anchorage. (Refer to Fig. 10-1-1)

(G) Traffic control

In this system no particular traffic system will be introduced.

The station pilot vessel, using its radar and communication system, will stay in touch with inbound and outbound vessels and give instructions and exchange information to secure safety.

Plan-2 : Sagar Roads system

(A) Outline of the plan

The special features of this system are the pilot station on the southwest part of Sagar Island and the pilot boarding point at Sagar Roads. It is about only 2 miles from the pilot station to the pilot boarding point. This system will greatly improve the safety, efficiency and working environment of pilotage. But this system, on the other hand, requires a large initial investment for establishment of the traffic lanes in the upper part of the approach channel including Middleton Channel, navigation aids and the traffic control system. Also, the maintenance costs of this system would be considerably expensive.

(B) Pilot boarding point

An area close to the southwest end of Sagar Island, centering 21°-39'.1N, 88°-0.1'0E approximately, will be designated as the pilot boarding point.

(Refer to Fig. 10-1-2 : Upper Traffic Lanes)

(C) Pilot boats

It is reported that the wave height at Sagar Roads sometimes reaches 1.5 meters in the southwest monsoon season. Tug-boat type pilot boats would be recommended for embarkation and disembarkation of pilots in order to secure safety and stable pilotage service throughout the year.

The principal particulars of the tug-boat type pilot vessels are shown in Table-1.

Two such pilot boats would be required to maintain reliable and efficient service. The purchase of another high-speed motor boat, 20-40 gross tonnes, should be considered to offer more efficient service in good weather conditions and to prepare for the times when a tug-boat type pilot boat has to engage in towage emergency operations. The principal particulars of high-speed motor boats are also shown in Table-1.

(D) Traffic lanes

(1) Upper traffic lanes

Traffic lanes about 16 miles long and 1 mile wide will be established between Lower Gasper Lightship and Sagar Roads and connect with the lower traffic lanes described above. The Upper lanes will consist of an inbound lane, an outbound lane and the separation zone. One way traffic must be observed in each lane.

Traffic lanes should be as straight as possible. It is most essential to keep up regular surveys and dredging of the lanes to maintain the design width and depth.

(2) Lower traffic lanes

These lanes will be the same as in Plan-1.

The layout of the traffic lanes is presented in Fig. 10-1-2.

(E) Navigation aids

(1) Upper traffic lanes

16 light buoys will be laid on the boundaries of the traffic lanes and at the pilot boarding area.

3 light buoys will be laid on the center line of the separation zone. One shows the upper end of the separation zone and the others are to be located at the turning points of the lanes.

Upper Gasper Lightship will be transferred to the center line of the lower end of this channel.

These buoys must comply with IALA's buoyage system. They should also be highly reliable, easy to maintain and able to bear the strong current and high waves in this area.

Radar reflectors should be equipped on all the buoys.

(2) Lower traffic lanes

Arrangement of the navigation aids is as described in Plan-1.

The joint of the upper and lower lanes is to be buoyed as shown in

Fig.-2.

The arrangement of the navigation aids is also presented in Fig.-2.

(F) Shore pilot station

(1) The station building

The station building will be built on the waterfront facing Sagar Roads at the southwest part of Sagar Island.

This station would be a 3-story building. The caretaker's room, dining room and office would be on the first floor, 6 pilot-rooms on the second floor and the traffic control center and rest rooms for operators on the third floor.

This station should be equipped with its own power plant and water supply system for stable and regular service.

A steel tower will be built on top of the station building for the antennas of the radar, VHF and UHF systems.

(2) Basin and pontoon

A basin and pontoon for mooring the pilot boats and the landing of pilots will be provided near the station building.

A breakwater and pontoon are necessary in consideration of the long swell in the southwest monsoon season and the big range of the tide.

The basin and pontoon have to be big and strong to support the mooring of two tug-boats at the same time.

A road will be constructed between the station building and the basin, and a motorcar should be provided for transportation of the pilots.

(G) Traffic control

Local navigation rules which regulate the position reporting system, safe speed in the traffic lanes, etc. will be established.

A traffic control system consisting of radar, computer, display and control console, and communication devices will be installed in the traffic control center.

Using this system, operators on duty will be able to obtain informations about inbound and outbound vessels such as speed, course, closest point of approach to other vessels and so forth.

Chart information should also be shown on the radar scope, so operators will be able to make sure whether the vessels are proceeding properly along the buoyed lanes.

Using VHF radio, operators will maintain contact with the masters of vessels and all necessary information will be exchanged. And, if necessary, instructions and assistance will be sent by this radio.

Portable radio equipment (UHF) will be carried in the pilot's car and by personnel working at the basin so that everybody will understand the intention of the control center.

Principal particulars of the radar system and communication system are presented in APPENDIX 10-1.

(H) Anchorage

In addition to the anchorage at Sandheads, another anchorage will be arranged at Sagar Roads. This anchorage will be used by vessels that have to stay there.

4 light buoys will be laid to mark the anchorage.

To secure safety, anchoring opearations should be carried out with the assistance of a pilot.

(I) Measures to secure safety

Under Plan-2, masters are supposed to navigate the vessels themselves to the pilot boarding point at Sagar Roads with the supervision and assistance of the traffic control center.

But certain vessels including large vessels that exceed 200 meters in length and deep draft oil tankers should be handled exceptionally. These special vessels would receive pilots at the joint of the upper and lower traffic lanes.

Also, in bad weather like dense fog, proper traffic control and assistance will be essential.

These measures should be studied among the parties concerned and be clearly stated in the local navigation rules.

Plan-3 : Lower Middleton Channel system

(A) Outline of the plan

This system is an intermediate system of Plans 1 and 2.

A shore pilot station will be established instead of using station vessels.

The pilot boarding point will be set around Gasper Lightship as under Plan-1, and pilots will travel between the shore station and the vessels using tug-boat type pilot boats.

(B) Pilot boarding point

Pilots will embark and disembark vessels at the same place as under Plan-1.

(C) Pilots boats

Tug-boat type boats are recommended.

Basically tug-boat type pilot boats will secure safe embarkation and disembarkation of the pilots.

If pilots have difficulty in boarding at the designated point because of choppy sea in the southwest monsoon season, they may embark offshore or conduct the vessel from the pilot boat up the channel to obtain smoother sea conditions.

(D) Traffic lanes

Lower traffic lanes will be set up as under Plan-1.

(E) Navigation aids

Navigation aids will be the same arrangement as under Plan-1.

(F) Shore pilot station

(1) The station building

The shore pilot station will be built at the same place as under Plan-2.

The main purpose of this station is to provide accommodations for pilots and the communication center.

Considering the development of the ports and the increase of vessel traffic in the future, it is recommended to reserve room for a traffic control system which may become essential for stepping up to Plan-2.

Therefore the design and layout of the pilot station would be the same as under Plan-2.

(2) Basin and landing pontoon

The basin and landing pontoon will be the same as under Plan-2.

(G) Anchorage

The anchorage will be the same as under Plan-1.

(H) Traffic control system

No particular traffic control system is necessary at this stage, but simple local regulations, such as a position reporting system, would be established.

During difficult conditions like poor visibility, the pilot boat (tug-boat) will supervise the traffic and take necessary measures to secure safety.

10-1-3 Recommendations

In the foregoing paragraphs, three plans are introduced. Plan-1 is almost a copy of the current system. The most drastic proposal is Plan-2, and Plan-3 is an intermediate plan between plan 1 and 2.

Plan-1, being similar to the current system, is easiest to introduce, but has the problem of the costs for construction, operation and maintenance of the station pilot-vessels. Newly built pilot vessels will make it possible to reduce the number of crew to less than half, but as for the maintenance costs, there will not be much difference.

It is said that when a vessel becomes more than 10 years old its maintenance cost increases rapidly. So it is necessary to consider that this plan has the same risk of high operational cost in the future as under the current system.

Furthermore, in case the number of vessels calling at Calcutta/Haldia increases drastically in the future, say to three times the present number, this system may not be able to accommodate all those vessels.

Plan-2 is indeed a fundamental and drastic review of the pilotage system and it is the most effective in improving the efficiency of pilotage service and pilots' working conditions.

If the number of vessels calling at the port increases drastically in the future, the other two systems may not be able to handle all the traffic.

It is predicted that cargo movement will increase to more than 1.5

times the current level by around 2000-2005. If the number of vessels calling at the port increases in proportion to the increase of the cargo movement, Plan-2 should be adopted within ten years for efficient port operation, because this is the only plan that can handle all those vessels. However this system, on the other hand, requires a large initial investment, as well as high operational and maintenance costs for the traffic lanes, navigation aids and traffic control system.

Therefore, this Plan-2, is to be considered as a future objective, and in the process of revising port operations related items such as the financial and technical possibility of maintenance of traffic lanes and the rate of increase of vessel traffic should be examined and confirmed in order to avoid unnecessary investment.

Plan-3 is an intermediate plan between the other two plans.

The abolition of station pilot vessels would be effective in reducing expensive operational costs. This plan does not require the establishment of upper traffic lanes and a traffic control system, and the shift to this new system is comparatively easy. These are the favorable aspects of this plan, but despite the considerable investment for tug-boats, the shore pilot station and the basin/pontoon, the improvement of efficiency and working conditions is much less than under Plan-2.

Therefore, Plan-3 should be considered as a temporary plan during the revision of port operations and as a step towards the realization of Plan-2.

Based on the above analysis, it is recommended that the reconstruction of the pilotage system in the approach area of the River Hooghly be carried out in accordance with the following program and procedure.

(1) First, lay light buoys in the channel from Sandheads to upper Gasper Lightship and make other arrangements to prepare the Lower Traffic Lanes.

(2) Transfer the pilot boarding point to the area around Gasper Lightships and start shorter-distance pilotage service as quickly as possible. In this stage, existing pilot vessels will still be used.

(3) Start building the tug-boats, and as soon as they are delivered use them for embarking and disembarking of pilots. One of the pilot vessels is to be at anchor at Sagar Roads and used as a temporary

pilot station.

The number of crew of the pilot vessel should be reduced as much as practicable. This stage is to be considered as a modified application of Plan-3, the temporary arrangement.

(4) Review and check cargo movement and vessels calling at the port to see if they are increasing as predicted.

A thorough study should be made about the possibility of construction and maintenance of the upper traffic lanes from both the financial and the technical aspects.

(5)-(A) If circumstances require stepping up to Plan-2, start construction of the pilot station, basin and pontoon for pilot boats as well as establishment of the traffic control system and traffic lanes.

Local navigation rules are to be prepared during this period.

(5)-(B) If circumstances do not require the adoption of Plan-2 for economic or technical reasons, Plan-3 should be adopted. Construction of the pilot station and basin and pontoon for pilot-boats should be commenced.

The pilot station is to be designed considering possible modification to include a traffic control system in the future.

Note : In this report, all four lightships will be used in each new system. However, the operational costs of the lightships is unfavorably expensive, so it is recommended that those lightships be replaced by reliable, cost-saving light buoys as soon as possible.

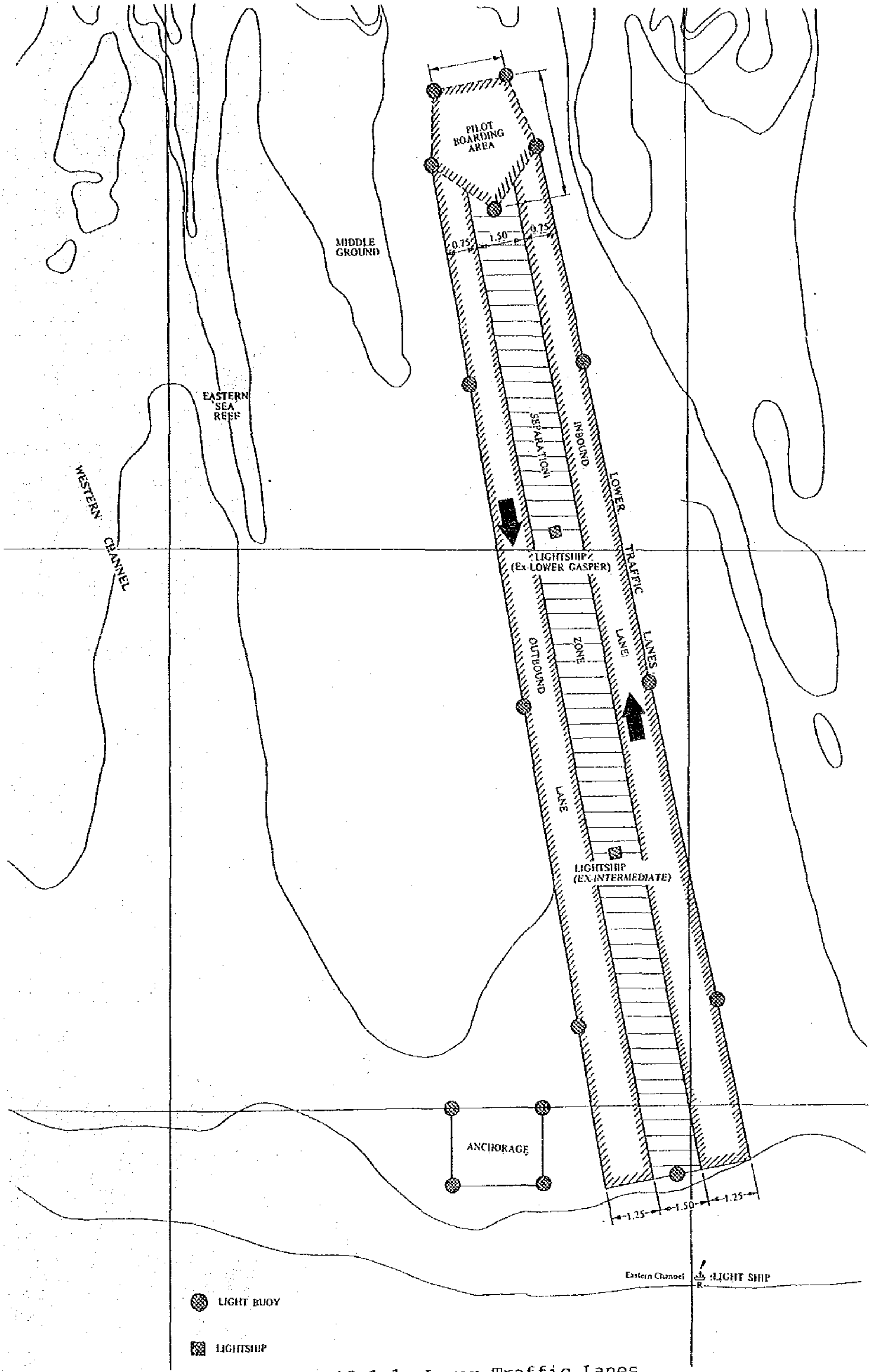


Fig. 10-1-1 Lower Traffic Lanes

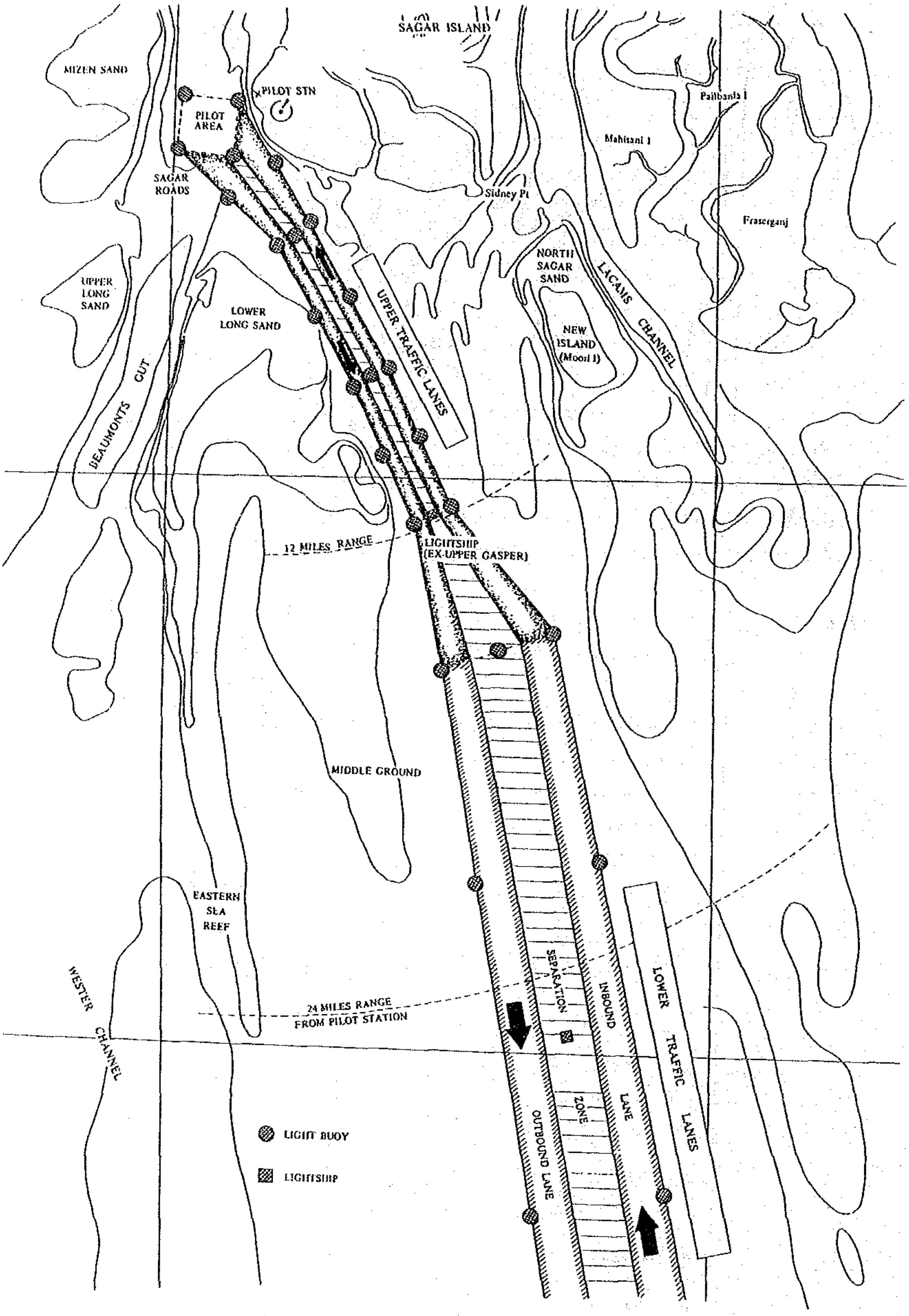


Fig. 10-1-2 Upper Traffic Lanes

Table 10-1-1 Principal Particulars of Pilot Vessel/Boat

(Unit : million yen)

	Station vessel type	Tug-boat type	Bay pilot boat type	Harbor pilot boat type
Gross Tonnage	about 1,000 tons	about 200 tons	about 40 tons	about 10 tons
Length overall	65.0 m	36.5 m	20.0 m	15.0 m
Width	12.0	8.8	5.0	3.5
Depth	5.5	3.7	2.4	1.6
Hull	Steel	Steel	H T S	H T S
Engine	Diesel x 2	Diesel x 2	Diesel x 2	Diesel x 2
PS x RPM	1,500PS x 750RPM x 2	1,500PS x 750RPM x 2	540PS x 2,200RPM x 2	300PS x 2,000RPM x 2
Propeller	Fixed	Z or Duck	Fixed	Fixed
Service speed	12 KTS	13 KTS	20 KTS	20 KTS
Accomodation				
Passengers	12	10	8	6
Crew	18	8	6	4
Navigation and Communication Equipment	Standard outfit	Standard outfit	Standard outfit	Standard outfit
Class	Lloyds	J G	J G	J G
Navigation area	Ocean going	Coastal	Coastal	Coastal
Delivery	11 months after contract	7 months	6 months	6 months
Price	1,100	450	195	150
Remarks	Fresh water tank 150m² FO tank 150m² Price includes deck-stowed small motor-boat x 2			

All principal particulars are approximate.
Prics are on the basis of FOB JAPAN.

10-2 Salient Points Raised by the Marine Department of CPT

1. The most salient points raised by the DMD on the initial recommendations are as follows.

(1) Plan 2 would be considerably expensive, and the safety aspect would also be compromised as compared to the present system, (Station Vessel System).

(2) Regarding Plan-3, whereas boarding at Gasper during the fair weather season will not prove at all difficult, boarding during the monsoon month at Gasper would be hazardous both to tug-boat type pilot vessels and to pilots due to ground swells.
Also, the overall costs (initial investment plus running costs) of plan-3 would be greater than the costs of the present Station Vessel System.

(3) It is not clear in what manner either system improves the efficiency of the Pilotage services.

(4) The present Station Vessel System is advocated by DMD considering the safety of the ships and the economic aspects.

(5) There is a possibility that the navigation channel will be shifted from the present Eastern Channel to the Western Channel.

2. The points raised by the DMD are useful for the formulation of a better alternative.

(1) In formulating this better alternatives, the following points should be taken into account.

1) Cost Comparison
Considering the overall costs (initial investment plus running costs), Plan-3 is cheaper than the present Station Vessel System as indicated as follows (Table 10-2-1).

Table 10-2-1 Comparison of Incremental Cost

Case (Existing)

1. Operating Cost		6.90
Personnel Cost		
78 Persons/Vessel x 2 x Average Pay of DMD	6.00	
Consumables		
780 KL/Year x 85 US$ / Ton	0.90	
2. Maintenance & Repair Cost		
Percentage of Construction Cost:Vessel (5%)		20.00
3. Administration and General Expenses		5.38
1 + 2 * 20% =		
4. Depreciation		13.33
a. Existing Vessels		
b. Replacement of Existing Vessels	13.33	
c. Procurement of Tug Boats		
d. Construction of Pilot Building		
e. Navigational Aid		
f. Buoys at Anchorage		
g. Traffic Control System		
5. Interest on Investment		20.28
Capital Expenditure	400 MRS.	
Interest Rate 10.75 % / Period of Loan 25 Years /		
Moratorium First 5 Years		
	TOTAL	65.89

Table 10-2-1 Comparison of Incremental Cost

Case (3)

1. Operating Cost		4.66
Personnel Cost		
19 Persons/Tug x 3 Team, + Supporting Members (20 persons)	2.98	
Consumables		
2 KL/day x 365 days / 2 Tugs x 85 US$/Ton	1.68	
2. Maintenance & Repair Cost		
-ditto-		
Vessel (5%), Pilot Bldng. (1%)		5.86
Navigation . Buoys . Traffic (4%)		
3. Administration and General Expenses		2.10
1 + 2 * 20% =		
4. Depreciation		6.41
a. Existing Vessels		
b. Replacement of Existing Vessels		
c. Procurement of Tug Boats	2.2	
d. Construction of Pilot Building	0.78	
e. Navigational Aid	1.37	
f. Buoys at Anchorage	0.17	
g. Traffic Control System	1.89	
5. Interest on Investment		17.28
Capital Expenditure	258.3 MRS.	
Interest Rate 10.75 % / Period of Loan 25 Years / Moratorium First 5 Years		
TOTAL		36.31

Table 10-2-1 Comparison of Incremental Cost

Case (4)

1. Operating Cost		8.46
Personnel Cost		
Existing Case + 19 persons for Maintaining Tugs during Monsoonseason	6.77	
Consumables		
Pilot Vessel: 1 year Tug: 6 months	1.69	
2. Maintenance & Repair Cost		
-ditto-		9.00
3. Administration and General Expenses		3.49
1 + 2 * 20% =		
4. Depreciation		3.74
a. Existing Vessels		
b. Replacement of Existing Vessels		
c. Procurement of Tug Boats	2.2	
d. Construction of Pilot Building		
e. Navigational Aid	1.37	
f. Buoys at Anchorage	0.17	
g. Traffic Control System		
5. Interest on Investment		13.76
Capital Expenditure	208.3 MRS.	
Interest Rate 10.75 % / Period of Loan 25 Years / Moratorium First 5 Years		
	TOTAL	38.45

A detailed study will be required to estimate the cost of Plan-2 because it involves the maintenance dredging cost. The overall cost can be minimized through counter-siltation technology which requires a detailed study.

2) Efficiency of the pilotage service

① Plan-2 is the most flexible and Plan-3 is more flexible than Plan-1 to overcome unexpected shortages of inbound pilots and therefore to reduce ship waiting by transporting the required pilots by land or by boat.

In more detail, in the cases of Plan-2 and Plan-3 pilots can be transported to the pilot station on Sagar Island anytime, and it will also be possible to sent pilots as required for inbound vessels.

② Plan-2 requires the least number and Plan-3 a lesser number of pilots than Plan-1 because Plan-2 and Plan-3 can easily supplement the inbound pilots by land or boat.

③ Improvement of competitiveness through reduction of pilotage charges derived from shorter distance.

3) Working environment of pilots

① Living on shore or waiting at home under Plans-2 and 3 : Pilots off duty or waiting are able to have sufficient rest at home or at the pilot station.

Plan-1 : Pilots have to come down to the Hooghly River on a vessel while on duty or off-duty through the night and must wait their turn on the pilot vessel.

② Transportation

The rudder steering-peller special tug boat is safer and more comfortable than a small pilot boat mounted on the station vessel.

③ Pilotage distance

The Pilotage distance will be reduced about 90 miles by Plan-2 and about 60 miles by Plans 1 and 3.

4) Safety aspect

Which alternative is more safe for the embarking and disembarking of pilots is controversial, because it depends upon varied factors such as the skill or expertise of pilots, local weather and sea conditions, craft and equipment and so on.

In connection with this, the following points should be noted.

① The rudder steering-peller type tug boat is far more maneuverable, powerful and modernized than the tractor-type which is used at present is extremely small and primitive, and the proposed Z-peller type tug-boat seems far more safe than the present boats. The salient features are as follows.

(a) High steering performance

Propulsion thrust can be pointed to any direction with twin Z-peller drive and the boat can quickly halt, start, spinning or side stepping.

(b) Powerful thrust

Input power is make maximized use of the kaplan propeller with a Kort nozzle.

The rudder steering-peller drive needs but small input power, about 35% to 45% less, for developing the same magnitude of thrust compared with conventional equipment.

(c) Simplified stern out fitting

The equipment is an easy-to-install packaged unit with a built-in swiveling mechanism.

Power is received from the engine through its input line formed with universal joints and drive shafts.

(d) Easy maintenance

There is no need of docking the boat to inspect the rudder steering-peller unit and can be lifted off the boat in the water.

(e) Compact remote control stand

The remote steering control is matched to the rudder steering-peller drive in every respect to enhance the advantages of this drive. Its control stand has all controls grouped together and arranged for easy steering.

② Pilotage has been carried out safely by the proposed method without any difficulty at all in the outer sea of Tokyo Bay which appears to have similar sea conditions to those at the site.

A comparison of the sea conditions is shown as follows. (Fig. 10-2-1)

However, this needs further detailed study.

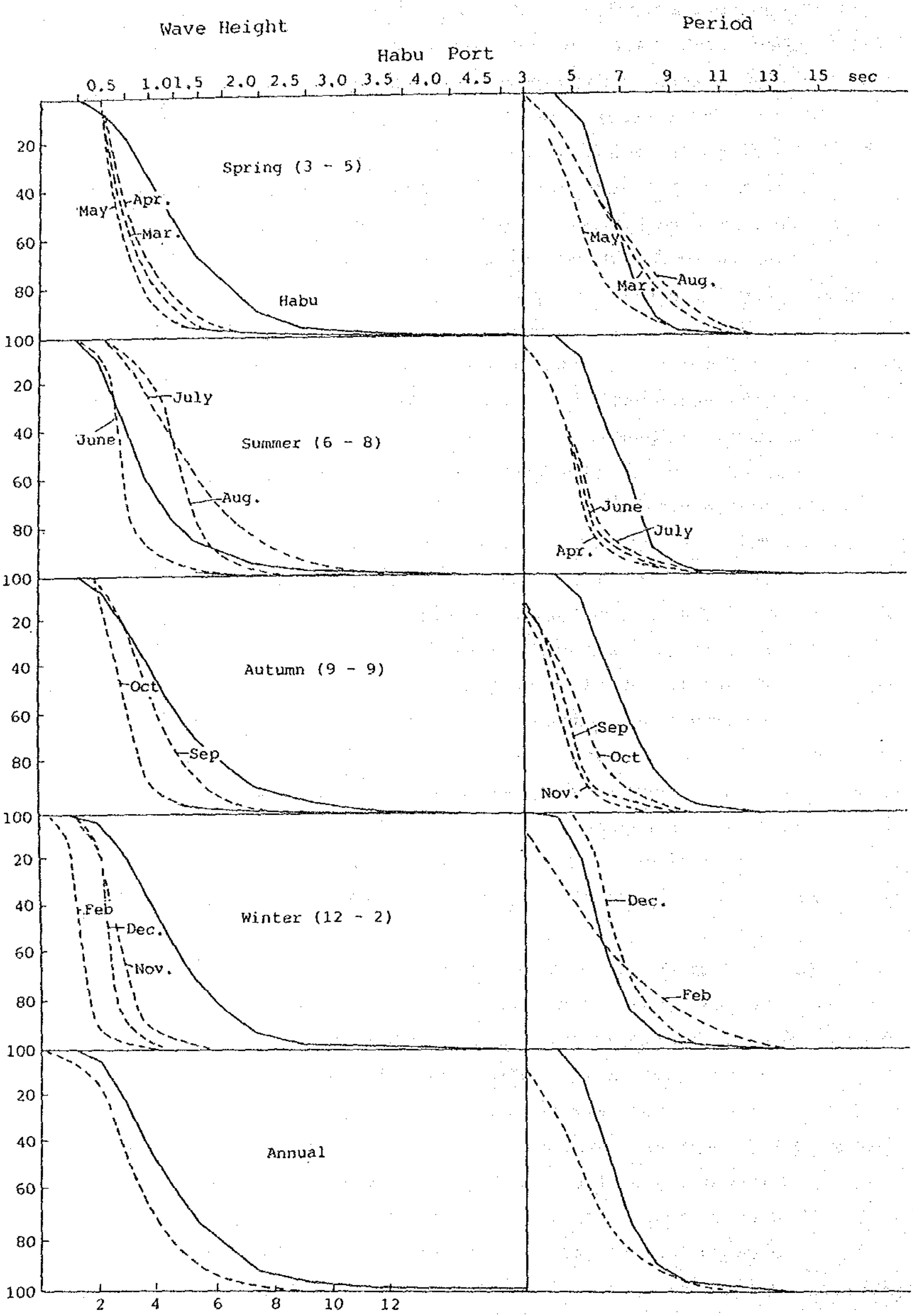
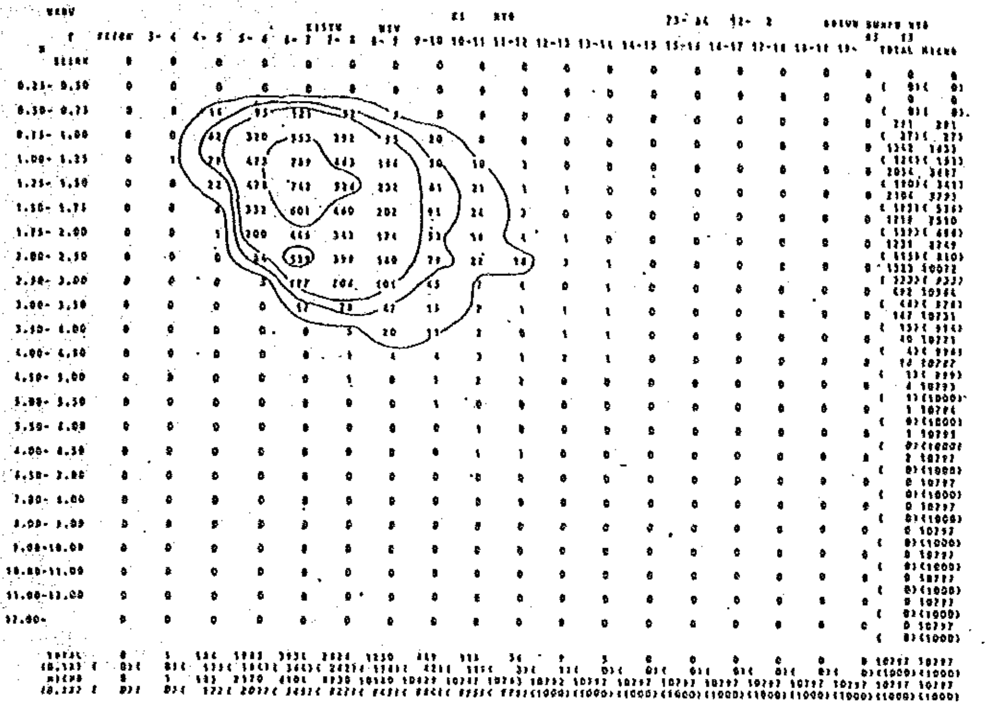

Wave Height
Period
Habu Port
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
3
5
7
9
11
13
15
sec
Spring (3 - 5)
May
Apr.
Mar.
Habu
May
Mar.
Aug.
Summer (6 - 8)
July
June
Aug.
June
July
Apr.
Autumn (9 - 9)
Oct
Sep
Sep
Oct
Nov.
Winter (12 - 2)
Feb
Dec.
Nov.
Dec.
Feb
Annual
20
40
60
80
100
2
4
6
8
10
12

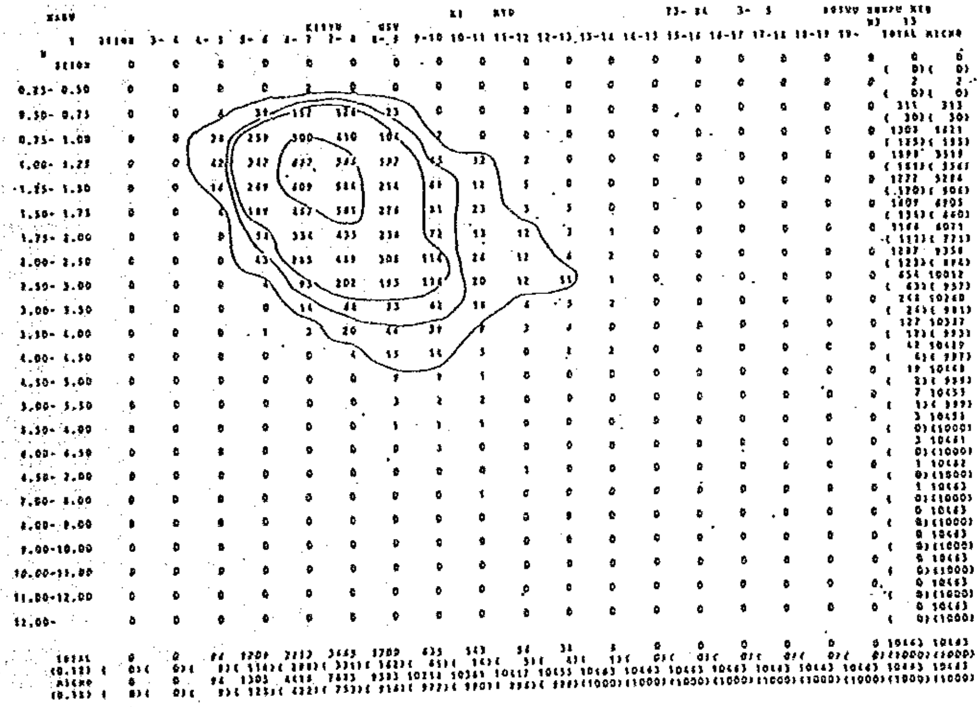
Fig. 10-2-1

Distribution of Wave Height and Period at Habu Port

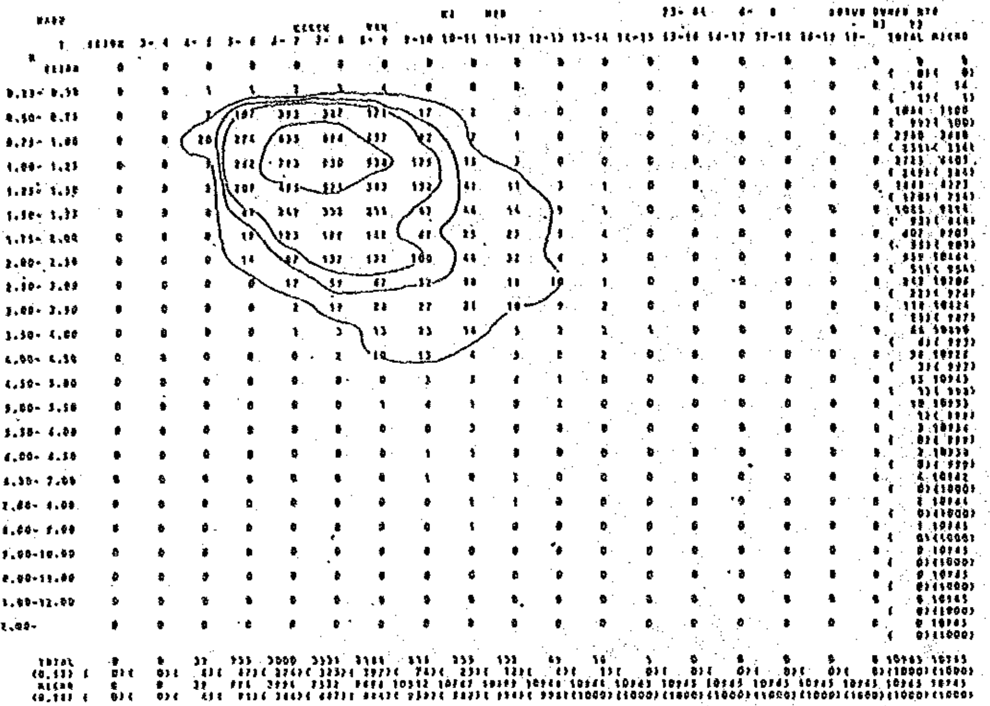
(Winter)



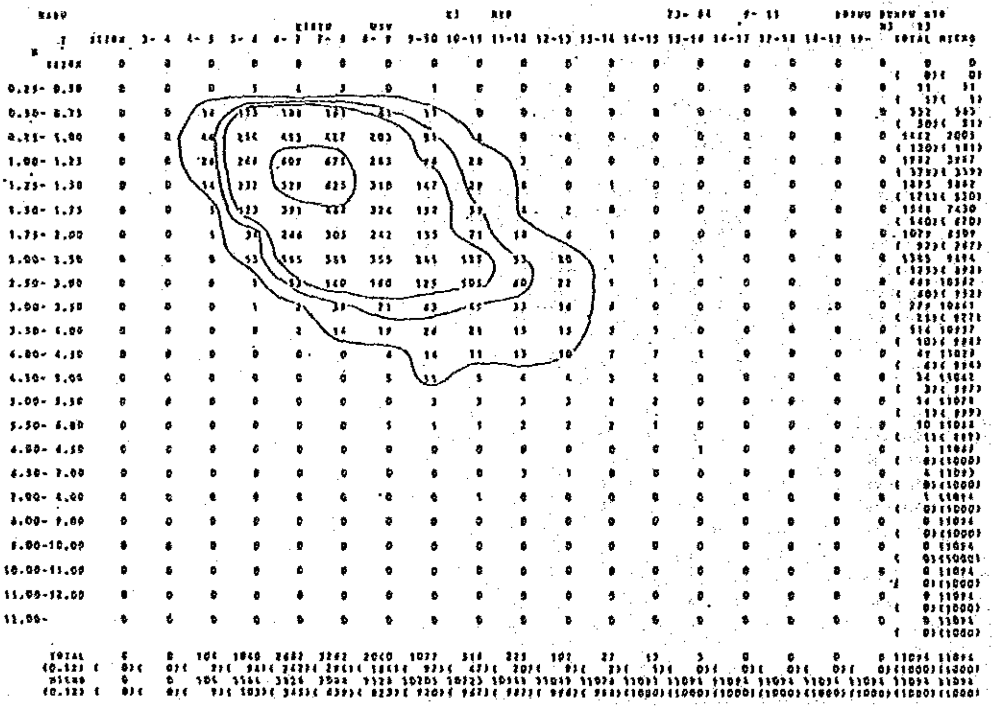
(Spring)



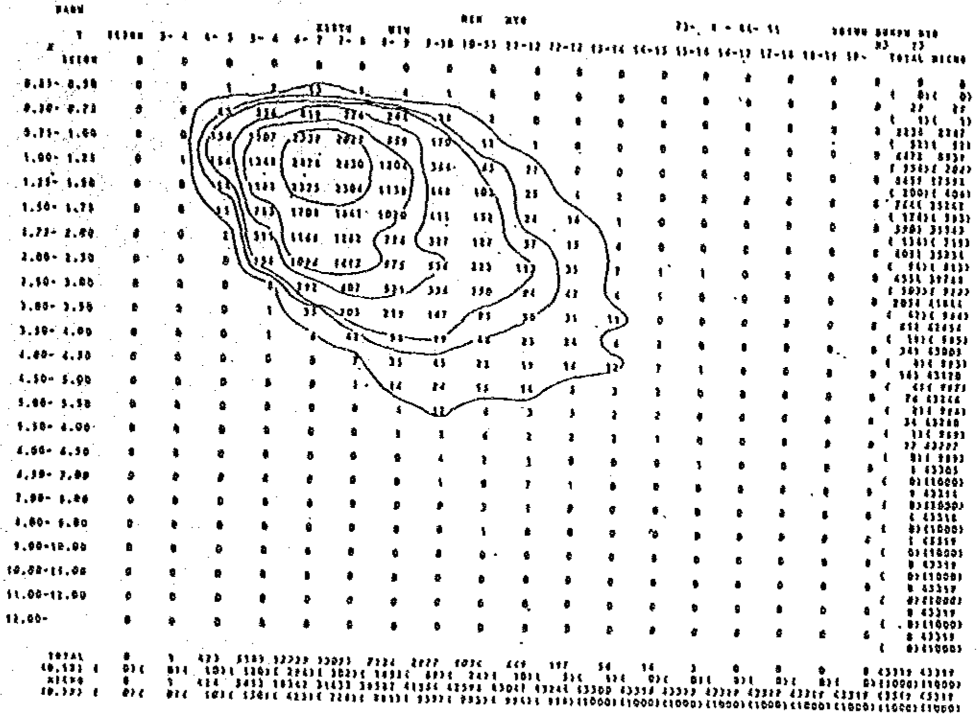
(Summer)



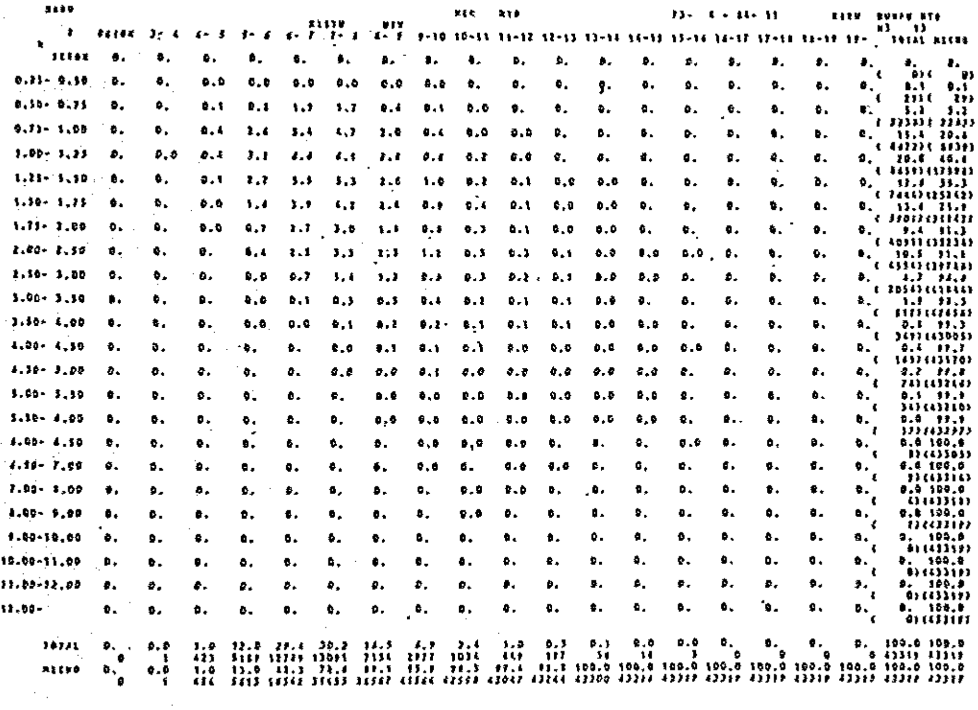
(Autumn)



Wave Height and Period (Through Year)



wave Percentage (Through Year)



③ All Japanese pilots have a master's license and sufficient experience. They receive the pilot's license after severe tests and examinations.
Every year they have to pass a physical examination.

④ A lot of ports have changed their pilotage systems to the proposed type (Plan-2 or Plan-3) from the Station Vessel System, from the viewpoint of improved safety, efficiency of port operation and economy.
For example, the following ports have changed their pilotage systems from the Station Vessel System to the new system. (Table 10-2-2)

(2) Considering all these factors, it seems that the proposed systems (Plan-2 and Plan-3) are viable, possible and beneficial to the port and the pilots.
However, there are many things which should be taken into account before a complete shift from the Present Station Vessel System, which are as follows:

1) Shifting to the new system takes time and should be carried out step by step because:

① There may be unforeseenable hidden difficulties, and those should be overcome during the shifting process.

② Familiarization by pilots and masters of the ships requires time.

2) Further detailed studies as well as discussions among Indian experts concerned will be required to proceed to the final stage (Plan-2), as follows;

① Natural conditions including
- wave / tidal current conditions in the area of Middleton and Gasper Channel
- Siltation and the countermeasures to minimize it in the area of Middleton and Gasper Channel
- condition of Western Channel

② The details of the electrical devices

③ Implementation programs

Taking all this into consideration, the final conclusions as the Team's recommendation is set forth in the next section.

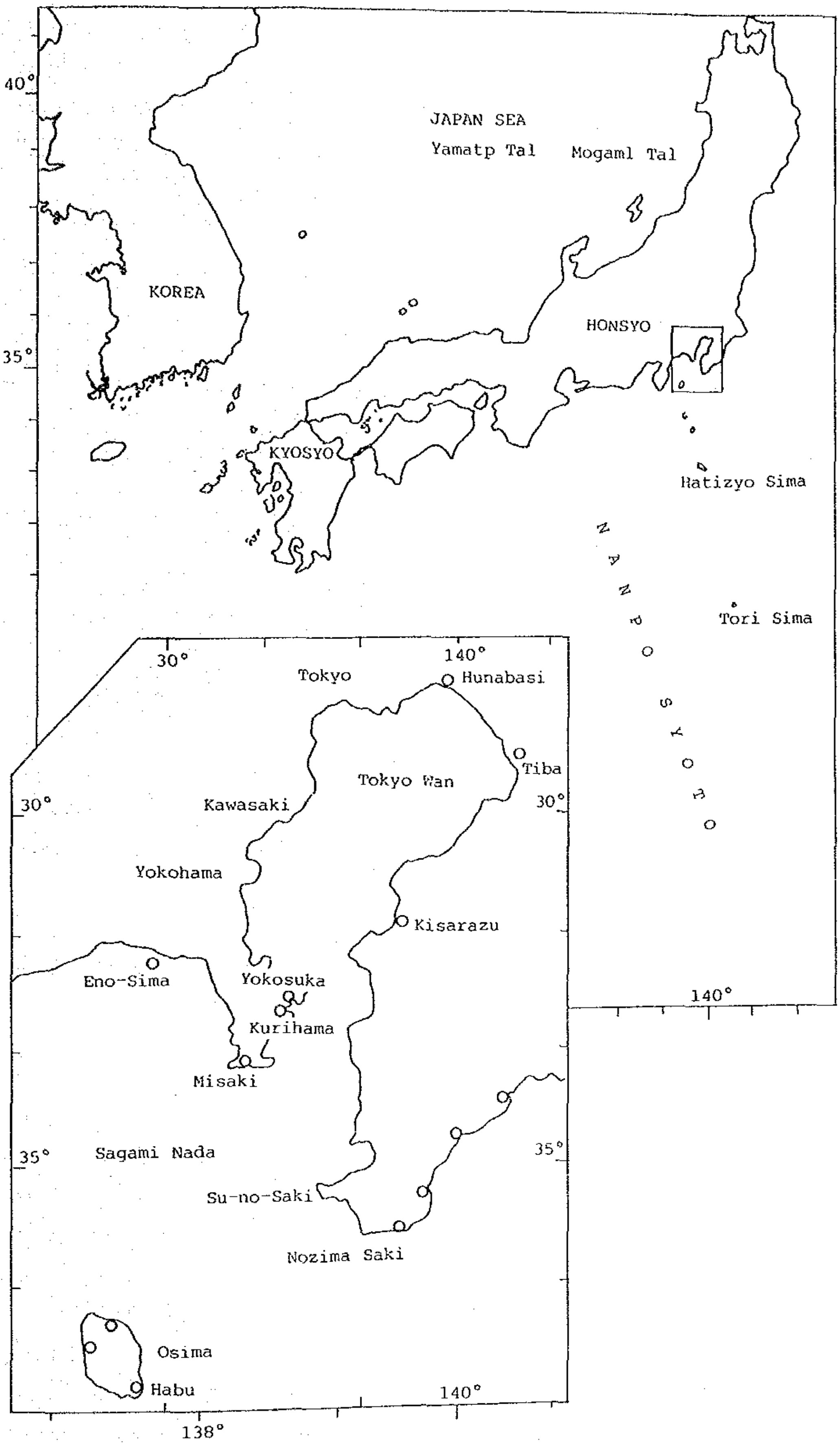


Fig. 10-2-2 Location of Habu Port

Table 10-2-2 Ports Adopted New Pilotage System

<table>
<tr><th>Port</th><th>Station Vessel</th><th>New System</th></tr>
<tr><td>San Francisco
(USA)</td><td>Sailing Vessel</td><td>85' type x 2, Speed 13 kt, Pilot: 10
65' type x 1, Speed 13 kt, Pilot: 4
service every 4 days by turns,
Reported more economical and efficient, than before.</td></tr>
<tr><td>New York
(USA)</td><td>New Jersey
G/T 988 LOA: 192'
Pilot 26
New York
G/T 779 LOA: 182'
Pilot 38</td><td>Service time ~2 months
Service time ~10 months
Chapel Hill G/T: 60, LOA: 64.5 ft
Pilot: 40, Speed 24 kt
Reported that the Station Vessels will be replaced by Chapel Hill type pilot boats in the future.</td></tr>
<tr><td>Folk Stone
(U.K)</td><td>Station Vessel was replaced by VTS center</td><td>Established VTS center on the share and transporting pilots by speed motor boats.</td></tr>
<tr><td>Rotterdam
(Holland)</td><td>Spica type x 3
LOA 213', Pilot 24 ea,
No. of crew: 22 ea,</td><td>3 spica type boats (one for inbound and the other for outbound and the think one stand-by for emergency or repair)
Recently the cabins of pilot vessels are not used practically, because the pilot tender boats (LOA: 75' and 17 1/2 kt) and helicopters are used properly.

Pilot boats for sea pilots:
<table>
<tr><th>Type</th><th>LOA</th><th>Speed</th><th>No. of pilot</th></tr>
<tr><td>Spica type Pilot Vessel x 3</td><td>213 ft</td><td></td><td>24 each</td></tr>
<tr><td>Pilot launch x 4</td><td>16 ft</td><td></td><td></td></tr>
<tr><td>Pilot tender x 4</td><td>75 ft</td><td>17 1/2 kt</td><td></td></tr>
</table></td></tr>
</table>

10-3 Conclusions

(1) The following phased plan is recommended by the study team. (Table 10-3-1)

Table 10-3-1 Phased Plan

Step No.	Plan Name	Description	Supposed Timing of Implementation
Step - 1	Plan - 4	i) 2 pilot boarding points will be used such as Sandheads and Gasper Lightships area. ii) Sandheads area is used in the SW Monsoon season by the present Pilot Vessel System and Gasper lightships area will be used in smoother seasons by tugboats as under Plan-3. iii) an approach channel will be established from Sandheads to Gasper pilot boarding point with navigation aids. iv) in the mean time, the problems which were discussed before, should be examined and clarified. v) the present pilot vessels will be used as a temporary pilot station anchoring at Sagar Roads	- 1994/95 (8th Plan)
Step - 2	Plan -4	i) the pilot boarding point will be set at Gasper Lightships area only. ii) pilots shall be transported between the shore pilot station and the vessel utilizing tug-boat type pilot boats. iii) the approach channel is as same as under Plan-4.	1995-2000 (9th Plan)
Step - 3	Plan -2	i) the pilot station is on Sagar island. ii) the pilot boarding point is at Sagar Road. iii) traffic lanes will be established and maintained constantly as planned iv) navigation aids will be laid in accordance with IALA's Standard. v) a traffic control system consisting of Radar computer, display and control console and communication devices will be installed in the traffic control center. vi) this system will greatly improve the safety, efficiency and working environment of pilotage.	2000/2005 (10th Plan)

Plan-4 : Combination System

(A) Outline of the plan

This is fundamentally a combined system with the current system and Plan-3.

In the SW Monsoon season, the current system will be carried out by the present station vessels.

And in the fair weather season, the pilots boarding point should be shifted to the Gasper Lightship area and pilots will travel between the station vessel anchoring at Sagar Roads and the vessels using tug-boat type pilot boats.

New traffic lanes between Sand-heads and Gasper Lightships must be established in order to make it possible to transfer the pilot boarding point upward.

In the meantime further detailed studies should be carried out to proceed to the final stage of the pilot system.

(B) Pilot boarding point

1) In the SW Monsoon season, the same area as under the current system.

2) In the fair weather season pilots will embark and disembark at the same area as under Plan-1.

(C) Pilot Vessels and Pilot boats

1) Pilot Vessels

The current pilot vessels will be used and operation of pilot vessels is basically the same as under the current system.

2) Pilot boats

Tug-boat type boats are recommended.

Basically rudder propeller tug-boat type pilot boats will secure safe embarkation and disembarkation of the pilots.

(D) Traffic lanes

An approach channel will be established from Sandheads to the Gasper pilot boarding point.

This channel shall consist of an inbound lane, an outbound lane and the center line, at least.

Navigation aids will be properly laid as described below, and all obstructions in the channel such as wrecks and shallow spots must be removed. As for the appropriate depth of water, this should be studied and determined in relation to the depth of the upper route and docks.

(E) Navigation Aids

1) Light buoys

At Least 6 buoys will be laid at the boundary of the traffic lanes and at the pilot boarding area.

3 bouys will be laid on the center line. These buoys must comply

with IALA's bouyage system.

They should not only be highly reliable and easy to maintain, but they must also be able to bear strong winds and high waves during cyclones and in the SW Monsoon season.

All buoys should be equipped with radar reflectors.

2) Light ships

The arrangement of the lightships is as described in Plan-1.

(F) Shore pilot station

After confirmation of the possibility of the Plan-3, the shore pilot station will be built on the Sagar Island.

The arrangement of the above facilities are as described in Plan-3.

(G) Anchorage

The anchorage will be the same as under Plan-1.

(H) Traffic control system

No particular traffic control system is necessary at this stage, and the system will be the same as under Plan-3.

(2) The stages comparison of each plans are as follows. (Table 10-3-2)

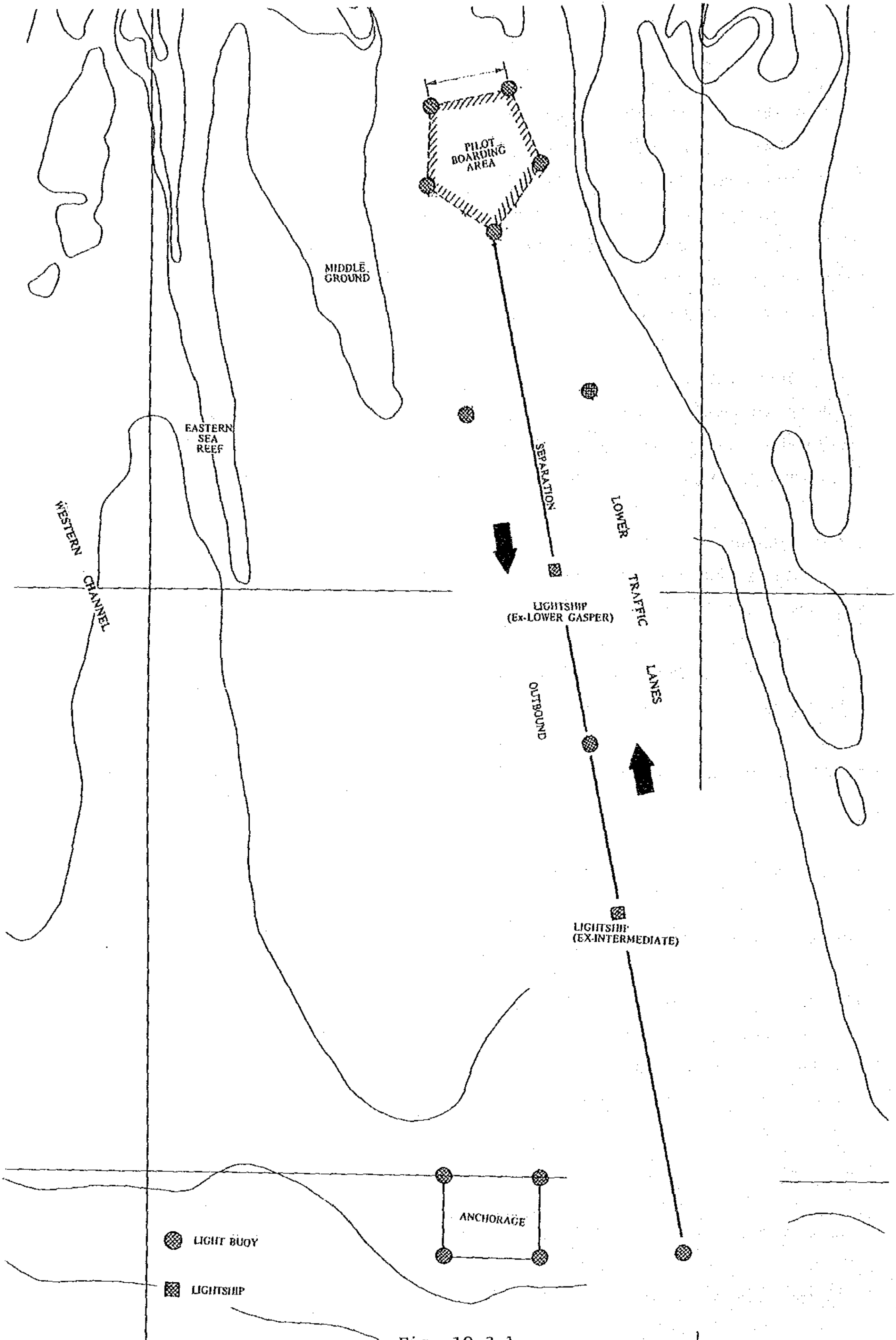

PILOT BOARDING AREA
MIDDLE GROUND
EASTERN SEA REEF
WESTERN CHANNEL
SEPARATION
LOWER TRAFFIC LANES
LIGHTSHIP (Ex-LOWER GASPER)
OUTBOUND
LIGHTSHIP (EX-INTERMEDIATE)
ANCHORAGE
● LIGHT BUOY
▨ LIGHTSHIP

Fig. 10-3-1

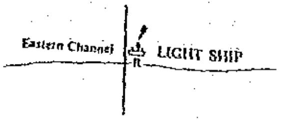

Eastern Channel
LIGHT SHIP

Table 10-3-2 Stage Comparison

	Current System	Plan-1	Plan-2	Plan-3	Plan-4
A. Pilot Boarding Points (1) Sandheads (2) Gasper channel (3) Sagar Road	Rough	Rather rough	Safer	Rather rough	Rough season Smoother "
B. Pilot Vessels (1) Mounted small-boat (2) Tug-boat	Large init-cost sometime risky	Sometime risky	Safer	Safer	Safer
C. Traffic Lanes (1) Upper traffic lane (2) Lower traffic lane	Will be surueyed and well maintained accordingly		Special cost		
D. Navigation Aids (1) Upper traffic lane (2) Lower traffic lane (3) Anchorage	Improved and well maintained accordingly	Light buoys will be laid accordingly	Laid accordingly		
E. Sagar Pilot Station (1) Station building (2) Basin & Pontoon			○ ○	○ ○	
F. Traffic Control		Radar and communication system only	Control center and system	Pilot station on sagar Island	Pilot vessel at sagar Roads
G. Distance Reduced	○	62 miles	92 miles	62 miles	0 - 62 miles
H. Stage Number			3	2	1

Chapter 11 Formulation of Master Plan

11-1 Calcutta Dock System (Including Budge Budge District)

11-1-1 Fundamentals of Master Plan

(1) General

In accordance with the port development policy stated in Chapter 9, Calcutta Dock System will mainly handle break bulk cargo and container cargo at the target year of the Short-term Development Plan, 1995, and the Master Plan, 2005. In spite of this basic policy, at Budge Budge District and some berths in Calcutta Dock System, liquid bulk cargo is now handled for firms located near the waterfront. These firms intend to continue their activities, and consequently liquid bulk cargo will continue to be handled.

Dry bulk cargo such as fertilizer, raw materials for fertilizer, coal, salt, and food grains is handled at some berths of Calcutta Dock System. Some of the dry bulk cargo handling will be transferred to Haldia Dock System, but other cargo will continue to be handled at some berths in Calcutta Dock System, because the consigners of those cargoes are located in the vicinity of the port area and will continue their activities there.

(2) Overall Evaluation of Existing Facilities

The Calcutta Dock System is located along the River Hooghly some 201 km away from the Sandheads river estuary. Because of draft limitations, the inbound vessels must use the high tide and cannot use their full capacity. There are numerous difficult places for maneuvering in the River Hooghly from Sandheads to the Calcutta Dock System.

In order to mitigate this difficult condition, CPT has made a program to deepen the shipping channel approaching the Calcutta Dock System to a depth of 7.4m by 1995 and 7.9m by 2005.

Becouse there are many difficult conditions for vessel maneuvering such as bars, bends and bores; the draft limitation which forces vessels to wait for high tide; and the long distance approach, the turn-round time of vessels from Sandheads to Sandheads is very long as shown in Table 11-1-1.

Table 11-1-1 Turn-round Time from Sandheads to Sandheads (Calcutta Dock Sytem)

(In days)

COMMODITY	1986-87	1985-86
i) Liquid Bulk Cargo		
a) Mineral Oil	4.40	4.19
b) Other Oil	5.36	5.15
ii) Dry Bulk Cargo		
a) Food grains	5.80	-
b) Fertilizer	20.52	27.85
c) Raw materials for fertiliser	11.94	22.08
d) Salt/Coal	28.59	49.17
e) Average of (ii)	18.67	28.92
iii) General Cargo	12.15	16.64
iv) Average of (i+ii+iii)	11.45	15.30

The long turn-round time deters some shipping firms from using the Calcutta Dock System.

The Calcutta Dock System consists of three docks: Netaji Subhas Dock (hereinafter referred to as NSD), Kidderpore Dock One (hereinafter referred to as KPD1) and Kidderpore Dock Two (hereinafter referred to as KPD2).

The construction works of KPD1 and KPD2 started in 1893 and NSD was constructed in 1928. These docks are very old and this contributes to the present problems of the Calcutta Dock System. The oil wharf at Budge Budge (hereinafter referred to as BB), located 13 miles downstream from the Calcutta Dock System, is also very old, and was constructed in 1886.

Because of the age of the facilities and due to other operational problems analyzed in Chapter 6, the Calcutta Dock System is now having many problems.

(3) Identification of Major Problems

There are several problems in the Calcutta Dock System as follows.

1 Low cargo handling productivity using manual handling.

2 Shortage of capacity of cargo handling equipment.

3 Shortage of open space within the docks, in particular cargo handling space for using mechanised equipment.

4 Shortage of parking space within the dock area and in the vicinity of the dock gates.

5 Low utilization of covered storage areas.

6 Road congestion in and around the dock area.

7 Inefficiency of cargo handling by rail between transit sheds and the hinterland.

8 Uncertainty of information and documentation system.

9 High berth occupancy rate and frequent berth shifting.

10 Lock restrictions.

11 Draft restrictions and difficulty of the approach channel

12 Narrow water area within the docks and bridge restriction

(4) Analysis of Existing Port Capacity

The current working berths in the Calcutta Dock System and at Budge Budge Jetties are as shown in Table 11-1-2. Judging from the sample data

Table 11-1-2 Current Working Berths

Calcutta

District	Berth	Berth Dimensions			Cargo Handling Amount				Berth Occupancy	
	Name	L	B	D	1984-85	1985-86	1986-87	1987-88	Rate in 1986-87	Major Commodity
		m	m	m	1000ton	1000ton	1000ton	1000ton	%	
K.P.D 1 (10B)	1	133	18.3	9.15	98	104	61	70	66.5	Gen. Log Fer.
	3	128	18.3	9.15	85	97	100	117	53.1	Gen. Con. Log
	4	136	15.2	9.15	24	34	60	85	62.2	Gen.
	5/7	229	18.3	9.15	109	110	103	128	86.5	Gen.
	6	118	15.2	9.15	66	47	53	56	85.4	Gen.
	8	128	15.2	9.15	80	90	74	93	71.2	Gen. Fert.
	9	108	18.3	9.15	123	118	105	114	70.4	Gen.
	10	161	15.2	9.15	92	81	93	97	84.1	Gen.
	11	151	18.3	9.15	82	77	100	82	80.0	Gen.
	12	143	15.2	9.15	98	110	79	103	62.7	Gen. Fert.
	Lock	157	21.9		858	867	829	945		
K.P.D 2 (8B)					(28)	(48)	(47)	(48)		
	22	151	12.2	9.15	37	43	37	32	53.6	Gen.(Pass.) Gen.
	23	147	12.2	9.15	78	124	100	80	60.5	Gen.(pass.) Gen.
	24	152	12.2	9.15	86	115	86	103	66.8	Gen.
	25	169	12.2	9.15	85	112	108	111	65.4	Gen. Log
	26	185	12.2	9.15	94	114	106	93	71.2	Gen.
	27	195	21.3	9.15	89	112	112	137	87.9	Gen. Log. Heavy
	28	195	21.3	9.15	112	92	87	140	63.8	Gen. Lor. Heavy Fert.
	29	183	21.3	9.15	107	117	114	135	86.5	Gen. Lor. Heavy
	20	147	9.3	9.15	50	63	59	9	52.0	Coal(stop operation)
	Lock	157	21.9		738	893	809	840		
N.S.D (9B)	A	174	15.2	9.15	121	135	135	122	66.3	Gen. Fert.
	B	174	15.2	9.15	136	120	137	123	70.6	Gen. Fert. Con. Log.
	C	152	Dolphin	9.15	167	131	120	112	35.6	POL(Lub.Oil)
	D	192	21.3	9.15	174	207	191	200	75.6	Con.
	1	200	13.7	9.15	99	89	107	119	81.0	Gen. Con. Heavy
	2	187	15.2	9.15	134	116	125	163	83.0	Gen Con. Log.
	3	183	15.2	9.15	141	109	122	153	86.5	Gen. Con. Log.
	4	181	12.2	9.15	134	118	108	149	85.2	Gen. Con. Log.
	5	183	12.2	9.15	106	143	180	179	70.6	Gen. Con.
	Lock	172	24.4	9.15	1,214	1,167	1,225	1,320		
BB (5B)	1	189	25.9		157	162	192	334	69.8	POL Vag.O.
	2	102	25.9		90	90	71	94	43.2	POL Veg.O.
	3	163	25.9		520	71	63	79	34.2	Bunk. Veg.O.
	5	189	25.9		138	265	293	255	58.9	POL Veg.O.
	8	189	25.9		155	154	140	187	30.6	POL Veg.O.
					1,061	741	759	1,898		
					3,871	3,668	3,622	5,003		

from vessel cards during November and December 1987 and January 1988, many of these berths are used as multi-purpose berths handling general cargo, container cargo and dry bulk cargo. The details of the relationships between respective berths and cargoes are shown in **Appendix 10-1-1.**

KPD2 now has 8 working berths handling general cargo, dry bulk cargo and passengers. Container cargo is sometimes handled at KPD2, but it is carried by conventional general cargo vessels. Half of No. 22 berth of KPD2 was used for passengers. No. 23 berth of KPD2 is allocated for food grains but is generally used for general cargo handling. No. 20 berth of KPD2 was allocated for coal handling but has recently stopped operation. KPD2 is located on the inner side of KPD1, so the vessels which use the berths in KPD2 must pass through a lock entrance 157m long and 21.9m wide, and through the 2 narrow waterways of Swing Bridge and Bascule Bridge. The berth occupancy rate of the respective berths was between 52 % and 88 % in 1986-87 and the throughput was 809 thousand tonnes. The berth occupancy rate was extreamely high but the cargo volume was not so large.

KPD1 now has 10 working berths handling mainly general cargo. The berth occupancy rate is also extremely high but the handling cargo volume is not so large. Berth No. 3 of KPD1 is allocated for container vessels but is used as a multi-purpose berth handling general cargo too. Dry bulk is also handled at some berths in KPD1.

NSD has 9 current working berths. Berths No. D and 5 are mainly used for handling container cargo, but other general cargo is also handled. Berth C of NSD is used for handling liquid bulk cargo. The berth occupancy rate of C berth is not so high but that of the other berths is very high.

There are now 5 working berths at BB. They are used for handling liquid bulk cargo and the berth occupancy rates of these berths are not so high.

The general level of berth occupancy rates can be summarized as follows.

① Liquid bulk cargo
The berth occupancy rate is not so high and the berths can handle more cargo without improvement of productivity.

② Dry bulk cargo
The berth occupancy rate for the coal berth is comparatively high as a single berth. The berth occupancy rate for the other dry bulk cargo berths is greatly influenced by other cargo handling,

particularly general cargo handling.

③ Container cargo and general cargo
The berth occupancy rate of the container and general cargo berths is extremely high and these berths cannot handle more cargo without improvement of productivity.

As shown in **Appendix** 11-1-2, the effective berth number for respective cargoes is as follows.

① Liquid bulk cargo berth	3	
② Dry bulk cargo berth	4	
③ Container cargo berth	4	22
④ General cargo berth	18	

(5) Present Vessel Movement

Inbound vessels arrive at Sandheads at first, and after pilot boarding they travel the River Hooghly up to the Calcutta Dock System. Because of draft limitations, some of them must wait at Sandheads for high tide in order to get enough depth for safe navigation.

In Appendix 11-1-3, we illustrate the characteristics of vessel movement by analyzing the vessel cards during April 1987 and March 1988. In Appendix 11-1-4, we illustrate the characteristics of vessel dimensions and arrival time distribution obtained by analyzing the sample data of the vessel cards during Nov. '87, Dec. '87, and Jan. '88.

From the sample data of vessel cards, the arrival draft of vessels is distributed from 2m to 7m, and the length over all is distributed from 50m to 170m.

As shown in FIg. A11-1-3-9(5) and (6) the arrival draft of break bulk cargo vessels having a length over all of some 155m varies form 4m to 7m. On the other hand, the full load draft of break bulk cargo vessels of some 155m is about 8.9m by using the relationship between the full load draft and the length over all stated in Appendix 11-1-6. Accordingly, the vessels using the Calcutta Dock System are only partially loaded.

From Fig. A11-1-3-1 and Fig. A11-1-4-2, the arrival time distribution was found to be an exponential distribution and the arrival of vessels at Sandheads is random.

From the sample data of vessel cards, the period after the pilot boarding time to the arrival time at the Calcutta Dock System does not change greatly and the period from the departure time from the Calcutta Dock System to the arrival time at Sandheads again does not vary so much.

After arriving at the Calcutta Dock System and passing through the lock entrance of wet docks, vessels arrive at berth and loading or unloading starts. Before starting the loading or unloading, some idle time at berth such as for opening the hatches of vessels is necessary, and also after finishing the loading or unloading, additional idle time at berth to prepare for departure is necessary. As shown in Table 11-1-3, total time at berth consists of time lost at berth and time worked at berth.

In case of full berth utilization, vessels wait at Sandheads until a berth becomes available.

Table 11-1-3 Average Service Time at Berth
(1986/87, days)

Commodity	Working Time at Berth	Lost Time at Berth	Total Time at Berth
1) Liquid Bulk Cargo	1.28	1.10	2.38
a) Mineral Oil	1.19	1.06	2.25
b) Other Oil	1.53	1.21	2.74
2) Dry Bulk Cargo	8.43	5.04	13.47
a) Food Grains	1.55	2.60	6.89
b) Fertilizer	8.51	4.41	12.92
c) Raw Materials	5.97	3.81	9.78
d) Salt/Coal	9.85	8.68	18.53
3) General Cargo	6.24	4.64	10.88
4) Container Cargo	2.35	0.97	3.32
Average	4.75	3.35	8.10

(6) Model for Determing the Number of Berths

Neglecting the traveling time from Sandheads to the Calcutta Dock System, the queueing model for determing the proper number of berths is a tandem queue. That is, at first, the vessel that arrives at the lock entrance must wait when the lock is occupied by other vessels. Next, the vessel that has passed through the lock must also wait when the berths are occupied by other vessels.

The service time at the lock entrance is not clear but reportedly is about 30 minutes per vessel. For the deep draft vessels that arrive at Sandheads, the allowable period to enter the stream per high tide is about 2 hours. Considering this situation, the capacity of the lock entrance for