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FEASIBILITY STUDY
VOLUME I
FINAL REPORT

FERTILIZER IMPORT SYSTEMS

PREPARED FOR

BANGLADESH AGRICULTURAL
DEVELOPMENT CORPORATION

FEASIBILITY STUDY
FINAL REPORT
BULKHANDLING AND BAGGING FACILITIES

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FEASIBILITY STUDY
FINAL REPORT
BULK HANDLING AND BAGGING FACILITIES

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SECTION 1

INTRODUCTION

1.1 GENERAL

The Government of Bangladesh, through the Bangladesh Agricultural Development Corporation (BADC), has contracted with Soros Associates to provide engineering and consulting services for a study to cover the importation of bulk fertilizer to the country.

The contract between BADC and Soros Associates, financed by the United States Agency for International Development (USAID) under USAID grant number 388-0024, was signed on 12 August 1978. The notice of issuance of the USAID letter of committment is dated 1 September 1978 and the effective date of the contract is 16 September 1978.

The Contract includes the feasibility study and the conceptual design of the facilities for importation of bulk fertilizer and examination of domestic TSP production alternatives as defined below.

Volume I of this report deals exclusively with the findings and recommendations of the feasibility study of import alternatives. Appendices to Volume I are furnished in a separate binder.

The report covering the feasibility of domestic TSP production versus importation of phosphate fertilizer is furnished in Volume II.

Volume III is the complete report furnished by the Jacobs Engineering Group. This report covers the evaluation of the use of the TSP factory facilities for the domestic manufacture of TSP and other phosphate fertilizers. It also discusses the options of conversion to other fertilizer manufacture.

The Conceptual Design - Phase I will be undertaken upon approval of the findings and recommendations contained herein.

An initial environmental examination (IEE) is a deliverable requirement of the Conceptual Design - Phase I. A draft copy of the IEE report is required concurrent with submission of the feasibility study report. The draft of this IEE report is submitted under separate cover.

1.2 OBJECTIVE

The objective defined for this study is: to identify recommended modes of operation to import bulk fertilizer into Bangladesh through the ports of Chittagong and Chalna, and from Chalna Port to a site in the Khulna area which will be a reception and transshipment facility for bagged fertilizer destined for delivery to the western portions of Bangladesh.

1.3 SCOPE

In order to realize the objective of the feasibility study, the scope of the study was divided into several elements as follows:

- Define the historical and forecast the future quantities of bulk fertilizers imported to Bangladesh for the past ten years and the future ten years and establish a rational distribution of these products between Chittagong and Chalna Port.

- Establish an integrated system for bulk ship unloading, storing and bagging of fertilizer at Chalna Port.

- Select a site in the Khulna District that will have a facility to store the bagged fertilizers received through Chalna Port. The criteria for this site will require access for barges from Chalna Port and eventual access to the Mungla/Khulna highway and railroad systems, which will be used to distribute the bagged fertilizer from the Khulna District Transshipment Terminal throughout the countryside.

- Develop the near-term and long-term transportation mode to be used to carry the fertilizer from Chalna Port to the Khulna District Transshipment Terminal.

- Establish an integrated system of bulk ship unloading, storing, reclaiming and bagging of fertilizer at Chittagong. The originally approved scope of this study defined the site of the storage and bagging facility to be on or adjacent to the site of the existing TSP plant operated by the Bangaldesh Chemical Industries Corporation (BCIC) in Chittagong. Subsequently, this scope was enlarged to include the feasibility of unloading bulk vessels at an offshore platform with transport of bulk product via a conveyor to shore,

where a bulk storage and bagging facility would be provided. This facility could be independent of the TSP plant.

- Include, for the offshore platform, an analysis of potential savings for handling other bulk borducts such as cement, cement clinker, coal, foodgrain and crude oil.

- Analyze alternative manufacturing options regarding the existing TSP plant relative to importation of bulk TSP and other fertilizers. These alternatives would include an economic comparison of the following:

  - Discontinuance of TSP manufacture,
  - Upgrade the TSP plant to full capacity as designed,
  - Upgrade the TSP plant to full capacity using imported phosphoric acid,
  - Converting the existing TSP plant to manufacture other fertilizers such as Nitro-Phos, Cal Ammonium Nitrate, DAP or MAP.

It is to be noted that, though this report is covered by the title "Feasibility Study" it is not a feasibility study in the normal definition used by USAID. Developed alternatives for each of the defined scope items are compared on technical and a simple economic cost basis to determine the best overall solution to the realization of defined objectives. Economic justification for the importation of bulk fertilizer has been established by other studies.

1.4 PROJECT LOCATIONS

Fertilizer will be brought into the country through the two main seaports in Bangladesh. Chittagong, in the eastern area of Bangladesh, is the foremost seaport of the country. Chalna Port, administered by the Chalna Port Authority, is located in the western part of Bangladesh on the Pusur River. Chalna Port is about 70 miles north of the Bay of Bengal and is located at the juncture of the Pusur and Mongla Rivers. Khulna is a river port approximately 25 miles north of Chalna Port. Chittagong, Chalna Port and the Khulna district are the areas of primary concern in this report. Figure 1-1 shows the locations of these areas.

A more detailed description of the existing facilities at each of these locations and the recommendations for rehabilitation and modernization of these facilities is contained in subsequent portions of this report.

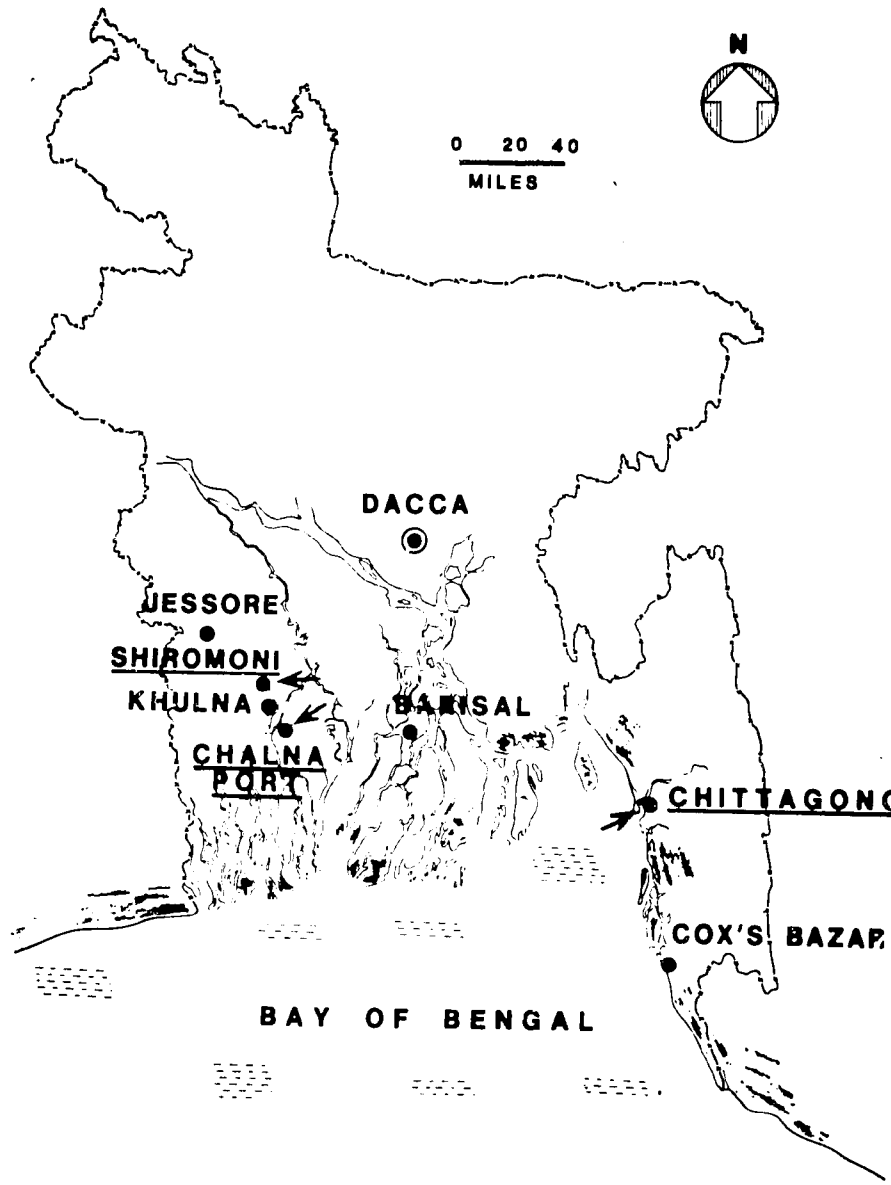


FIGURE 1-1: PROJECT LOCATION MAP

SECTION 2

FINDINGS AND RECOMMENDATIONS

2.1 FINDINGS

2.1.1 General

The results of this study show that it is both technically feasible and economically justified to construct unloading and transport facilities in Bangladesh to receive and store bulk fertilizer and other bulk products, using vessels up to 32,000 DWT size, at both the ports of Chittagong and Chalna without need of dredging or construction of breakwaters.

Present fertilizer imports are already over 600,000 tons per annum and are expected to rise to 1,600,000 tons by FY 1989/90. In fact, recent records show that for the year ending 1978 the country imported 648,000 tons of bagged fertilizer. Had the country been equipped to receive this cargo in bulk, there would have been savings of between $18.00/ton and $36.00/ton in the costs for bulk over bagged cargo, depending on the type of unloading facilities employed. This would have resulted in C & F savings of between 12 and 23 million dollars on 648,000 tons.

However, because of a lack of adequate unloading and storage facilities, all fertilizer is imported in bags and continued imports of over 600,000 tons per annum cannot be achieved in bags without seriously upsetting the balance of other cargo handled at the ports of Chittagong and Chalna. The inevitable result will be congestion and long queues of ships waiting to be serviced. Demurrage charges will be considerable and shipping companies will be reluctant to accept charters to Bangladesh. Therefore, apart from the economic benefits of switching to bulk, it is mandatory that the country be equipped to receive and store the fertilizer at unloading cadences with storage spaces that are compatible to high yearly tonnages and this can only be achieved with bulk cargo.

The mere switch from bag to bulk is significant, however, considerable additional efficiencies and economies can be realized if the country is also able to receive and dispatch larger vessels of the 25,000 DWT to 32,000 DWT class. Here again, the unloading cadence at the ports will determine the availability of such vessels.

The bulk receipt and storage of fertilizer and related bagging operations should be located only at the ports of Chittagong and Chalna, whereby, depending on the size and type of consignment, Chittagong will remain the first port of call and Chalna the second and all inventories will be controlled from these two locations. Further in-country distribution will origniate from these two ports only with all barge distribution from Chalna Port and road and rail from Chittagong.

2.1.2 Chittagong

The port of Chittagong is extremely crowded with shipping. Its jetties operate at close to 100 percent berth occupancy.

For fiscal year 77/78, the Port of Chittagong imported 4,685,000 tons of cargo of which 3,256,000 tons was dry cargo. Of this total, 1,376,000 tons was received in bulk (foodgrains, clinker and coal) which represents 40% of the total dry tonnage. This percentage is expected to rise to over 50% when fertilizer import is changed to bulk and to 60% if finished cement imports are also changed from bagged to bulk.

This is significant considering that the basic character of the facilities at the port of Chittagong is that of a general cargo port. Thus, the inner harbor at Chittagong is not suited for bulk cargo handling if the maximum economies are to be realized.

The whole premise of handling cargo in bulk is to reduce freight costs. Therefore, todays typical bulk handling berths are equipped with high speed handling equipment that is compatible to large size bulkers. The combination of faster ship turn around time and fewer voyages reduces freight costs considerably. The make-up of Chittagong Port with all jetties located on the Karnaphuli River makes it unfeasible to

commission a true bulk berth within the port complex wihtout the use of a costly dredging program to increase the draft. There are depth restrictions which limit the draft of entering ships to not more than 24 feet. Therefore, vessels of greater draft must be lightered prior to entry. In addition, the port has a restriction on vessel length of not more than 585 feet.

Because of the draft limitation and the restriction on vessel length, the port jetties can accommodate only small general cargo ships (8000 ton average payload) at unloading rates that are adequate for general cargo but considerably lower than normal for bulk shipments.

Given these conditions, the consultant has investigated locations at the outer anchorage on the Bay of Bengal, where there is sufficient depth to berth bulkers up to 32,000 DWT class. Here an offshore platform with conveyor connection to the industrial complex can be constructed to serve as a high speed bulk unloading berth. This scheme is defined as the "Offshore Platform" alternative. Expansion of the port's bulk handling capacity to the offshore area will contribute considerably toward relieving the over crowding presently experienced at the Karnaphuli jetties.

If the present level of cargo were handled at berth occupancy levels which are normal for ports such as Chittagong, six additional jetties on the river would be required. However, since a great portion of the cargo is or could be in the form of loose dry bulk, additional jetties on the Karnaphuli will not really afford the level of cost economies regularly associated with bulk shipments. It is not economical to lighter large, 32,000 DWT, bulk carriers in the anchorage nor is it possible for these vessels to enter the inner port even when lightered. Yet large vessels and quick unloading are the path to realization of the kinds of cost savings which are achievable. One offshore platform with its high-speed unloading equipment will handle 2,000,000 tons of bulk cargo per year.

Located at the outer anchorage, the platform will handle the tonnage equivalent to ten jetties on the Karnaphuli River at considerably

lower freight costs and at the same time greatly relieve port congestion. It will accommodate vessels up to 32,000 DWT. Freight savings of at least $12.00 per ton or $24 million per year will be realized.

In addition to a bulk freight handling scheme using an offshore unloading berth, the consultant has developed a plan which uses the TSP jetty and a high capacity bulk shuttle vessel with its own loading and unloading equipment. This is known as the "Shuttle Bulker" alternative. With an upgraded conveyor system, compatible to the bulker's capacity to unload, some of the cost benefits of modern bulk handling can be realized. However, this system has a limited capacity as dictated by the available occupancy of the TSP jetty berth and the need to lighter every delivery vessel in the outer anchorage via the shuttle bulker. This means double cargo handling but at a speed considerably greater than present conditions allow.

A study was made of five potential bagging plant sites in and around the existing Chittagong TSP factory. Of those studied only two were considered suitable. One site, called Site D, is in a presently unoccupied location on the west side of the Azia Patenga Road. The other, Site E, would utilize the facilities of the existing TSP factory. The Site E location could only be used if the present TSP manufacturing process were shut down and the facilities dedicated as an imported bulk fertilizer bagging plant.

Each of the two alternative systems were examined for each of the two bagging plant site locations. Capital and operating costs for each of the alternatives were developed. Capital and operating costs were reduced to costs per ton for each of several discrete throughputs so that comparisons could be made.

Concurrent with the study of import schemes, a careful study of present and rehabilitated uses of the TSP factory for manufacturing TSP were made. Then, manufacturing options were compared with import options on an economic basis. This study is presented in detail in Volume II of this report. It is concluded that the domestic manufacture of TSP is not economical compared to using the TSP factory facilities for a bulk fertilizer reception and bagging center.

Having reached this conclusion, a comparison of importation alternatives resulted in the definition of the offshore platform alternative as superior to the shuttle bulker alternative. The platform system results in a lower cost per ton, will handle the full forecast of fertilizer plus other products to a total of 2,000,000 tons per year. The shuttle bulker system has a maximum capacity of 600,000 tons per year, imposed by the occupancy limitations of one jetty. Thus the shuttle bulker system will be incapable of carrying the forecast of fertilizer beyond 1987/88.

2.1.3 Chalna Port

Chalna Port is on the Pusur River approximately 70 miles from the Bay of Bengal. It is presently undeveloped as a port. However, construction of five jetties is almost complete and it is being developed in accordance with a port master plan. Like the Karnaphuli River, the limiting draft to the Pusur river is also 24 feet, however, there are no vessel length restrictions and its location is as far up river as is feasible to afford access by ocean going ships up to 32,000 DWT class which have offloaded about 43% of their cargo at Chittagong.

Alternative locations of the bagging facility at Chalna Port and along the Pusur River were examined. However, since Chalna Port had been selected as the site of a major port in this area and since construction is well advanced, consideration of alternate locations for the fertilizer import complex was limited to the Chalna Port complex. Several arrangements for the facility within the port complex were examined. These alternatives are discussed in the body of the report but have no significant impact on the overall capital cost of the facility.

2.2 RECOMMENDATIONS

2.2.1 General

The conclusions lead to the primary recommendations that: the TSP factory site be used as a bulk fertilizer reception and bagging facility; and the offshore platform concept be adopted as the method of bulk ship unloading at Chittagong.

The construction program for full implementation of the platform concept requires five years. Therefore, other schemes were examined to take early advantage of the potential cost savings which are available when importing fertilizer in bulk rather than in bags. From this examination a program of progressive bulk material importing capacity was developed. Three stages of development were defined as follows.

- Initial Stage: A 3 year program to begin immediately (FY 79/80) and run through FY 81/82.
- Interim Stage: A 2 year program to be operational by FY 82/83 and run through FY 83/84.
- Final Stage: To be operational by FY 84/85.

2.2.2 Initial Stage

Bulk delivery vessels will arrive at the Chittagong anchorage. There they would be lightered only to the extent required to enter the Karnaphuli River. Both the lighter and the delivery vessel would proceed to the TSP jetty where unloading via ships' gear would procceed using the existing TSP factory conveyors.

Lighters, of the barge type, would be unloaded with a mobile clamshell crane located on the TSP jetty. After unloading the cargo consigned to Chittagong, the delivery vessel would proceed to Chalna Port where the remainder of the fertilizer cargo would be bagged on ship and discharged in bags. This system will require the negotiation of a freight charter for bulk cargo with an add on rate per ton for each ton of product bagged on ship and discharged. Details of the discharge requirements for bags will have to be stipulated. The shipper would be responsible for bagging and stevedoring. In case a "Bag-on-Ship" charter cannot be made, it is recommended that portable bagging equipment be placed at Chalna to handle the forecasted throughput. The recommended program could begin by November 1979. If portable bagging is needed at Chalna Port, in the event that "Bag-on-Ship" arrangements cannot be made, that system could be ready by April 1980. Using the recommended scheme, the forecast of fertilizer

can be met during the duration of the Initial Program, which lasts until July 1982. At Chittagong 200,000 tons per year can be handled through the TSP facilities and the remainder bagged on ship and discharged at general cargo jetties. Based upon the forecast an average of 108,000 tons per year will have to be bagged on ship at Chittagong. At Chalna Port the throughput for "Bag-on-Ship" will average at 412,000 tons per year.

There is no new equipment investment required for this stage and the cumulative savings over present bagging import costs will be about $40 million over three years.

2.2.3 Interim Stage

The interim stage would begin in FY 82/83 at which time full fertilizer facilities at Chlana and all on shore fertilizer facilities at Chittagong will become operational. At this time, the offshore platform and approach conveyor at Chittagong will still be 2 years away from completion. Therefore, to take advantage of the already completed facilities at both ports, it is recommended that one self-loading/unloading bulker be chartered for dedicated service at Chittagong to shuttle between the outer anchorage and the TSP jetty. The "shuttle bulker" would load itself from the delivery vessel at the anchoarage and discharge to an upgraded conveying system at the TSP jetty for transfer to the storage and bagging plant located at the TSP factory site.

After being partially unloaded the delivery vessel will sail to Chalna Port where it can be unloaded by shore based equipment. All unloaded fertilizer at Chalna would be delivered to the new bagging plant.

Using the TSP facilities has an economical advantage in that, to modify it for the final stage, it requires about $16 million less capital investment than to construct a new bulk reception and bagging facility.

2.2.4 Final Stage - Chittagong

The recommended scheme for Chittagong is described in Section 7.

For the final stage at Chittagong it is recommended that the shuttle bulker be discontinued and a bulk unloading platform be installed about 1½ miles offshore in the Bay of Bengal with an approach conveyor connecting the offshore platform to the bulk storage and bagging complexes. This platform and conveyor would be completed and be operational by FY 84/85 and will replace the self-loading/unloading shuttle bulker. The location of the platform is in a natural deep trench. Vessels up to 32,000 DWT may sail from deep water on the tide and berth directly at the platform. Lightering is no longer required, hence, the shuttle bulker is no longer needed. The trench is self-scouring, therefore, no dredging is required. The offshore platform is located in an unprotected area but after detailed study of historical weather and oceanographic conditions and their effect on a ship's mooring at this location, the consultants have concluded that the platform can be operational as a fair weather berth for 8 months of an average year. Even at this limited availability the platform is capable of receiving annual throughputs of 2,000,000 tons per year and therefore will be capable of handling other bulk products such as finished cement, foodgrains and clinker. As demonstrated in Section 12, the savings realized for this variety of products when compared to present import methods is considerable.

2.2.5 Final Stage - Chalna Port

The recommended scheme for Chalna is described in Section 8. At Chalna, site selection is fixed by the existence of the Mongla jetties. Here new bulk storage and bagging facilities will be constructed on land immediate to the northern most jetty. The complete fertilizer facilities will be operational by FY 82/83 and will be designed to receive partially loaded vessels up to 32,000 DWT size which have already offloaded about 43% of their cargo at Chittagong.

2.2.6 Khulna District Transshipment Station

Three sites in Khulna and one in Shiromoni were examined as Khulna District Fertilizer Transshipment Stations. The existing BADC facility at Shiromoni is recommended for this

function. The site is adequate for the throughput. It has river front facilities which can be readily developed and it is in relatively close proximity to the main line railroad which is destined to distribute about 75 percent of the total volume passing through the station.

2.2.7 Transport Chalna Port to Khulna District

In order to handle the projected forecast of 470,000 tons per year of bagged fertilizer from Chalna Port to Shiromoni, a fleet of eight 1,000 DWT barges plus one 1,700 horsepower, pusher type, river towboat is recommended.

SECTION 3

FERTILIZER IMPORTS, HISTORY AND FORECAST

3.1 GENERAL

The accurate forecasting of bulk fertilizer imports for the country of Bangladesh is made difficult by the diverse factors which affect the outcome. On the one hand we have the agronomic needs of the land and some data which relates the increase of yield to fertilizer usage. On the other hand, we have historical evidence that fertilizer application has not been near the optimum use rate. This is in part due to the fact that foreign exchange has been lacking. Therefore, much of the fertilizer import volume has been dependent upon donor nations' grants, which are not amenable to long term forecasting. On top of this are the production rates experienced by domestic fertilizer manufacturing facilities. Many difficulties, which have reduced the expected domestic fertilizer production, have been experienced. This section presents the historical record of fertilizer usage and production, a forecast of fertilizer use and domestic production and an estimated agronomic demand for fertilizer, which have all been made by others. From these a forecast of imports has been made and criteria established for purposes of import system design.

3.2 HISTORICAL FERTILIZER USE AND PRODUCTION

Table 3-1 shows the history of fertilizer usage for the years from 1967/68 through 1977/78. The tabulated year runs from 1 July through 30 June. In addition, on the same table, the history of internal production is shown along with the resulting fertilizer imports for the same period.

It can be seen that the use of fertilizer in the country is increasing, however it is still far below the usage rates which are required from an agronomic standpoint. Table 3-2 shows the estimated agronomic fertilizer requirements of Bangladesh in 1976/77. Based upon this analysis, the total tons of annual fertilizer needed at that time was estimated at over 4.5 million tons.

TABLE 3-1

HISTORICAL FERTILIZER USE AND DOMESTIC PRODUCTION*

(1000's LT)

Year	Consumption				Domestic Production				Imports			
	Urea	TSP	MP	Total	(A) Urea	(B) Urea	Urea Total	(C) TSP	Urea	TSP	MP	Total
1967-68	152	48	11	211	109	-	109	-	43	48	11	102
1968-69	160	53	12	225	87	-	87	-	73	53	12	138
1969-70	196	66	15	277	94	-	94	-	102	66	15	183
1970-71	212	76	18	306	55	44	99	-	113	76	18	207
1971-72	170	60	14	244	46	-	46	-	124	60	14	198
1972-73	277	89	18	384	39	172	211	-	66	89	18	173
1973-74	268	94	18	380	60	218	278	-		94	18	112
1974-75	176	76	18	270	58	11	69	30	107	46	18	171
1975-76	312	111	22	445	52	225	277	48	35	63	22	120
1976-77	349	124	22	495	-	-	294	46	-	-	-	107
1977-78**	459	195	43	697	-	-	251	41	260	100	38	398

* Bangladesh Agricultural Development Corporation

** Final 3 months prorated.

(A) Fenchuganj

(B) Ghorasal

(C) Chittangong

TABLE 3-2

FERTILIZER REQUIREMENTS FOR BANGLADESH - 1976/77

Major Crops	(1,000 Acres) Area Cultivated	Nutrient Recommendations (lbs/Acre)			Nutrient Recommendations (1,000 MT)			Fertilizer Requirements (1,000 MT)		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	Urea	TSP	Potash
Aus: i) HYV	901	80	60	40	32.8	24.6	16.4	71.3	53.5	27.3
ii) Local	7,050	60	60	40	192.3	192.3	128.2	418.0	418.0	213.7
Aman: i) HYV	1,046	100	80	60	47.5	38.0	28.5	103.3	82.6	47.5
ii) Local	13,308	60	60	40	362.9	362.9	242.0	788.9	788.9	403.3
Boro: i) HYV	1,338	100	80	60	60.8	48.7	36.5	132.2	105.9	60.8
ii) Local	744	40	40	40	14.1	14.1	14.1	30.7	30.7	23.5
Jute	1,602	40	20	40	29.1	14.6	29.1	63.3	31.7	48.5
Sugarcane	357	150	80	80	24.3	13.0	13.0	52.8	28.3	21.7
Wheat: i) HYV	288	80	60	40	10.5	7.9	5.2	22.8	17.2	8.7
ii) Local	107	40	40	40	1.9	1.9	1.9	4.1	4.1	3.2
Potato	385	150	100	100	26.2	17.5	17.5	57.0	38.0	29.2
Tobacco	116	70	20	40	3.7	1.0	2.1	8.0	2.2	3.5
Maize	6	90	40	60	0.2	0.1	0.2	0.4	0.2	0.3
Vegetables	310	150	30	30	21.1	4.2	4.2	45.9	9.0	7.0
Fruits	310	120	75	75	16.9	10.6	10.6	36.7	23.0	17.7
Tea	96	80	---	---	3.5	-----	-----	7.6	-----	-----
Cotton	17	30	15	25	0.4	0.2	0.2	0.9	0.4	0.3
Condiments	341	30	25	25	4.6	3.9	3.9	10.0	8.5	6.5
Oil Seeds	666	30	60	30	9.1	18.2	9.1	19.8	39.6	15.2
Others	1,149	60	40	20	31.3	20.9	10.5	68.0	45.4	22.7
TOTAL	30,167				892.7	794.6	571.3	1,941.7	1,727.2	960.6

Source: USAID/Dacca Estimates based on Bangladesh Bureau of Statistics, crop reports for 1976/77 and Bangladesh Soils Fertility and Soil Testing Institute recommendations for fertilizer.

3.3 FORECAST OF FERTILIZER IMPORTS

There have been a number of widely varying forecasts of fertilizer consumption made in the past. For example, predictions of fertilizer demand for 1989 have ranged from 1,500,000 tons to double this amount. Since domestic production forecasts cover a wide range, import predictions based upon the above data are subject to an even greater variation than the total demand predictions. In general, previous import predictions have been off the mark on the low side when compared with actual records for the periods projected.

Given this disparity, it has been concluded that the best approach to establishing design criteria for the system is to develop a solution which will handle fertilizer imports over a range of reasonable expectancy. Further, the recommended system has been examined from a justification standpoint at lower volumes.

Table 3-3 displays a summary forecast of fertilizer imports starting in the year 1978/79 for the condition where TSP is manufactured domestically. For the next two years TSP is assumed to be produced at increasing rates using the same process as in present use and afterwards at an improved rate based upon the recommentation of the Jacobs Engineering Group for their Alternative II as described in Volume III of this report. Table 3-4 is a forecast of imports assuming that the TSP factory is shut down and that no TSP is produced domestically. As qualified above, annual domestic production of urea and TSP are shown. All imported phosphate fertilizer is assumed to be DAP and the import requirement for urea has been reduced to account for the nitrogen in the imported DAP. For the case in which TSP is manufactured domestically, the annual imports of bulk material have been increased for the amount of phosphate rock, which is required to operate at about 90 percent of design capacity, a reasonable annual rate. When this quantity of bulk material is added to the total import volume forecast for the TSP manufacture case, the total annual bulk import requirements for the two cases are not greatly different.

Figure 3-1 shows a plot of the derived national forecasts with and without TSP production and a plot of import levels assumed for design

TABLE 3-3

BULK FERTILIZER IMPORT FORECAST WITH TSP PRODUCTION
(1,000's TPY)

FISCAL YEAR	% SALES INCREASE		UREA	TSP	DAP	MP	SUBTOTAL	STORAGE INCR'MT	TOTAL IMPORT	43% CHITTAGONG (3)	57% CHALNA
78/79	12	S	506	194	-	45					
		P	230	40	-	-					
		D	-	-	-	-					
		I	276	154	-	45	475	62	537	231	306
79/80	25	S	633	-	180	56					
		P	285	62	-	-					
		D	92	-	-	-					
		I	275	124 (1)	180	56	635	78	713	253	460
80/81	15	S	728	-	200	64					
		P	283	78	-	-					
		D	80	-	-	-					
		I	365	156 (1)	200	64	78	59	844	314	416
81/82	15	S	836	140	180						
		P	495	140	-						
		D	72	-	-	-					
		I	269	50 (2)	180	74	573	67	640	303	336
82/83	15	S	962	280	88	85					
		P	674	280	-	-					
		D	36	-	-	-					
		I	252	100 (2)	88	85	525	76	601	315	286
83/84	15	S	1106	280	143	98					
		P	820	280	-	-					
		D	57	-	-	-					
		I	229	100 (2)	143	98	570	89	659	340	319
84/85	10	S	1217	280	185	107					
		P	820	280	-	-					
		D	74	-	-	-					
		I	323	100 (2)	185	107	715	67	782	393	389
85/86	10	S	1339	280	232	118					
		P	820	280	-	-					
		D	93	-	-	-					
		I	426	100 (2)	232	118	876	75	951	465	485
86/87	10	S	1472	280	283	130					
		P	820	280	-	-					
		D	113	-	-	-					
		I	539	100 (2)	283	130	1052	82	1134	545	589
87/88	7	S	1576	280	323	139					
		P	820	280	-	-					
		D	129	-	-	-					
		I	627	100 (2)	323	139	1189	64	1253	596	657
88/89	7	S	1686	280	365	149					
		P	802	280	-	-					
		D	146	-	-	-					
		I	720	100 (2)	365	149	1334	67	1401	659	742
89/90	7	S	1804	280	410	158					
		P	820	280	-	-					
		D	164	-	-	-					
		I	820	100 (2)	410	158	1489	72	1561	728	833

LEGEND

S - Forecasted Annual Sales for Urea, Includes Urea Equivalent in DAP.
P - Forecasted Annual Domestic Production.
D - Equivalent Urea Tonnage in Imported DAP.
I - New Forecasted Import Tonnage.
Storage Increment is Amount Required by Year to be Added to Storage to Maintain 5 Months Buffer Stock in Country.
(1) Import Quantity Includes Rock Phosphate and Sulfur for Domestic TSP Manufacture.
(2) Import Quantity Includes Rock Phosphate for Domestic TSP Manufacture Using Imported Phosphoric Acid.
(3) Chittagong Import Includes 43% Imported Fertilizer plus All Raw Materials for TSP Plant Operation.

TABLE 3-4

BULK FERTILIZER IMPORT FORECAST WITHOUT TSP PRODUCTION
(1,000's TPY)

FISCAL YEAR	% SALES INCREASE		UREA	DAP	MP	SUBTOTAL	STORAGE INCR'MT	TOTAL IMPORT	43% CHITTAGONG	57% CHALNA
78/79	12	S	506	154(1)	45					
		P	230	-	-					
		D	-	-	-					
		I	276	154	45	475	62	537	231	306
79/80	25	S	633	242	56					
		P	285	-	-					
		D	97	-	-					
		I	251	242	56	549	78	627	270	357
80/81	15	S	728	278	64					
		P	288	-	-					
		D	111	-	-					
		I	329	278	64	671	59	730	314	416
81/82	15	S	836	320	74					
		P	495	-	-					
		D	128	-	-					
		I	213	320	74	607	67	674	290	384
82/83	15	S	962	366	85					
		P	674							
		D	146	-	-					
		I	142	366	85	593	76	669	288	381
83/84	15	S	1106	423	98					
		P	820	-	-					
		D	169	-	-					
		I	117	423	98	638	89	727	312	415
84/85	15	S	1217	465	107					
		P	820	-	-					
		D	186	-	-					
		I	211	465	107	783	67	850	366	484
85/86	10	S	1339	512	118					
		P	820	-	-					
		D	205	-	-					
		I	314	512	118	944	75	1019	438	581
86/87	10	S	1472	563	130					
		P	820	-	-					
		D	225	-	-					
		I	427	563	130	1120	82	1202	517	685
87/88	7	S	1576	603	139					
		P	820	-	-					
		D	241	-	-					
		I	515	603	139	1257	64	1321	568	753
88/89	7	S	1686	645	149					
		P	820	-	-					
		D	258	-	-					
		I	608	645	149	1402	67	1469	632	837
89/90	7	S	1804	690	158					
		P	820	-	-					
		D	276	-	-					
		I	708	690	158	1557	72	1629	700	929

LEGEND

S - Forecasted Annual Sales for Urea, includes Urea Equivalent in DAP.
P - Forecasted Annual Domestic Production.
D - Equivalent Urea Tonnage in Imported DAP.
I - New Forecasted Import Tonnage.
Storage Increment is Amount Required by Year to be Added to Storage to Maintain 5 Months Buffer Stock in Country.
(1) For 78/79 This is TSP.

over the next 10 years. The lower design curve shows the forecast for Chalna POrt, the upper design curve shows the national design forecast. The Chittagong forecast is the portion between the curves. The drop showing in the forecast of imports from 1980/81 to 82/83 is due to the Ashugnaj plant comming on stream. The curve with TSP production includes the TSP raw materials. Since the TSP plant is assumed in one case to operate as at present for 2½ years, the import requirements are higher for those years with production than without it because the present process requires that twice as much raw materials be imported than the fertilizer producted. This changes after the assumed plant conversion takes place in 1981.

The national fertilizer import level is set at 1,600,000 tons per year for purposes of final system design. The design criteria curves establish the basis for system capacity targets during the initial and interim stages.

Table 3-5 shows the forecast of domestic production on which the import forecasts shown in Tables 3-3 and 3-4 are made. It is assumed that Ashuganj will come on stream at 40% of capacity. From 1983/84 and onward, all domestic urea production is leveled at 85% of capacity. The prediction for TSP production is based upon a conversion of the existing plant to operate using imported phosphoric acid as discussed in the Jacobs Engineering Group report which is furnished in Volume III of this report.

TABLE 3-5

FORECAST OF DOMESTIC FERTILIZER PRODUCTION
(1,000 MT)

YEAR	FENCHUGANJ UREA	GHORASAL UREA	ASHUGANJ UREA	TOTAL UREA	CHITTAGONG TSP	TOTAL PRODUCTION WITH TSP	TOTAL PRODUCTION WITHOUT TSP
1978/79	25	205	---	230	40	270	230
1979/80	70	218	---	285	62	347	285
1980/81	70	218	---	288	78	366	288
1981/82	70	218	209	495	140	635	495
1982/83	75	235	364	674	280	954	674
1983/84	90	285	445	820	280	1100	820
1984/85	90	285	445	820	280	1100	820
1985/86	90	285	445	820	280	1100	820
1986/87	90	285	445	820	280	1100	820
1987/88	90	285	445	820	280	1100	820
1988/89	90	285	445	820	280	1100	820
1989/90	90	285	445	820	280	1100	820
1990/91	90	285	445	820	280	1100	820
1995/69	90	285	445	820	280	1100	820

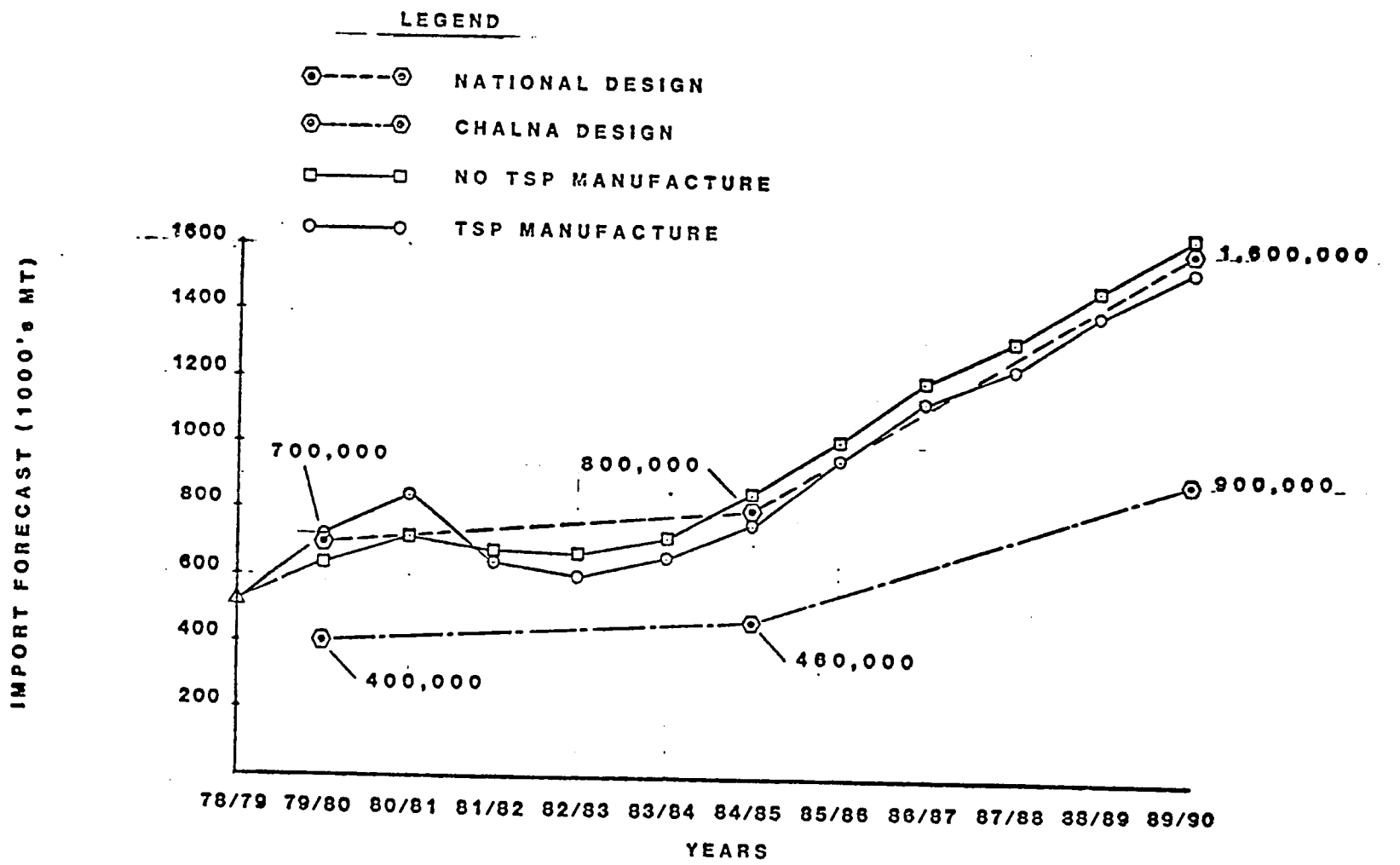


FIGURE 3-1 FERTILIZER IMPORT FORECAST

SECTION 4

FERTILIZER IMPORT PROGRAM - SYSTEM DESCRIPTIONS

4.1 GENERAL

This section describes the fertilizer import system as it exists for bagged cargoes including current costs; and develops a cost for importation of fertilizer in bulk using present bulk handling operating methods. This bulk handling cost establishes a base case for further comparison with improved systems which are capable of handling the increased quantities of fertilizer forecast for the future. In addition, the rationale for certain basic design assumptions, and a recommended change of internal distribution pattern are presented along with conceptual descriptions of the two alternative bulk fertilizer import systems which have been developed for comparative analysis as final solutions, as well as a phased program of options.

4.2 DESCRIPTION OF PRESENT OPERATION - BAGGED FERTILIZER

4.2.1 Flow Pattern

Delivery vessels call first at the outer anchorage at Chittagong. Here the bagged cargo is lightered into a variety of river craft which then proceed either into Chittagong Port or sail directly by inland waterway to Dacca District (Narayanganj), depending on the allocation requirements for the cargo.

Generally, when the delivery vessel is lightered sufficiently to clear the outer bar (24 foot draft limitation) it will proceed into Chittagong Port for further discharge at one of the general cargo jetties. When the alloted cargo for Chittagong has been discharged, the vessel is then dispatched to the Chalna Port anchorage where the remainder of its cargo is discharged into river craft for further dispatch to Khunla, Barisal and Patuakhali.

4.2.2 Bagged Cargo Hanlding Rates

For the 10 month period of January through October 1978, Bangladesh imported a total of 424,000 tons of bagged fertilizer over 40 vessel calls or an average of 10,600 ton payload per vessel. Of the above total, 63% or 266,000 tons, was offloaded at Chittagong at an average of 770 TPD as follows:

- Cargo handled at outer anchorage 87,000 tons in 110 days = 810 TPD.
- Cargo handled at PTA jetties 179,000 tons in 235 days = 762 TPD.
- Total cargo 266,000 tons in 345 days = 770 TPD average.

Total waiting time at the outer anchorage was 93 days or 2.3 days per vessel, which is well under the contingent days included in WW SHEX charter terms as apply to Bangladesh shipments. Normal charter terms for bagged fertilizer to Bangladesh are: loading/unloading 1000/750 WW SHEX. Since the ports have averaged faster unloading rates, it can be concluded that some dispatch bonus had been earned. However, the amount would be insignificant. For the purpose of this study, an unloading cadence of 750 TPD for bagged cargo can be assumed as normal for the ports and an applicable freight rate applied.

4.2.3 C & F Cost - Bagged Fertilizer

In response to a USAID tender dated 6 November 1978 for supply of 20,000 MT bagged DAP from the U.S. Gulf Coast to Bangladesh, the following quotations were received on an FOB basis for lots of 10,000 tons for shipments between December 1978 and February 1979.

Bidder	Price Per M.T.
Sumitomo	$184.89
Cargill	187.34
Leonard J. Buck	182.85
ICEC	183.15
Inter Ore	181.31
Chemical Exchange	181.27
Grace	181.59
AVERAGE PRICE	$183.20 per M.T.

The average freight rate from the U.S. Gulf to Bangladesh in a non-U.S. carrier as developed by Gotaas-Larsen, Inc. for an 11,600 ton cargo at 1000/750 WW SHEX loading/unloading terms is $34.90 per ton (see appendix A).

Therefore, we can assume an average C & F cost for bagged DAP to be $183.20 plus $34.91 = $218.11/MT, which will be used in the report as a base for comparison to the several recommended bulk programs.

4.3 BULK HANDLING UNDER PRESENT PORT CONDITIONS

4.3.1 Flow Pattern

The bulk delivery vessel will be lightered at the Chittagong anchorage sufficiently to clear the bar. It will then proceed into Chittagong Port to be discharged at a general jetty with portable bagging facilities. After the cargo alloted for Chittagong has been discharged, it will proceed to Chalna Port where the remainder of its cargo will be bagged on ship and/or, discharged in bulk via ship's gear and bagged with portable bagging equipment.

4.3.2 Bulk Cargo Handling Rates

There are no records of bulk fertilizer handled in Bangladesh. However, records supplied by the cement clinker factory at Chittagong for unloading bulk clinker give some idea of the unloading rates, that could be achieved for bulk fertilizer at present port conditions.

The record for unloading bulk clinker at Chittagong covering the years 1976 and 1977 and the first 10 months of 1978 is as follows:

1976 -	148,634 tons over 147 days	=	1011 TPD
1977 -	199,907 tons over 197 days	=	1014 TPD
1978 -	173,034 tons over 160 days	=	1081 TPD
	AVERAGE		1035 TPD

From the above, it is assumed that bulk fertilizer could be unloaded at the two ports at an average of 1000 tons per day each.

4.3.3 C & F Cost - Bulk Fertilizer

As stated previously, there are no records of bulk fertilizer shipments to Bangladesh. However Pakistan received fertilizer in bulk port conditions that can be considered somewhat similar to Bangladesh. Therefore for the purpose of establishing a bulk FOB cost, recent quotations to Pakistan are cited.

In response to the USAID tender cited previously, the following quotations for supply of 100,000 MT of bulk DAP from the U.S. Gulf to Pakistan were received on an FOB basis for lots of 10,000 tons including empty bags for shipments between December 1978 and February 1979.

Bidder	Price per M.T.
Sumitomo	$159.97
Cargill	157.82
ICEC	156.34
Inter Ore	158.10
Chemical Exchange	157.06
Grace	158.98
AVERAGE PRICE	$158.09 per M.T.

The average frieght rate per Gotaas-Larsen, Inc. for an 11,600 ton cargo at 2000/1000 WW SHEX loading/unloading terms is $30.29 per ton which would apply to present conditions at the two ports of Bangladesh. Therefore, for the condition of handling bulk at the present operation, we can assume an average C & F cost for bulk DAP to be $158.09 plus $30.29 = $188.38/MT.

4.4 COST COMPARISON BAGGED VERSUS BULK - PRESENT CONDITIONS

The C & F cost of bagged DAP as developed in Article 4.2.3 is $218.11/MT.

The derived C & F cost of bulk DAP delivered to Bangladesh under present port conditions is $188.38/MT.

Therefore, the basic C & F cost savings by merely converting to a bulk import program is $29.73/MT.

This savings applies irrespective of the product since it accrues mainly from bagging labor and some small freight savings.

The C & F costs developed above are used as the basis of comparison for bagged versus bulk import in Sections 11 and 12 of this report wherein the total net costs including stevedoring, local bagging of bulk, storage charges, etc. are dealt with.

4.5 SYSTEM DESIGN ASSUMPTIONS

The primary system design assumptions are:

- Ships having fertilizer cargoes for Bangladesh will call first at Chittagong and then, if required, at Chalna Port.

- Transport of cargoes from Chalna Port will be by barge, not only immediately, but also in the future.

4.5.1 Chittagong, First Port of Call

There are two facilities in Bangladesh suitable for the reception of bulk cargoes from ships. These are Chittagong and Chalna Port.

Both ports have an entry restriction on ships draft, which may not exceed 24 feet at either port. This requires lightering of virtually every vessel prior to entry. The docks at Chittagong are within 10 miles of the lightering anchorage, whereas the jetties at Chalna Port are 70 miles up the Pusur River from a deepsea anchorage. It was judged to be operationally and economically impossible to transport lightered cargo the great distance required at Chalna Port when the much shorter distance at Chittagong would suffice. Sufficient cargo can always be removed at Chittagong to make delivery vessels light enough to negotiate the entry bar at the Pusur River without difficulty and sail directly to Chalna Port.

In addition to the 24 foot draft restriction ships of a length over 585 feet cannot negotiate the Gupta Bend in the Karnaphuli River. Therefore, it is better to eliminate entry into the Karnaphuli altogether by lightering in the anchorage at Chittagong first and sending all ships to Chalna Port for unloading completion at dockside. The Pusur River has no length restriction on ships.

Therefore, it is assumed that all vessels will call at Chittagong first.

It is to be noted that this assumption is also conditioned by the fact that the conclusions reached as a result of this study assume that no dredging of the bar at the mouth of the Pusur River is done. If dredging in this area is done in the future, the recommended options for delivery will increase.

4.5.2 Chalna Port to Khulna Division Transport

Cargo received at Chalna Port must be distributed by barge at the present time since neither road nor rail connections to the site exist. Excellent waterway connections exist to the southwest region; to the Khulna District which gives access to the northwest region; and to the Barisal and Dacca areas. A road connection from

Khulna to the Chalna Port wharves is presently under construction. It is scheduled to be completed by 1982 but since it is being constructed on the east bank of the river it will depend on a ferry crossing to reach Khulna. A rail connection between Khulna and Chalna Port is also planned but work has not begun and no schedule has been established for either its start or completion.

4.6 FERTILIZER IMPORT DISTRIBUTION

4.6.1 Present Flow Pattern - Bagged Cargo

The present import of bagged fertilizer follows a general flow pattern as shown on Figure 4-1.

Vessels call first at the outer anchorage at Chittagong. There the bagged cargo is lightered into a variety of river carft which then proceed either into Chittagong Port or sail directly by inland waterway to Dacca District (Narayanganj), depending on the allocation requirements for the cargo.

Generally, when the delivery vessel is lightered sufficiently to clear the outer bar at the entrance to the Karnafuli River it will proceed into Chittagong Port for further discharge at one of the general cargo jetties. When the alloted cargo for Chittagong has been discharged, the vessel is then dispatched to Chalna Port where the remainder of its cargo is discharged into river craft for further dispatch to Khulna, Barisal and Patuakhali.

4.6.2 Recommended Flow Pattern - Bulk Cargo

The importation of all fertilizer in bulk will represent a substantial savings as compared to bagged import. However, this will require a different pattern from the present flow for bagged fertilizer.

The present method of shipping bagged cargo directly from the Chittagong outer anchorage to the Dacca district (Narayanganj) is not recommended for bulk cargo since this would require a bulk unloading and bagging facility, which could not be justified, at Narayanganj. It would therefore be more advantageous to reprogram the flow pattern of bulk fertilizers

into Bangladesh so that all cargo destined for the Dacca district would be routed through Chalna Port where it will be bagged and then be dispatched to the Dacca district by inland waterway. The recommended distribution pattern is as shown in Figure 4-2.

With this system of internal distribution several major advantages become evident. Only Chittagong and Chalna Port will have bulk reception and bagging facilities. This consolidates inventory control and allows efficient distribution throughout the country. The Chittagong distribution will be rail and truck oriented while Chalna Port will be barge oriented. This will result in a more efficient design for each facility and will also relieve an already congested Chittagong Port by about 20% of fertilizer cargo. Distribution of all fertilizer cargoes to the Dacca district through Chalna POrt has the further advantage that a substantial volume of this traffic can be carried on jute barges returning upstream to the Dacca area.

4.6.3 Distribution of Design Throughput

The design target for national fertilizer throughput as established above in Section 3 is 1,600,000 metric tons per year. Using the distribution percentages as defined in Figure 4-2 the average yearly imports in metric tons to Chittagong and Chalna is shown in Figure 4-3.

4.7 FERTILIZER IMPORT ALTERNATIVES - SYSTEM DESCRIPTIONS

4.7.1 General

These basic systems are described in concept below. Detailed descriptions of these systems as they apply to each port of call are to be found in Section 7 for Chittagong and Section 8 for Chalna Port.

Construction of the facilities required for the final bulk import system will take some years. Therefore, a program for a phased improvement of present methods has been developed. The description of the improvement program is in Article 4.8.

4.7.2 Shuttle Bulker Alternative

This scheme is described in flow sheet form on Figure 4-4. Two 27,000 DWT self-loading/self-unloading bulk carriers on charter are premanently stationed at Chittagong. A delivery vessel moors to a bulk carrier riding at a dedicated buoy mooring in the anchorage. Approximately 43% of the cargo is removed from the delivery vessel on the average. However, as much as 14,000 tons could be taken by each of the described shuttle bulkers and still have them meet the draft requirements for the Karnafuli River. Once the delivery vessel is lightered it would proceed immediately to Chalna Port with the remainder of its cargo.

The bulkers would deliver the cargo to the TSP jetty. From the TSP jetty the bulk materials would be moved to the bagging plant via an upgraded belt conveyor system. The location of the bagging plant at Chittagong is subject to alternative evaluation. This comparison and recommendation is to be found in Section 7.

4.7.3 Offshore Platform Alternative

This scheme is described in flowsheet form on Figure 4-5. All delivery vessels moor to the platform which is located in the Chittagong offshore anchorage area. Approximately 43% of the cargo is removed from the ship by means of platform mounted ship-unloaders. After removal of the cargo consigned to Chittagong, the delivery vessel will proceed to Chalna Port with the remainder of its cargo.

Fertilizer cargoes unloaded at Chittagong will be moved to the fertilizer bagging plant via belt conveyor. The location of the bagging plant at Chittagong is subject to alternative evaluation. This comparison and a recommendation is to be found in Section 7.

In addition to fertilizer the offshore platform system at Chittagong will have the capability of handling bulk products over and above the defined forecast for fertilizer. These products include, finished cement, cement clinker, coal, foodgrains and oil. An analysis of which of these products should be handled and the benefits of doing so is to be found in Section 12.

4.8 PHASED PROGRAM OPTIONS

4.8.1 General

Since it will require a 3 to 5 year engineering and construction program to install the high capacity bulk unloading, storage and bagging facilities that are required to handle the forecast of bulk imports and since the potential savings are significant if improvements are made, it is desirable to implement a phased program to receive bulk shipments immediately. A three-stage program of gradual improvement is identified as follows:

- An Initial Stage, 1, that is compatible with present port capability and can be operational by FY 79/80.
- An Interim Stage, 2, that will combine existing facilities with new equipment that will be operational by FY 82/83.
- The Final Stage, 3, that will handle the maximum throughput and be operational by FY 84/85.

The options for phased development are described briefly below. However a full discussion of the costs of import associated with each of these options is discussed in Section 12 of this volume and in Volume II.

4.8.2 Initial Stage - Options 1A, 1B, 1C

Option 1A would be to contract fur bulk shipment on a delivered-in-bag basis. The shipper would be responsible for bagging on ship and delivering a guaranteed tonnage to the jetties at Chittagong and the anchorage at Chalna. Based on the previous records, it is the consultants opinion that an average of 1000 tons per day can be offloaded in this way; however, there are indications from shippers that charter terms of 1200 tons per day can be obtained. This would depend on the shippers knowledge of bagging and stevedoring operations in Bangladesh and his willingness to contract for guaranteed throughput. Further indications are that for bulk fertilizer this "Bag-on-Ship" option would only be feasible during guaranteed fair weather months or the 6 month period of October through March.

Option 1B would be possible if the present TSP factory facilities became available for use as a bulk import reception center. This option would utilize the existing TSP plant and its jetty and conveying system, all of which would be dedicated to the receipt of bulk fertilizers beginning in FY 79/80. At this time, bulk fertilizer could only come to Chittagong since Chalna will not be ready with the facilities required to store and bag. By FY 80/81 however, portable bagging units and temporary bagged storage could be operational at Chlana to enable receipt of bulk at two Mongla jetties with bagging performed at the dockside. This is called Option 1C.

With the successive implementation of options 1B and 1C, 1000 tons per day could be achieved at the TSP jetty in Chittagong and later at the Mongla jetties in Chalna. Further with an average berth availability of 70% at the anchorage and 88% at the TSP jetty, as defined in section 5.7, it should be feasible to have a combined availibility of 79% or 288 days. Therefore, by selecting a berth occupancy of 70% or 200 operating days, the annual throughput potential would be 200,000 tons per year at Chittagong in FY 79/80. This would increase nationally to 465,000 tons per year in FY 80/81 when Chalna Port would become operable for temporary bulk fertilizer receipt and bagging and could handle its 57% allocation of 265,000 tons by utilizing two jetties. This option, however, would fall below the national import forecast of 720,000 tons by FY 80/81 and would have a higher than normal degree of shrinkage at Chalna Port.

The existing buildings at the TSP plant are capable of bulk and bagged storage of about 35,000 tons without modifications. This is adequate for the initial program and the existing two bagging lines could handle the 200,000 tons of imported bulk fertilizer forecast for Chittagong during this stage. Therefore, at Chittagong, the only extra requirement for this temporary program would be a local trucking contract to transport the bulk fertilizer from the existing rock storage areas to the bulk and bagging area.

4.8.2 Interim Stage - Options 2A, 2B, 2C

The interim stage begins in FY 82/83 at which time the bagging plant at Chittagong will be ready with a high speed conveying system. At this time, one shuttle bulker would be deployed and would operate at Chittagong until the final stage begins in FY 84/85. Option 2A considers the condition when the Chittagong bagging plant is ready but the Chalna Port plant is not. Option 2A combined unloading at Chittagong to a bagging plant combined with the portable bagging units at Chalna Port. Theoretically, this option could handle a national throughput of 740,000 TPY (340,000 at Chittagong plus 400,000 at two mongla jetties). However, given the lack of full facilities at Chalna, this condition must by considered questionable and is prone to having a high degree of shrinkage at Chalna Port.

It is more realistic to consider Option 2B which is an extension of Option 2A when the travelling unloaders and new bulk storage and bagging facilities will be operable at Chalna Port in FY 82/83 and they replace the portable bagging units. Here, with full facilities in effect at Chalna, the national throughput capability of 800,000 TPY could easily be obtained. Options 2A and 2B assume the TSP plant facilities will be available for use in the import program.

Option 2C is an alternate option to 2B. Option 2C calls for construction of a new bulk storage and bagging facility at Chittagong rather then using the TSP plant. This option would also coincide with the planned start-up of option 2B at Chalna Port.

4.8.3 Final Stage - Options 3A Through 3F

The final stage options will be made operational by either of the two alternate schemes for final import systems as described in article 4.7 above.

Options 3A and 3B only, would reflect a continuation of the interim stage by commissioning a second shuttle bulker at Chittagong. This combination of two shuttle bulkers along with the completed facilities at Chalna will enable the two ports to receive up to a maximum of 1,400,000 tons per year.

Option 3A uses a fully modified TSP plant. Option 3B uses the new bulk and bagging facility at Chittagong.

Options 3C through 3F are variations of the offshore platform alternative at Chittagong described in article 4.7. Because of its high speed unloading capability, the platform will not be fully utilized for fertilizer alone as put forth in Options 3C and 3D. Therefore, options 3E and 3F are introduced in which the platform will be utilized to handle fertilizer and other bulk commodities such as finished cement and foodgrains and possibly clinker. These options will enable the two ports to handle a maximum of 1,600,000 TPY of fertilizer plus an additional 1,300,000 TPY of other bulk commodities over the platform at Chittagong giving a national bulk commodity total of 2,900,000 TPY.

Options 3C and 3E use a fully modified TSP plant. Options 3D and 3F use the new bulk and bagging facility at Chittagong.

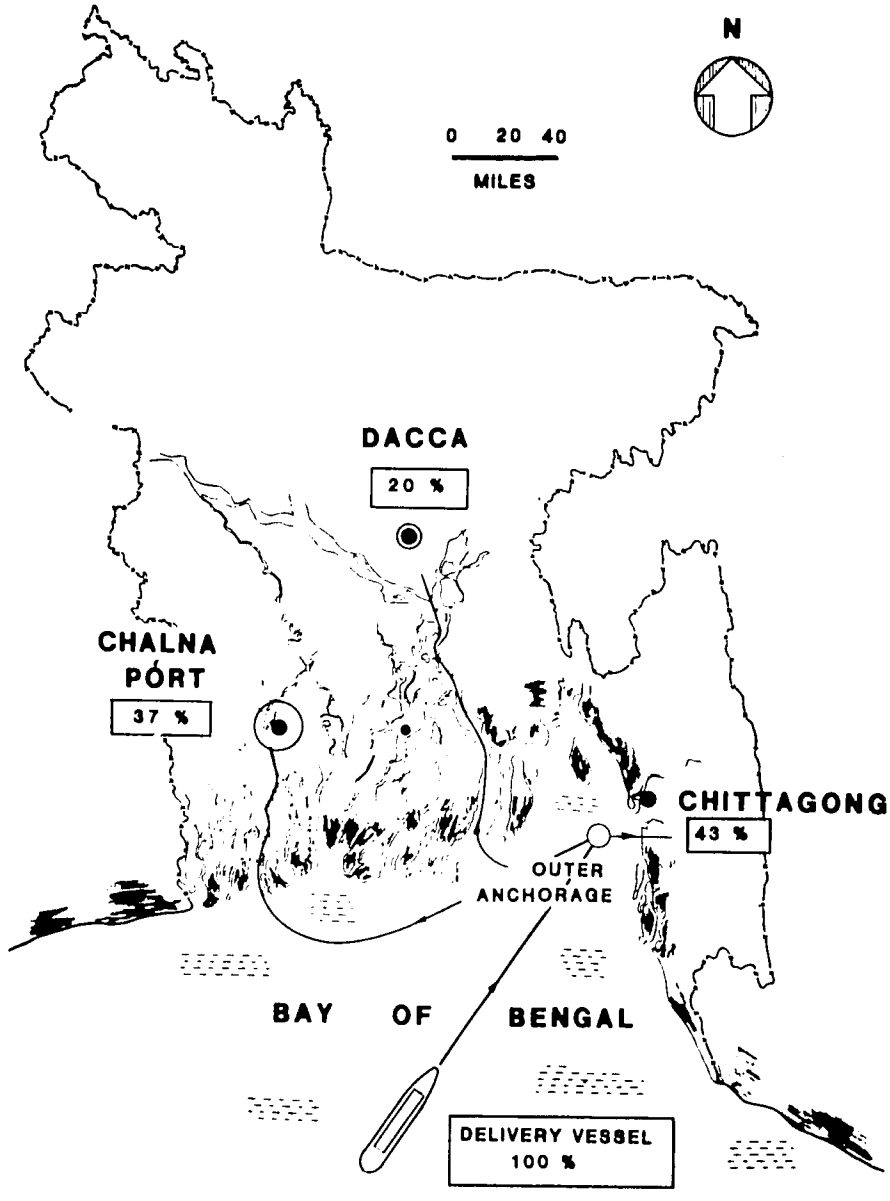


FIGURE 4-1: BAGGED CARGO DISTRIBUTION PATTERN

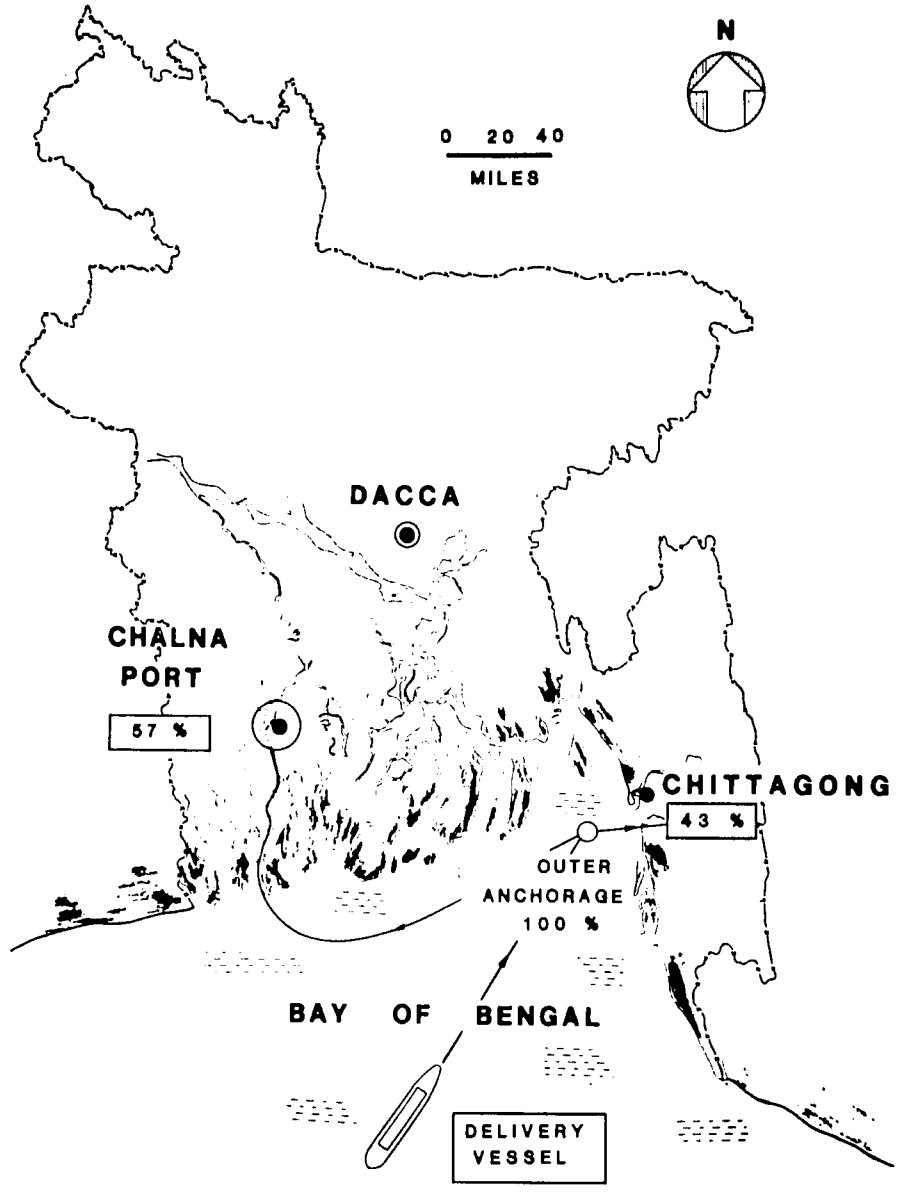


FIGURE 4-2: BULK CARGO DISTRIBUTION PATTERN

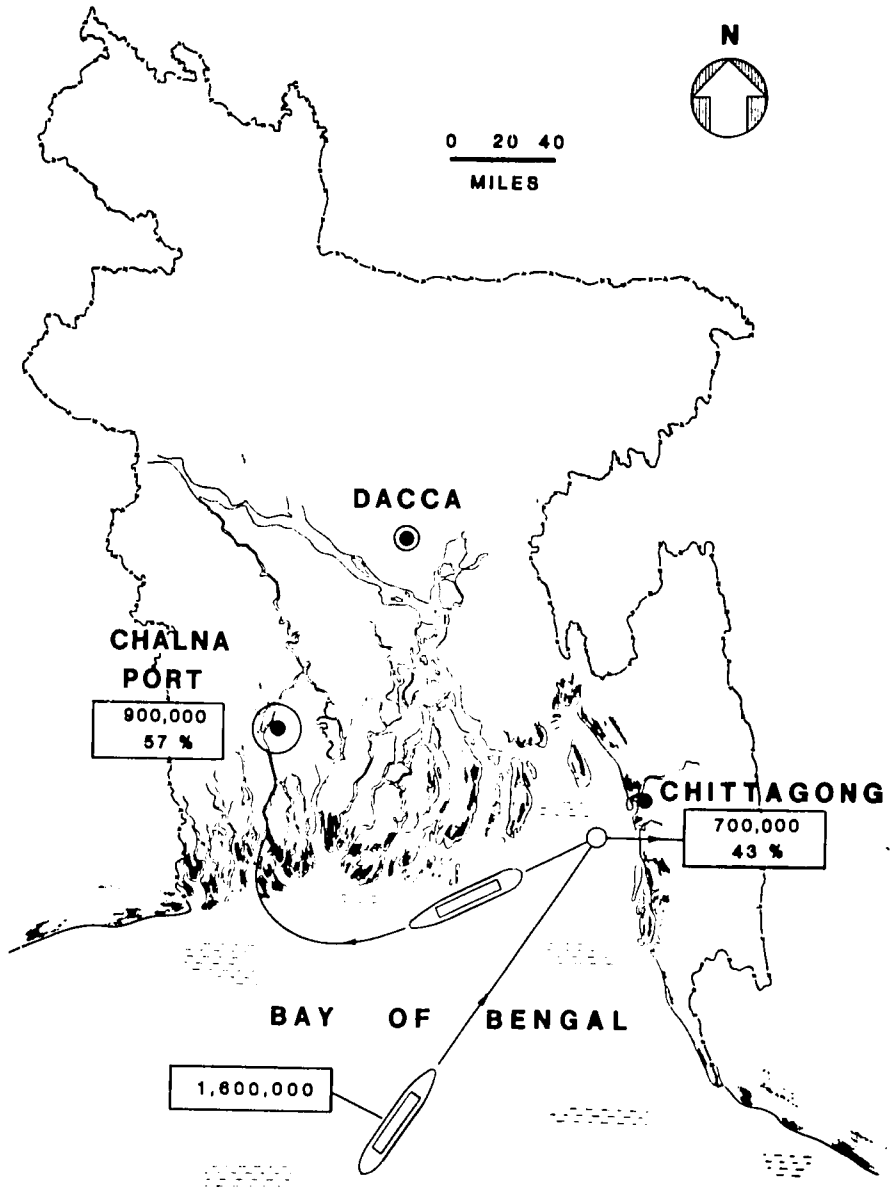


FIGURE 4-3: DISTRIBUTION OF FERTILIZER DESIGN BASIS

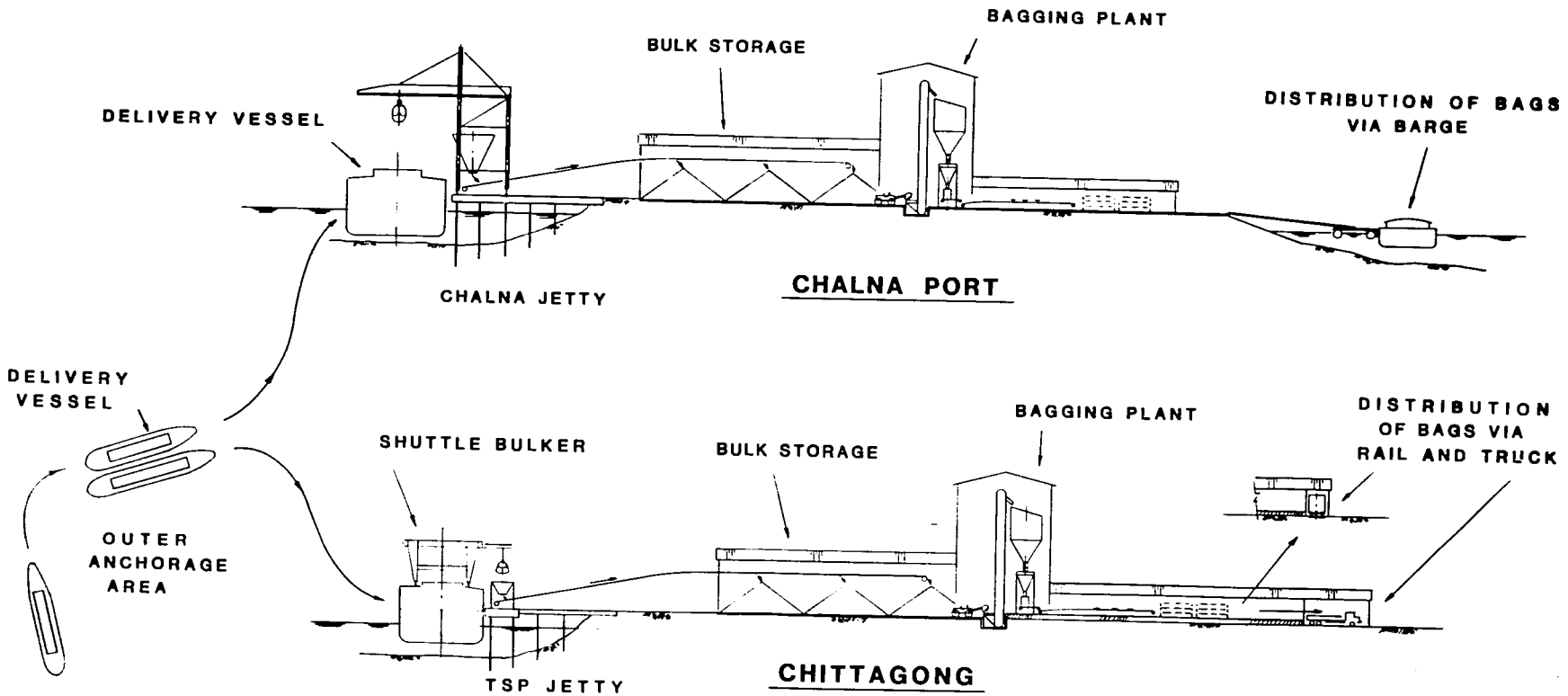


FIGURE 4-4: SHUTTLE BULKER ALTERNATIVE SCHEMATIC

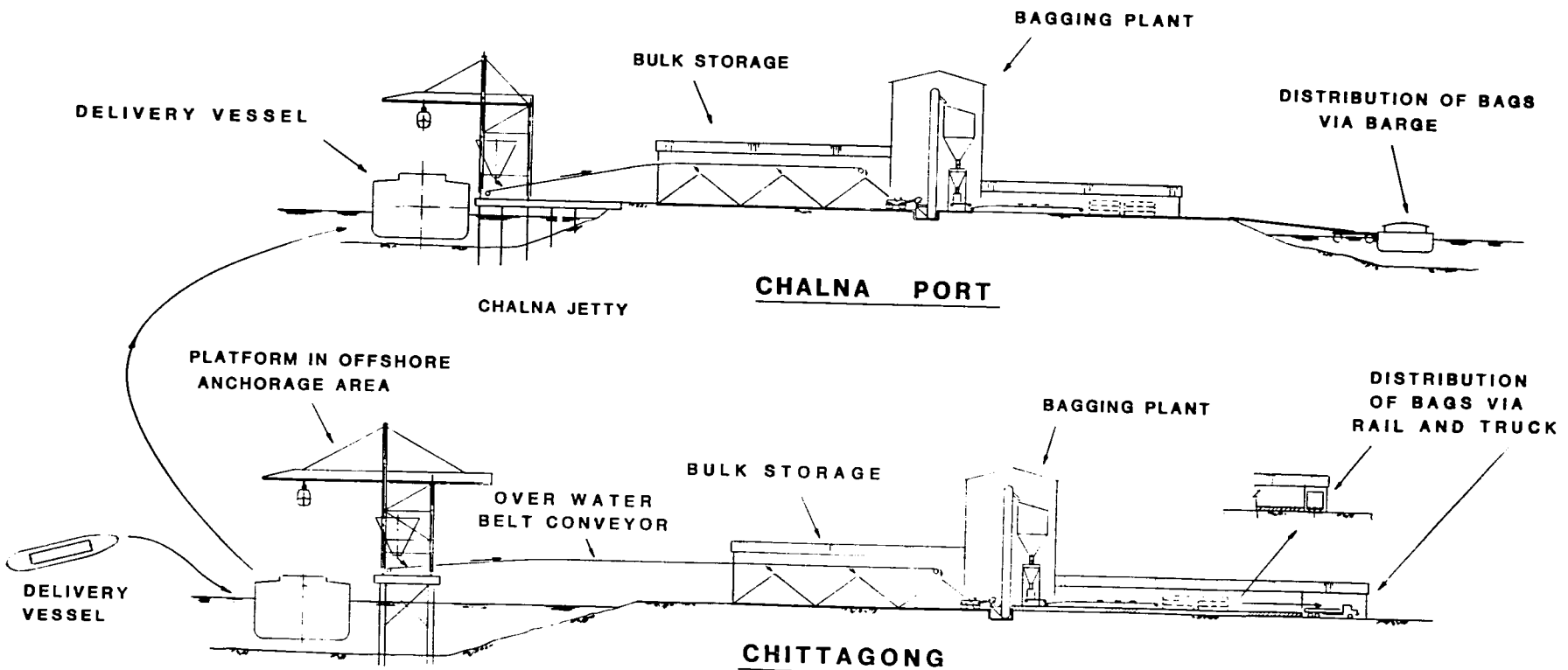


FIGURE 4-5: OFFSHORE PLATFORM ALTERNATIVE SCHEMATIC

SECTION 5

PORT OPERATIONAL ANALYSIS AND OCEAN FREIGHT DEVELOPMENT

5.1 GENERAL

PORTLOG, a computerized simulation system was used to analyze the effect of handling the projected increased annual throughput at the Ports of Chittagong and Chalna and therefore determine relative shipping costs. The computer simulation builds a mathematical model representing the ships' traffic behaviour in port over a ten year period. It then calculates and lists the results in statistical tables. The computer calculations are based on the Queueing Theory using a semi-scheduled ship arrival pattern.

The purpose of this analysis is to determine a system balance for the two ports by selecting unloading equipment of a size, which is economically justified, yet is of sufficient cargo handling capacity to be in tune with cargo volumes to be handled. This unloading cadence determines berth occupancy, which is used to project a ship's total time spent in port (waiting time plus service time).

This is then used to project average yearly dispatch/demurrage costs. When the average yearly dispatch/demurrage costs have a minimal effect on the cargo frieght costs, the system is then considered to be in balance.

5.2 SYSTEM INPUT PROGRAMS

As described in Section 4, there are two system alternatives recommended to achieve high unloading speeds. These have been identified as the Shuttle Bulker alternative and the Offshore Platform Alternative.

Each of these alternative systems has been programmed into the computer and their operations were simulated over a ten year period at various maximum throughputs to determine their effect on ship traffic behaviour.

For the interim stage of throughput, only the shuttle bulker scheme was considered using a single shuttle bulker to handle fertilizer only.

For the final stage of throughput the two shuttle bulker scheme was programmed to handle fertilizer only and the offshore platform scheme was programmed both as a fertilizer only program and as a multi-products berth.

Since the initial stage is put forth only as a temporary program, it has not been dealt with as part of the computer analysis.

5.3 DELVIERY FLEET

The size of an individual bulk cargo is significant in determining freight costs. In order to cast a true picture of freight costs, assumed delivery fleet compositions have been identified and are referred to as initial, interim and final fleets. The initial fleet is composed of vessels whose size and type will be much like those now delivering bagged cargo to Bangladesh. The interim fleet would come into use after the Interim systems were installed and operating at both ports; that is, in project year three. The interim fleet has larger vessels on the average. The final fleet is meant to be operating in project year five. Ship size and fleet composition for each of these fleets is shown in Table 5-1.

TABLE 5-1

DELIVERY FLEET COMPOSITION IN PERCENT

Vessel Size DWT	Cargo Tonnage	(1) Initial	(2) Interim	Final
12,600	11,600	100	20	-
15,200	14,250	-	20	-
20,000	18,850	-	40	30
25,000	23,800	-	10	20
32,000	30,600	-	10	50
TOTAL		100%	100%	100%

(1) Since the computer was programmed only for the high capacity systems, the initial fleet is ignored for the PORTLOG analysis.

TABLE 5-1
DELIVERY FLEET COMPOSITION IN PERCENT
(CONTINUED)

(2) For the purposes of this analysis, the following tonnages, which approximate 43% of the delivered cargo, were assumed to be removed by the shuttle bulker from the various delivery vessels.

Delivery Vessel DWT	Delivery Vessel Cargo	Tonnage Removed By the Shuttle Bulker
12,600	11,600	5,000
15,200	14,250	6,100
20,000	18,850	8,100
25,000	23,800	10,200
32,000	30,600	13,200.

FREIGHT COSTS

A detailed analysis has been obtained from Gotaas-Larson Inc. for freight charter rates to Bangladesh. These figures are shown in tabular form in Appendix A. A variety of standard charter loading and unloading rates for vessels of various sizes, are shown along with the associated costs per ton of delivered product. It is assumed for purposes of simplicifation that all vessels travel from the US Gulf, therefore, the analysis of freight costs for the various alternatives are based upon this data.

APPENDIX A contains the basic correspondence from Gotaas-Larsen outlining their recommendations and giving background for the interpretation of the sea freight cost data.

5.5 SHIP UNLOADING RATES

5.5.1 General

The ship unloading rates used are expressed as effective daily rates. An effective rate is that tonnage that actually can be unloaded over a long period of time. At the start of an unloading cycle there is sufficient material in the vessel such that the unloading equipment will operate at its best, or "cream digging" rate. As the vessel nears completion clean-up is required. During this period the unloading operation is at its lowest efficiency. The effective rate takes all of this into account.

5.5.2 Chittagong:

Shuttle Bulker: Each shuttle bulker is equipped with two cranes travelling on its deck. The combined daily output of these two cranes is 6000 tons when lightering a vessel in the outer anchorage.

TSP Jetty: When the shuttle bulker is used to supply Chittagong, a new receiving conveyor system is required. The shuttle bulker's crane will yield a combined daily output of 4500 tons when it unloads itself at the TSP jetty. This unloading rate is lower than the shuttle bulker loading rate since it includes an allowance for cleanup.

Offshore Platform: The offshore platform will be equipped with two gantry type clamshell unloaders. The combined daily output of these unloaders is 16,000 tons.

5.5.3 Chalna

Two gantry type clamshell unloaders were considered in the simulations. The combined effective daily output of these machines is 9300 tons.

5.6 COMPARATIVE FREIGHT RATES

Using the fleet composition identified in Table 5-1 and applying freight charter rates from the Gotaas-Larsen table in Appendix A an average cost per ton based on trip cost for the combined fleet at standard charter terms is as follows:

For the Interim Fleet delivering 800,000 tons/year at 6000/5000 Load/Discharge Terms the average freight cost is $22.79/ton. (Shuttle Bulker)

For the Final Fleet Delivering 1,600,000 tons/year at 6000/5000 Load/Discharge Terms the average freight cost is $19.12 per ton (Shuttle Bulker).

For the Final Fleet Delivering 1,600,000 tons/year at 6000/10000 load/discharge terms the average freight cost is $18.51 per ton (Offshore Platform).

These rates are later modified because of dispatch/demurrage based on waiting and service times as developed by the computer.

5.7 BERTH AVAILABILITY AND OCCUPANCY FACTORS

5.7.1 Berth Availability

Berth Availability is that time during a year when the berth is available for operation and is not closed or restricted because of inclement weather or major holidays.

Berth availability at an offshore berth or at a bouy mooring in the anchorage off the coast at Chittagong is limited by currents, waves, winds and precipitation. Sea and wind over a certain level prevent a vessel from mooring or remaining at the mooring. Heavy rain prevents the handling of bulk fertilizer.

In order to evaluate the total time out of a typical year that vessel unloading operations could take place, a subcontract was placed with A.H. Glenn Associates to prepare a report on the statistical variation of currents, waves, winds and precipitation in this area. This report is included in its entirety in Appendix B along with a discussion of its significance to cargo operations offshore.

An analysis of the statistical meteorological and oceanographic data results in the estimate that an offshore platform berth would be available about 66 percent of the total year. Avaliability during the period from mid May through mid September, the worst part of the southwest monsoon, would be as low as 32 percent and during the rest of the year 88 percent of the time.

The berth availability at a single point buoy mooring is judged to be greater since the vessels would move in response to wind and waves, whereas a ship moored to a platform would have to remain in a fixed direction. The berth availability at the buoy is estimated to be in the order of 70% of the time on a year round basis.

Both TSP jetty and Chalna Port are in protected areas, and at these locations rain is the only factor to consider for unloading of bulk fertilizer. Therefore, the berth availability is estimated at 88%.

5.7.2 Berth Occupancy

In general, the berth occupancy rate is a measure of the overall port efficiency and is arrived at by dividing the total vessel service time in port by the time during a year when the berth is actually available (Berth Availability).

The optimum berth occupancy for any particular port depends upon the relative costs of ship delays and the cost of providing facilities, for example, 30 to 40 percent is normal for large tanker berths where discharging facilities are simple, and 70 to 75 percent is normal for general cargo berths with expensive cranes and sheds.

The optimum range of about 50 to 60 percent is broadly the range that would be expected for a single berth bulk terminal where arrivals are semi-scheduled.

This would apply to the offshore platform at Chittagong and at Chalna Port in all cases. For the shuttle bulker service between the outer anchorage and the TSP jetty however, where service is more dedicated, occupancies of 60 to 70 percent can be allowed for.

5.8 "PORTLOG" ANALYSIS OF ALTERNATIVES

5.8.1 Alternate Programs

Using the input data developed in Articles 5.2 through 5.7, several PORTLOG simulation models were used for the optimization of each of the two alternative solutions.

The shuttle bulker simulation models take into consideration: vessels arriving at the Chittagong anchorage, lightering by the shuttle bulker, the delivery vessel going to Chalna Port to complete unloading and the shuttle bulker going to Chittagong to unload its cargo. One jetty in each of the above locations is assumed to be dedicated for the import of bulk fertilizer.

The offshore platform simulation models take into consideration: vessels arriving in the Chittagong anchorage, fertilizer vessels lightering at the platform and the delivery vessels going to Chalna Port to complete unloading. Other products vessels, when applicable, are fully unloaded at the platform.

Based on the effective unloading rates selected in article 5.5 the following upper limit trial conditions were selected for the computer program in order to determine each system's maximum capability.

For the Shuttle Bulker Alternative:

*Program A - Interim stage throughput - 800,000 tons /year (340,000 Chittagong - 460,000 Chalna).

Program B - Final stage throughput - 1,600,000 tons/year fertilizer only (700,000 Chittagong - 900,000 Chalna).

Program C - Final stage throughput - 1,400,000 tons/year (600,000 Chittagong - 800,000 Chalna).

For the Offshore Platform Alternative:

Program AA - Final stage throughput - 1,600,000 tons/year fertilizer only (700,000 Chittagong - 900,000 Chlana).

Program BB - Final stage throughput - 3,050,000 tons/year fertilizer, finished cement and foodgrains (2,150,000 Chittagong - 900,000 Chalna).

Program CC - Final stage throughput - 2,900,000 tons/year fertilizer, finished cement and foodgrains (2,000,000 Chittagong - 900,000 Chalna).

* Program A was also run at the temporary condition of using portable bagging machines at Chalna for analytical purposes only. The results of this run are not included for consideration and are appended only in appendix C as a sample illustration of a typical program run.

Table 5-2 summarizes the results of the various programs considered.

5.8.2 Shuttle Bulker Analysis

One shuttle bulker, case A, is already at its maximum capacity as is indicated by its occupancy factor. When occupancies exceed 70% the efficiency

TABLE 5-2

SUMMARY OF PORTLOG ANALYSIS - ALTERNATIVE IMPORT SYSTEMS

Alternative		Shuttle Bulker			Offshore Platform		
CASE		A	B	C	AA	BB	CC
NUMBER OF BULKERS USED		1	2	2	-	-	-
Tonnage (MT/YR)		800,000	1,600,000	1,400,000	1,600,000	3,050,000	2,900,000
SHIP UNLOADING RATES (MT/DAY)	CHITTAGONG ANCHORAGE	6,000	6,000	6,000	16,000	16,000	16,000
	CHALNA JETTY	9,300	9,300	9,300	9,300	9,300	9,300
	CHITTAGONG JETTY	4,500	4,500	4,500	------	------	------
AVERAGE WAITING TIME DELIVERY VESSELS (HOURS)	CHITTAGONG ANCHORAGE	22	48	14	8	40	29
	CHALNA JETTY	0	4	2	3	7	6
	CHITTAGONG JETTY	0	46	31	------	------	------
AVERAGE SERVICE TIME DELIVERY VESSELS (HOURS)	CHITTAGONG ANCHORAGE	37	52	51	28	30	29
	CHALNA JET	36	54	40	40	40	40
	CHITTAGONG JETTY	49	65	64	------	------	------
TOTAL TIME DELIVERY VESSELS (HOURS)	TWO PORT	122	184	132	106	143	131
TOTAL OPERATING TIME BULKER (HOURS)		140	220	200	------	------	------
OCCUPANCIES PERCENT	BULKER AT ANCHORAGE	71%	81%	65%	------	------	------
	CHALNA JETTY	32%	61%	44%	51%	51%	51%
	CHITTAGONG JETTY	45%	87%	42%	------	------	------
	PLATFORM	------	------	------	18%	69%	56%

[illegible] TO APPENDIX C FOR EXPLANATION OF TERMS.

rapidly decreases. Time is required to perform maintenance and other similar functions. Therefore, the upper limit for one shuttle bulker is reached when the national import total approaches 800,000 tons. This equals a Chittagong tonnage of 43% of the national total, or about 340,000 TPY.

Case B, two shuttle bulkers handling a national import of 1,600,000 tons per year, yield an occupancy factor of 81% per shuttle bulker. This is considered to be beyond practical limits.

Case C, where the national import is reduced to 1,400,000 million tons/year has a much more practical occupancy factor.

The two shuttle bulkers together can handle 600,000 tons/year at Chittagong, or 300,000 tons each. This is somewhat less than case 1A where the single shuttle bulker carried 340,000 tons/year. The reduction in yearly throughput is a result of the two shuttle bulkers interfering with each other at the jetty in Chittagong.

Therefore, one shuttle bulker can support a national import level of maximum 800,000 tons and two can support 1,400,000 tons nationally. This is dependent upon 43/57% split between Chittagong and Chalna Port which is rather an inexact assumption.

5.8.3 Offshore Platform Analysis

Case AA consideres handling fertilizers only through the offshore platform when the national import is 1,600,000 tons yearly. As the occupancy factor indicates, the platform at Chittagong is operating well below the acceptable occupancy. The occupancy at Chalna is within the normal range.

For case BB, the following commodity tonnages were programmed:

At Platform	700,000	fertilizer
	500,000	finished cement
	950,000	foodgrains
	2,150,000	
at Chalna	900,000	fertilizer.

For case BB, the occupancy factor at the platform was 69% and therefore 150,000 tons of grain was removed for case CC. A 56% occupancy factor resulted, which is within the practical operating range.

5.9 DISPATCH AND DEMURRAGE

Given the relative waiting and service time developed by the computer, dispatch and demurrage costs then have been calculated for the following feasible programs:

(A)	One Shuttle Bulker	800,000	tons/year
(C)	Two Shuttle Bulkers	1,400,000	tons/year
(AA)	Offshore Platform FERTILIZER ONLY	1,600,000	tons/year
(CC)	Offshore Platform,	1,600,000	tons/year Fert.
		500,000	tons/year Finished cement
		800,000	tons/year Food grains.
		2,900,000	tons/year TOTAL.

The calculations were based on the total time spent in port for each size of fertilizer vessel.

Those vessels that spent less than the contract days in port were paid dispatch.

Vessels spending the exact contract time neither collected demurrage nor paid dispatch.

Vessels spending more than the contractural days in port collected demurrage.

Table 5-3 shows the dispatch and demurrage per ton and the final freight costs that are a result of this.

It can be seen from this table, that dispatch and demurrage do not significantly affect the standard charter rates, therefore the two port system can be considered to be in balance for the national throughputs and material handling capacities selected.

TABLE 5-3

DISPATCH AND DEMURRAGE

ALTERNATIVE	NATIONAL THRUPUT (MT)	AVERAGE FREIGHT COSTS FOR STANDARD CHARTER TERMS $/MT	DISPATCH (-) DEMURRAGE (+) $/MT	FINAL FERTILIZER FREIGHT COST $/MT
One Shuttle Bulker	800,000	22.79	(-)0.28	22.51
Two Shuttle Bulkers	1,400,000	19.12	(+)0.07	19.19
Offshore Platform	1,600,000	18.51	(-)0.10	18.41
Offshore Platform	2,900,000 (fertilizer plus other bulk products)	18.51	(+)0.27	18.73

SECTION 6

OFFSHORE PLATFORM AS MULTI-PRODUCT BERTH

6.1 CAPABILITY FOR HANDLING OTHER BULK CARGO

It has been demonstrated in previous sections that there are considerable savings to be made by shipping cargo in bulk rather than in bags. It has also been demonstrated that additional savings can be realized by handling bulk at higher unloading speeds and delivering the cargoes in larger vessels.

This is the case especially at the offshore platform and given the fact that the offshore platform will be under-utilized for a fertilizer only program, the consultant has identified the additional savings available by handling other bulk products at the platform.

In Section 5, the PORTLOG analysis has proven the feasibility of handling 2,000,000 tons per year over the platform at Chittagong. When this is translated into national capability for the two ports after Chalna is equipped to receive fertilizer only, we have a total of 2,900,000 tons per year of national bulk import capacity (2,000,000 at Chittagong plus 900,000 of fertilizer at Chalna). However, given the fact that Chalna is projected to become a full service industrial port complex, the total projection of national bulk import could well be as follows by following the delivery pattern outlined in Section 4 for bulk fertilizer.

	Chittagong	Chalna	National
Fertilizer	700,000	900,000	1,600,000
Cement	500,000	1,200,000	1,700,000
Foodgrains	800,000	1,000,000	1,800,000
TOTAL	2,000,000	3,100,000	5,100,000

The above throughput capability at Chittagong will all be routed through the platform in the Bay of Bengal thereby freeing the Karnaphuli jetties to handle general, break bulk cargo, liquid and other dry bulk cargoes.

6.2 RELIEF OF CONGESTION AT CHITTAGONG PORT

Under a rehabilitation program to general cargo berths Nos.1 through 6, it is expected that by mid 1980 Chittagong port will have 13 general cargo jetties, each equipped with two-3 ton cranes capable of handling 200,000 tons of cargo per year per jetty at a normal 70 to 75 percent berth occupancy. In addition there are 4 general cargo jetties used for manual handling only. These are capable of handling 157,500 tons per year each at normal berth occupancy.

These 17 jetties will give a total yearly throughput capability of general dry cargo of 3,230,000 tons at normal berth occupancy or average 190,000 TPY per jetty. This is considered normal for general cargo. However, the port presently operates at almost 100 berth occupancy and, by 1980/81 when the jetties are expected to be completed, forecasted general dry cargo tonnage is expected to reach over 4.5 million tons, including loose dry bulk, which will exceed 100% berth occupancy thereby creating an impossible situation. The inevitable result will be congestion and long queues of ships waiting to be serviced. Demurrage charges will be considerable and shipping companies will be reluctant to accept charter to Bangladesh.

If this 4.5 million tons per year is equated to a normal 70 to 75% berth occupancy factor for the port, the port would require 23 jetties to handle this tonnage or 6 jetties additional to the above 17. This would add facilities to an already congested port complex at a considerable capital investment requirement.

However, the make-up of Chittagong Port with all jetties located on the Karnaphuli River makes it unfeasible to commission a true bulk berth within the port complex without the use of a costly dredging program to increase the draft. Even then, a bulk berth would have to be located south of the Gupta Bend, which presently limits entering vessels to a maximum of 585 feet in length, but this location is out of the industrual complex and would offer no efficient connection to the complex. Therefore, since a great portion of the cargo is

or could be in the form of loose dry bulk, additional jetties on the Karnaphuli will not really afford the level of cost economies regularly associated with bulk shipments. It is not economical to lighter large, 32,000 DWT, bulk carriers in the anchorage, nor is it possible for these vessels to enter the inner port even when lightered.

The offshore platform, with its 2,000,000 ton/year of bulk handling capability, would in effect be eqivalent to over 10 jetties in dry loose bulk capability and would be a big step to solving the problem of congestion, not to mention the freight and handling savings that would accrue for bulk products as a result of high speed handling and the ability to berth large, 32,000 DWT, delivery vessels. It would free the Karnaphuli River from such traffic as fertilizer, finished cement, and a major portion of foodgrains. It would make available the TSP jetty for handling general cargo. It would also free those jetties that are presently occupied with the handling of bagged fertilizer and cement as well as lowering the occupancy at the foodgrain jetty.

SECTION 7

THE PORT OF CHITTAGONG - ANALYSIS OF ALTERNATES AND RECOMMENDED SYSTEM

7.1 GENERAL

The study for import alternatives at Chittagong had to deal with two prime considerations. These were, the method of handling imports from the delivery vessel to shore, and the location and latout of the bagging plant. Several alternative methods and sites were considered. These alternatives along with a brief description of existing facilities are discussed in this section.

7.2 EXISTING FACILITIES

Figure 7-1 is a general view of the Chittagong Port area. General cargo and dedicated ship berths are available in the Karnafuli River. There is a draft restriction imposed upon entering vessels by virtue of the bar at the mouth of the Karnafuli River and a sharp reverse curve in the river known as the Gupta Bend. Due to there restrictions entering vessels may neither draw more than 24 feet nor exceed 585 feet in overall length.

Becuase of the draft restriction, most vessels are lightered in the outer anchorage. After drafts are reduced to less than 24 feet, both the lightered vessel and the lighters are directed to open jetties on the Karnafuli to complete unloading.

Figure 7-2 shows the existing TSP plant area which is of particular interest to this study since the existing TSP jetty, and the TSP property is a prospective site of the bulk fertilizer reception area and bagging plant at Chittagong.

7.3 BAGGING PLANT LOCATION ALTERNATIVES

Figure 7-3 shows the sites that have been analyzed for bagging plants.

Site A, near the river between the cement clinker plant and the grain storage area, was considered but finally discarded, since it is

not large enough to handle the requirements for bulk storage and the large numbers of trucks and rail traffic required to carry the bagged product away.

The adjacent Patenga Road and the existing rail line between the Karnafuli River and Patenga Road are already very crowded.

Site B, to the north of the TSP plant's entry off the Patenga Road, even if the area to the south of the entry road is included, is too small.

Site C, to the north of the rock storage godowns and the area west of the TSP plant sulfur storage area, is too broken up to be used in an efficient bagging plant layout.

Site D, located to the west of the Aziz Patenga Road is an agricultural area, and is unencumbered by existing construction and activity. It has access to the Aziz Patenga Road and a relatively short extension from the existing mainline railroad affords the necessary rail connection. Ample space is available for truck parking and the maintenance and administration services, which will be required for the operation. The site is close enough to the existing TSP plant so that management of fertilizer distributing can be effectively administered from one location. Therefore, Site D was selected as the location if a new bagging plant were selected.

Site E, is the existing TSP plant. It is also a candidate location for the bulk storage and bagging plant. The discussion of the justification for using the TSP plant for manufacture or for a fertilizer import terminal is discussed in Volume II of this report.

7.4 BULK FERTILIZER IMPORT ALTERNATIVES

7.4.1 General

As identified in Section 4, there are two alternative systems which can provide the Port of Chittagong with high-speed bulk handling capacity to service delivery vessels up to the 30,000 DWT class: The Shuttle Bulker System or the Offshore Platform System. With both

systems, unloading of the delivery vessel must be performed at the outer anchorage because of the draft restrictions on the Karnaphuli River.

Prior to identifying the above as feasible alternative solutions, an analysis was made of installing high-speed equipment at an existing or a new jetty on the Karnaphuli River in the existing port complex. This condition has been rejected, however, since the draft and length restrictions on the Karnaphuli River would still limit entering vessels to maximum payloads of only 8,000 tons. This would in essence reflect little improvement on freight rates presently experienced. Most ships in this class size are general cargo tween-deckers, and because of their small hatch openings and the presence of the tween-deck high-speed unloaders cannot be used efficiently, if at all.

A case in point is the bucketwheel unloader now laying idle at the cement clinker jetty. This machine has been retired for the very reason that most of the clinker is delivered in small tween-deck vessels.

7.4.2 Shuttle Bulker Scheme

Figure 7-4 shows the shuttle bulker arrangement with the bagging plant located at Site "D". In this scheme the existing TSP jetty will be rehabilitated and the existing conveyor system from the jetty to the TSP plant will be upgraded to match the unloading rate of the shuttle bulker. From the TSP plant a new conveyor system will be installed to deliver the bulk fertilizer to a newly constructed bulk storage and bagging plant at Site "D" location just west of the Aziz Patenga Road.

The conveyor system in this scheme follows the same alignment as the existing conveyor line, since it will be a requirement to continue imports of Phosphate Rock and Sulphur to the TSP plant and these materials would be handled at reduced capacities to the existing rock and sulphur storage conveyors.

A new rail spur will be connected to the main line at a point northwest of the present industrial complex and all truck traffic will utilize the Aziz Patenga road.

Figure 7-5 shows the shuttle bulker arrangement with the bagging plant located at Site "E", the TSP plant.

In this scheme, the existing TSP jetty will be rehabilitated and a new conveyor line will be installed and arranged to feed the fertilizer bulk storage areas as created by modifying the existing plant buildings. The existing rail spur will be rearranged and rail and truck will continue to use the same pattern as for the existing TSP transport.

7.4.3 Offshore Platform Scheme

Figures 7-6 and 7-7 show the offshore platform arrangement with the bagging plant located at Site "D". Figures 7-8 and 7-9 show the offshore platform arrangement to the Site "E", the TSP plant.

At both sites "D" and "E" it has been assumed that the shuttle bulker scheme will in any case be implemented In the interim stage using a single shuttle bulker, which will be retired when the offshore platform comes on stream. Therefore, the conveyor systems installed at the interim shuttle bulker stage will have to be modified to be incorporated into the offshore schemes. In the case of site "D", the conveyor system between the new bagging plant and the existing TSP plant will be reversed to deliver phosphate rock and sulphur coming over the platform to the TSP plant at reduced capacity. In the case of site "E", the offshore conveyor connection will merely run a longer distance to the TSP plant. In both cases, the interim stage jetty conveyor and transport conveyor to the TSP plant will be dismantled to be utilized as spare parts.

7.5 RECOMMENDED FACILITY DESCRIPTION

Figure 7-9, which is the recommended scheme, as justified by the discussion in Section 12 of Volume I and Section 3 of Volume II, shows the offshore platform scheme as a multi-products system to the recommended site "E" and the arrangement for delivering other bulk products to their respective facilities.

Reference is made to figure 7-10 which shows the typical sections of the proposed offshore platform and the trestle connecting the platform to shore.

Delivery vessels will moor to the platform fully laden. Primary ship unloading will be accomplished with two gantry type, rail mounted, travelling clamshell rigs which are rated at 800 metric tons per hour each. Bulk commodities will be fed onto the jetty conveyor at a regulated rate from each of the unloaders. Sufficient surge hopper capacity will be furnished on the unloaders to ensure continuous belt loading. The material will be carried to the north end of the platform and transferred to the multi-products conveyor which will convey a distance of about 18,000 feet to a common transfer point in the Site "E" area. Provision will be made on the belt to weigh all incoming material for inventory control and comparison with vessels' manifests.

When unloading fertilizer, only the clamshells will be required since the fertilizer vessels will offload only a portion of their cargo at Chittagong with the remainder being retained for Chalna Port and therefore vessel "clean-up" is not required at the platform. Finished cement and foodgrains however, will require vessel clean-up since these total cargoes will offload at Chittagong. Therefore, for clean-up of finished cement and foodgrains, the platform will also be equipped with pneumatic unloading equipment, one type dedicated to clean-up of finished cement and another to foodgrains. If clinker is also handled it will also require clean-up. Clinker however, cannot be handled pneumatically, therefore all clinker shipments will be limited to vessels not to exceed 585 feet LOA to enable vessel clean-up to be performed at the existing clinker jetty on the Karnafuli River.

The 18,000 foot connecting conveyor to site "E" is carried over a trestle to shore. After reaching shore the conveyor is carried overhead, supported on intermittent bents, to the bagging plant. The trestle has provision for a single lane roadway allowing shore vehicle access to the platform for maintenante and delivery of spare parts, personnel and supplies.

This roadway starts at the existing Wapda Embankment which protects the fresh water irrigation rice paddy area. Access to the trestle road would be by a new single land road from the Aziz Patenga Road.

The offshore platform, all unloading machines and the trestle conveyor will be designated as common facilities to handle the several bulk commodities to the common transfer point.

The offshore platform schemes also show provision for separate conveyors on the platform and trestle. This was shown in deference to the concerns expressed to the Consultant in Bangladesh, of mixing foodgrains with mineral products. The economics however, do not favor the large additional capital cost required to install an 18,000 ft second conveyor and in view of the fact that the products will never be handled simultaneously, it is recommended that a single conveyor only, with proper belt cleaning equipment be utilized as common to all products.

In this regard, the consultant refers to their design of a multi-product terminal for the Georgia Ports Authority in the U.S.A. in which a variety of cargo including kaolin, fertilizers, ores, concentrates, peanuts, wheat and other food stuffs are all handled on a common conveying system.

The common transfer point at the discharge of the 18,000 ft common connecting conveyor is fitted with a 3 way discharge chute to divert the different products to individual conveyor lines which are designated as dedicated facilities. The fertilizer will be conveyed to the site "E" bagging plant, the foodgrains to the existing grain silo and the finished cement to a newly constructed cement storage and bagging plant. If clinker is handled, this would be stockpiled under the head end of the finished cement conveyor in open ground storage, from which it will be transported by truck to the existing grinding plant.

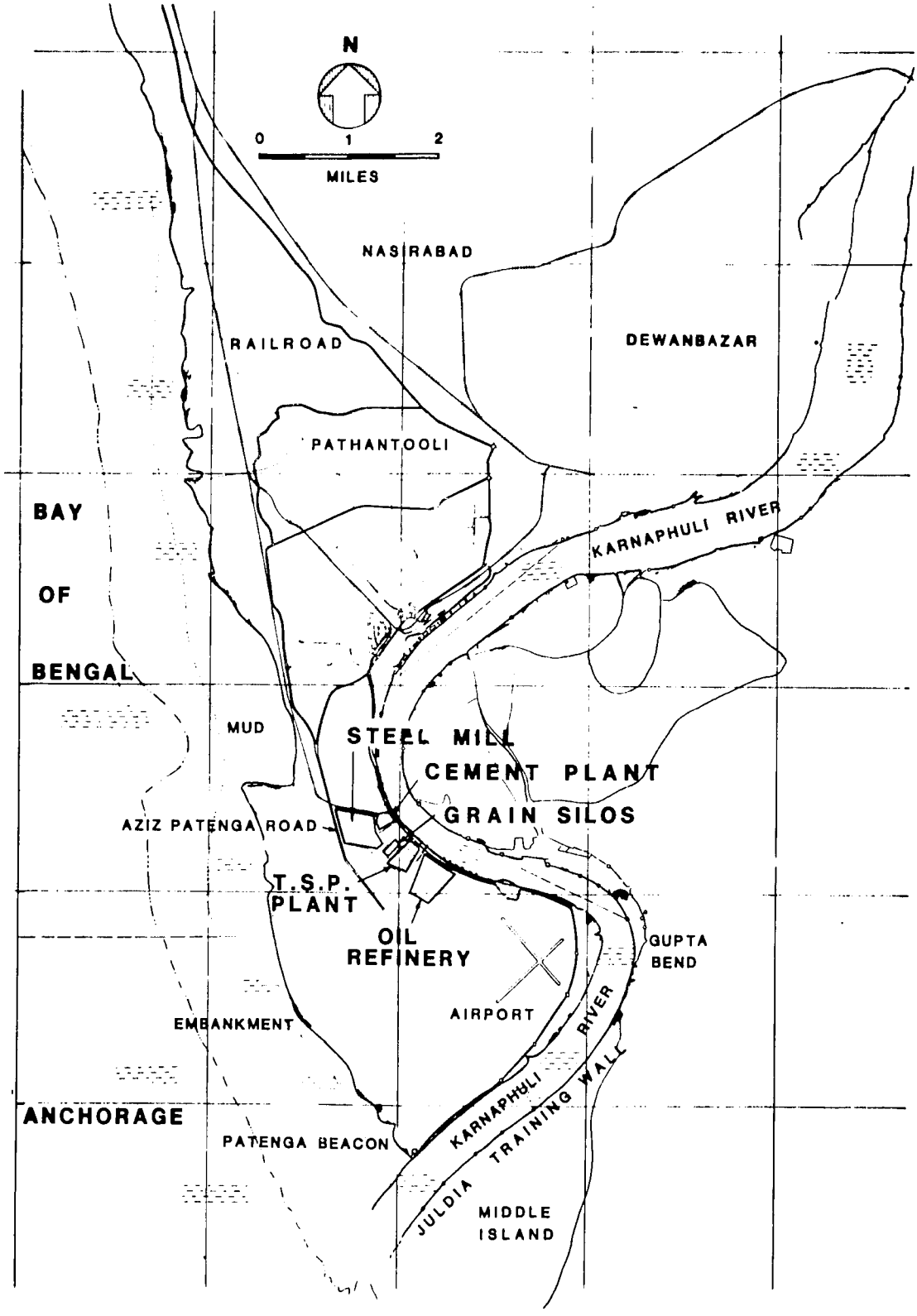


FIGURE 7-1: CHITTAGONG
GENERAL AREA MAP

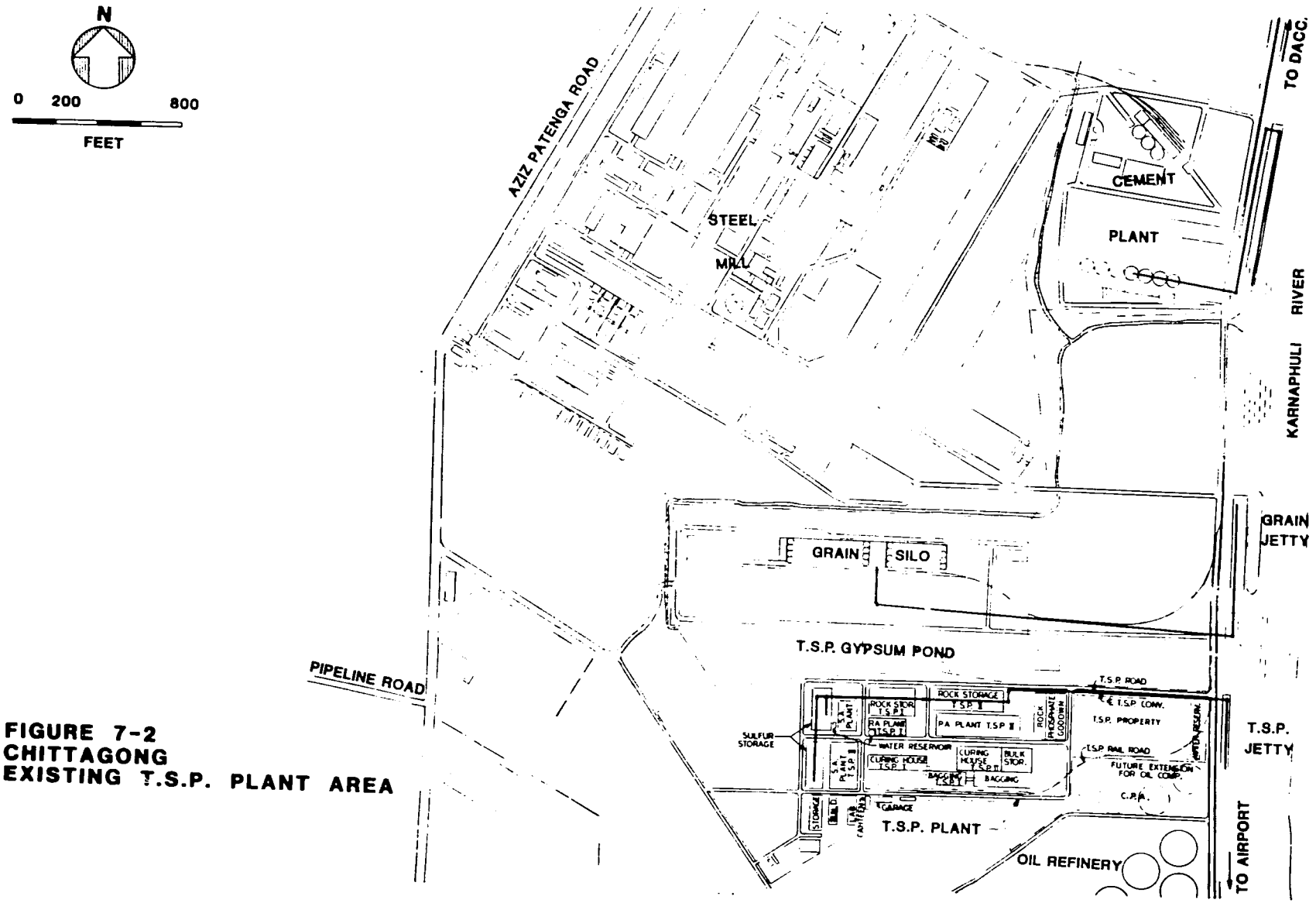


FIGURE 7-2
CHITTAGONG
EXISTING T.S.P. PLANT AREA

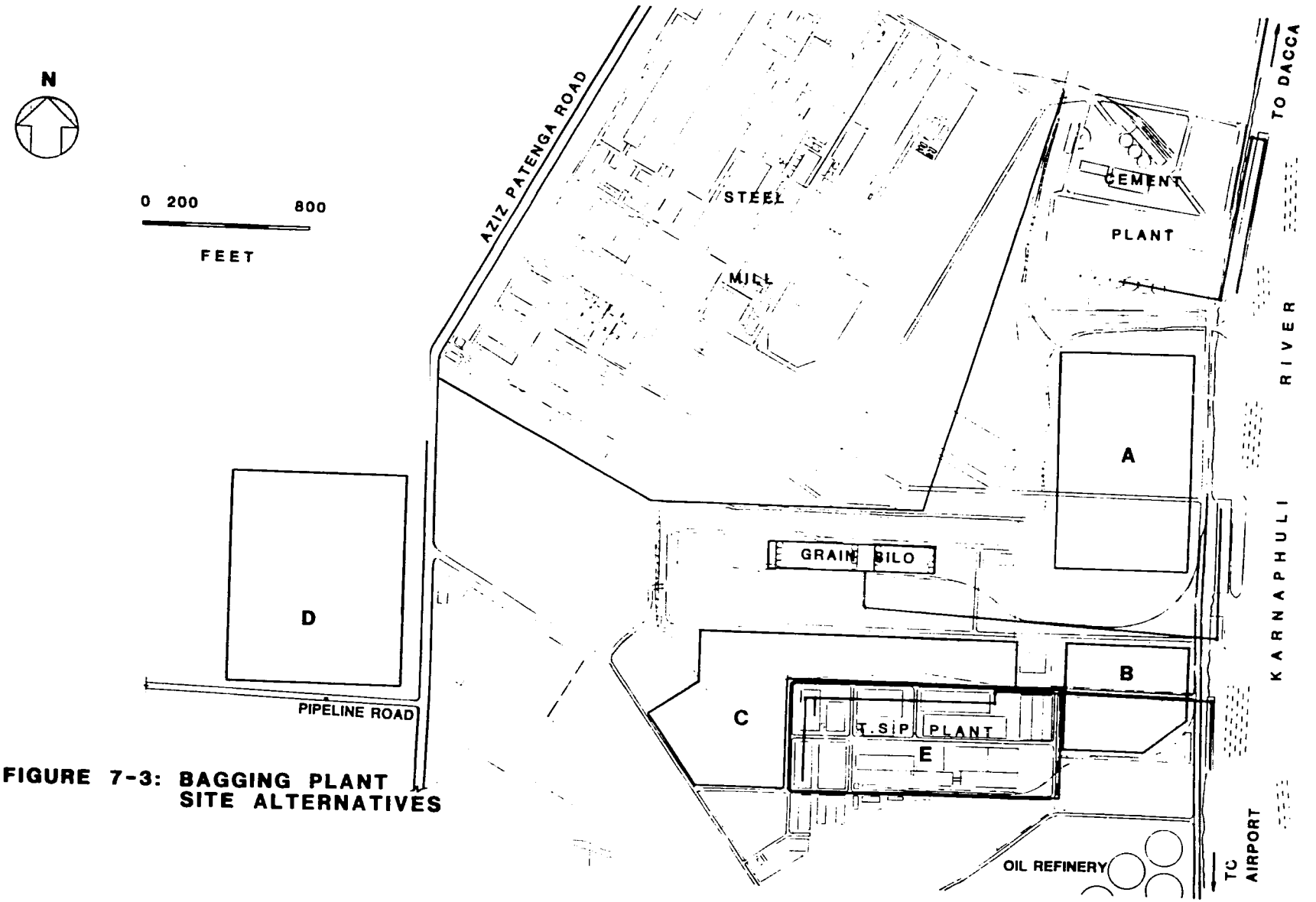


FIGURE 7-3: BAGGING PLANT SITE ALTERNATIVES

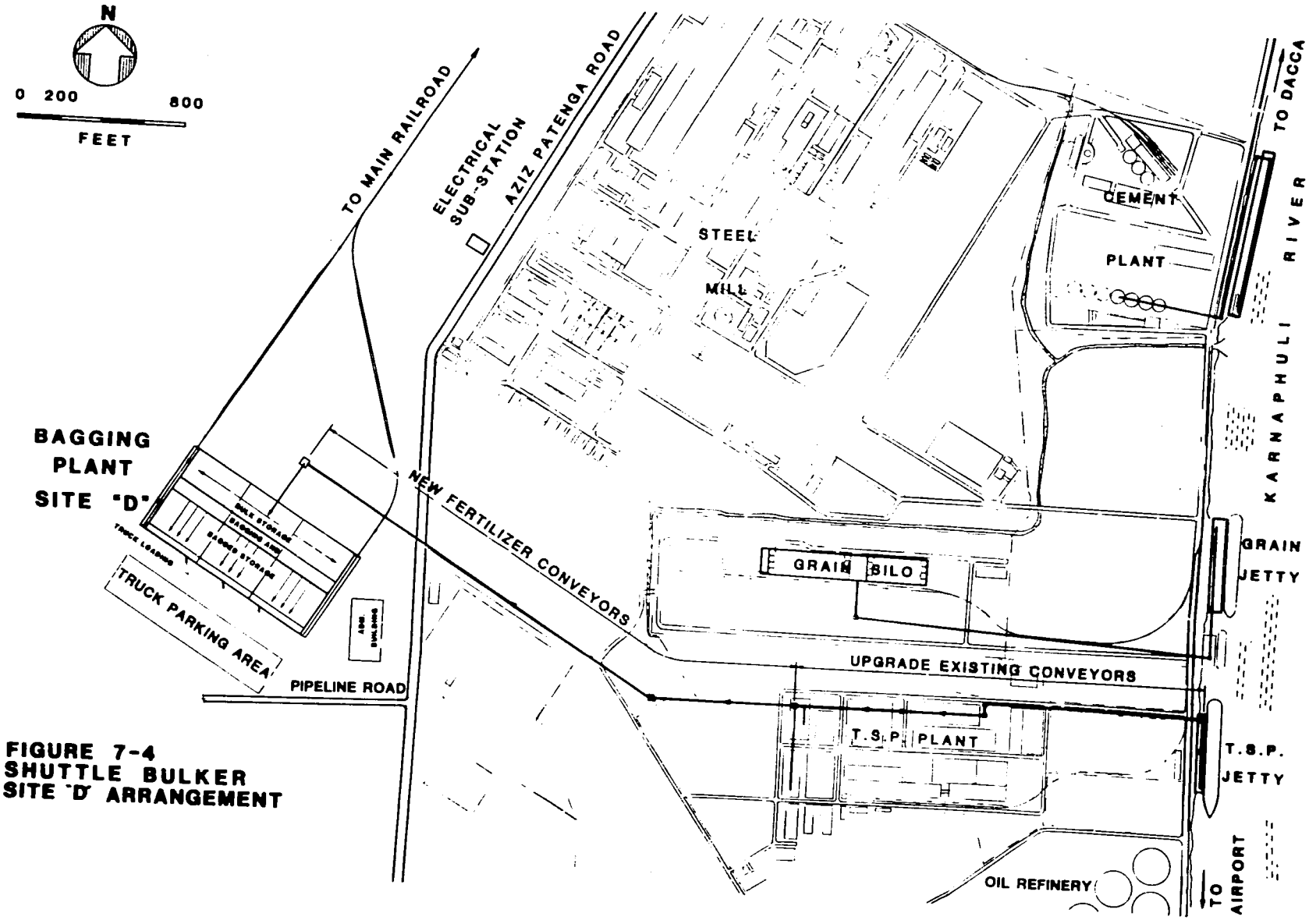


FIGURE 7-4
SHUTTLE BULKER
SITE "D" ARRANGEMENT

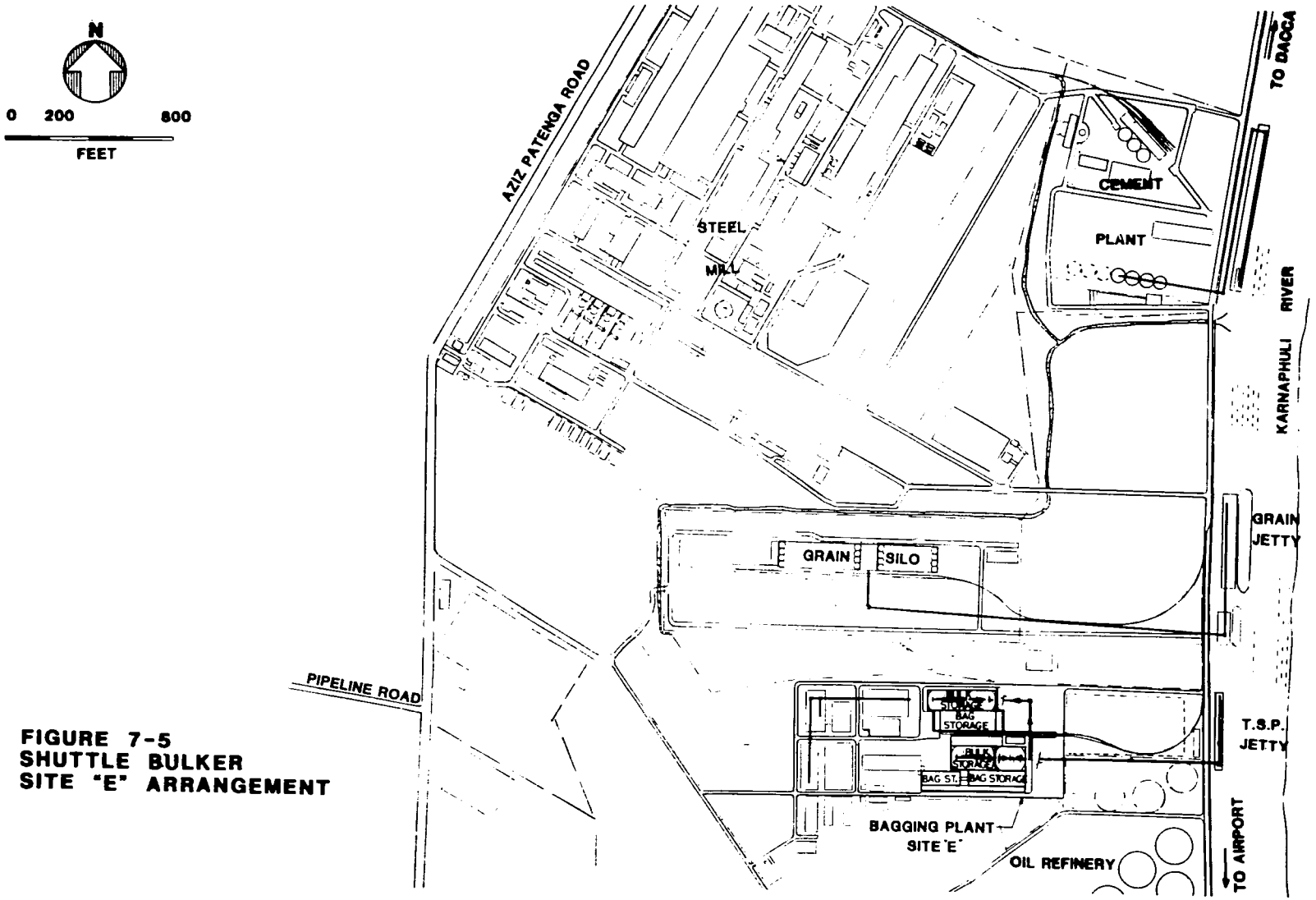


FIGURE 7-5
SHUTTLE BULKER
SITE "E" ARRANGEMENT

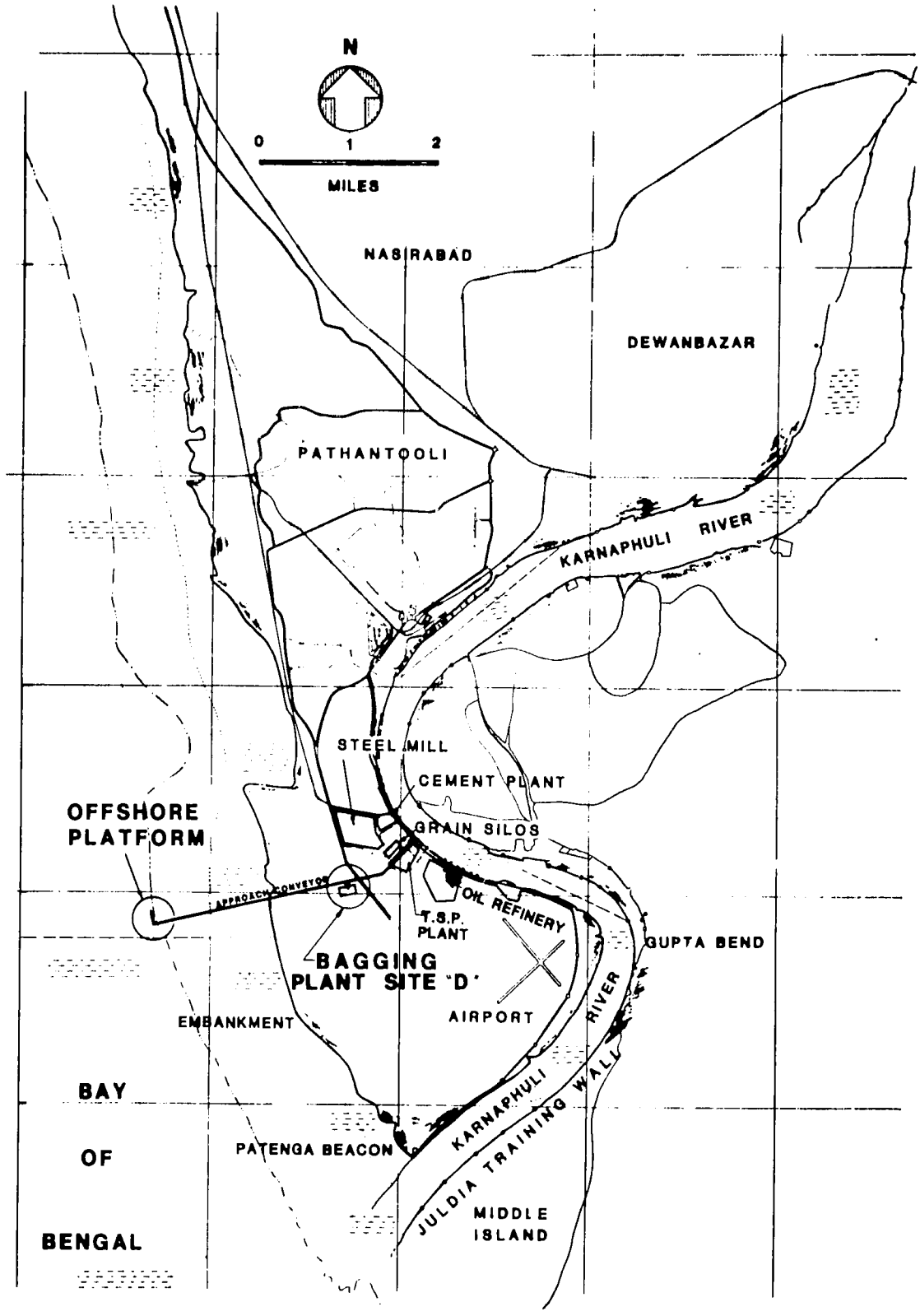


FIGURE 7-6: OFFSHORE PLATFORM SITE 'D' ARRANGEMENT

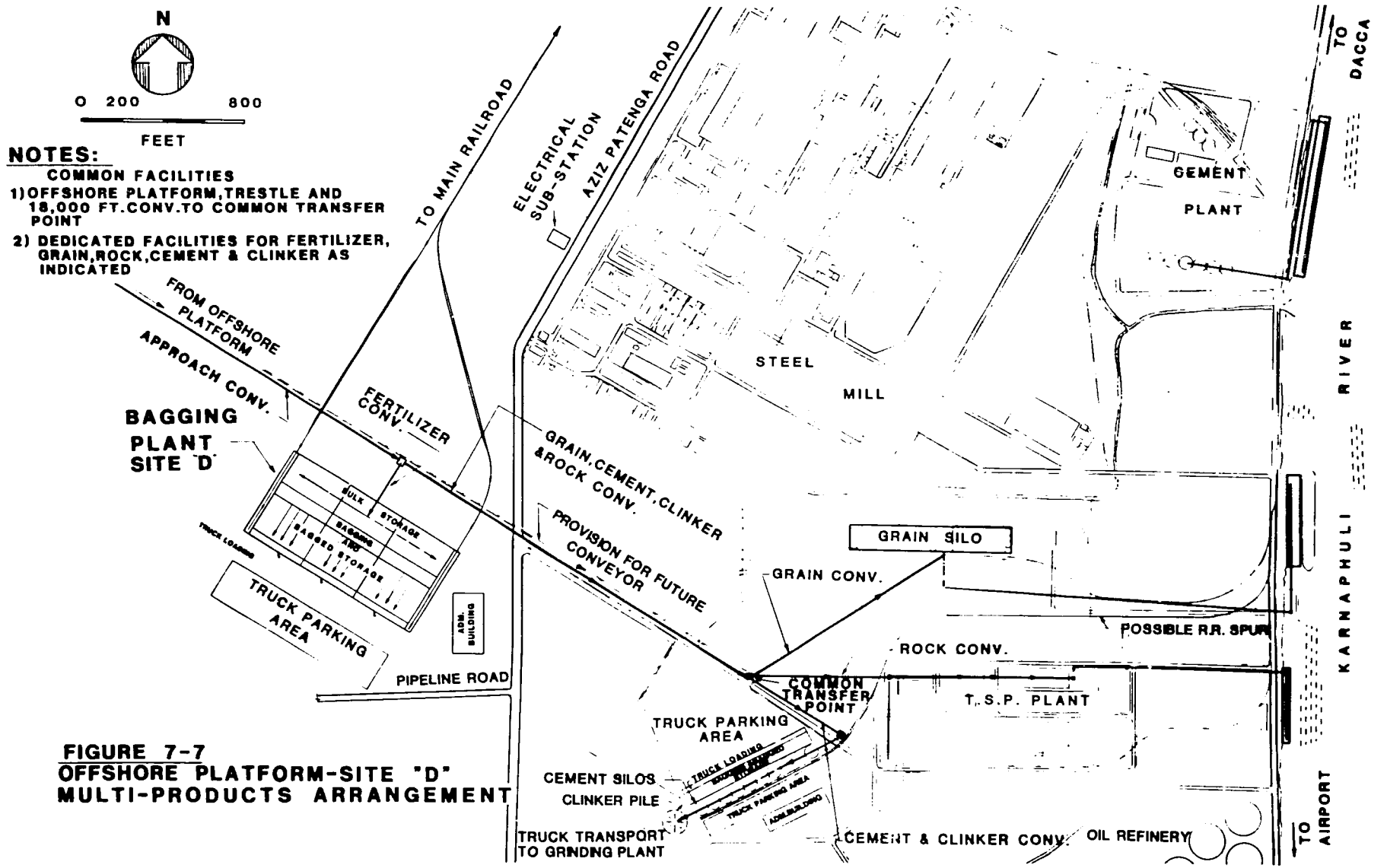


FIGURE 7-7
OFFSHORE PLATFORM-SITE "D" MULTI-PRODUCTS ARRANGEMENT

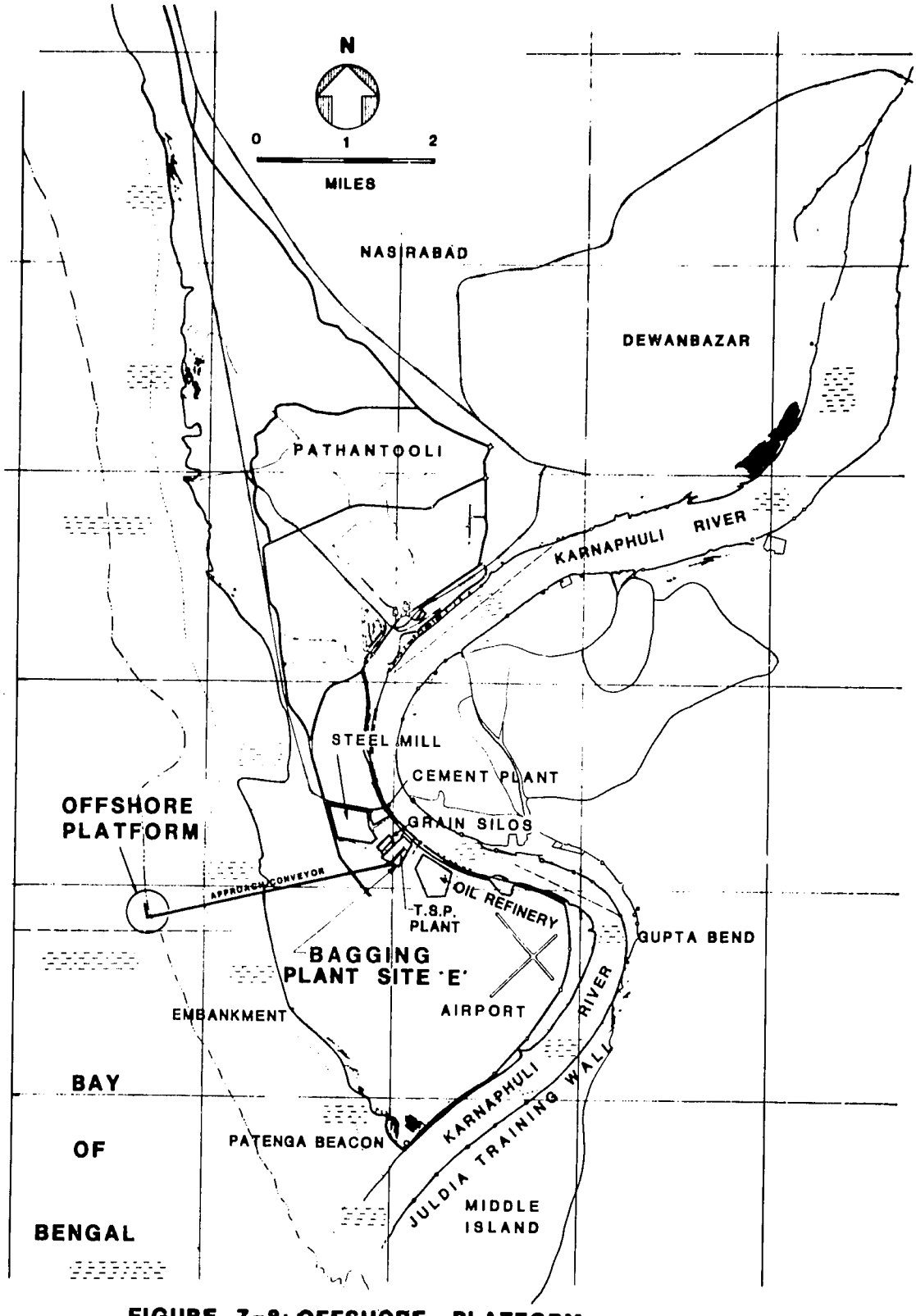
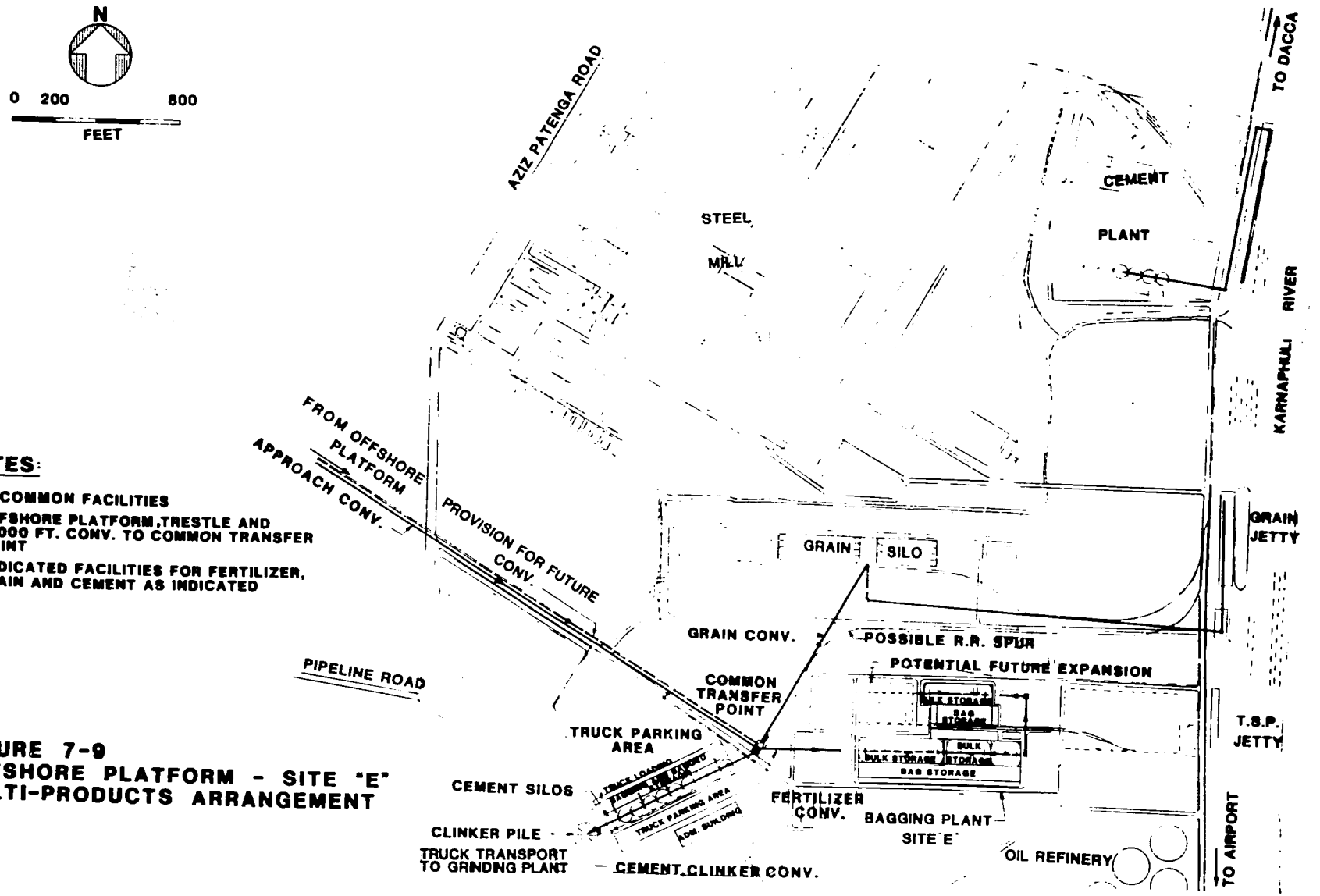


FIGURE 7-8: OFFSHORE PLATFORM SITE 'E' ARRANGEMENT



NOTES:

COMMON FACILITIES

1) OFFSHORE PLATFORM, TRESTLE AND 18000 FT. CONV. TO COMMON TRANSFER POINT
2) DEDICATED FACILITIES FOR FERTILIZER, GRAIN AND CEMENT AS INDICATED

FIGURE 7-9
OFFSHORE PLATFORM - SITE "E"
MULTI-PRODUCTS ARRANGEMENT

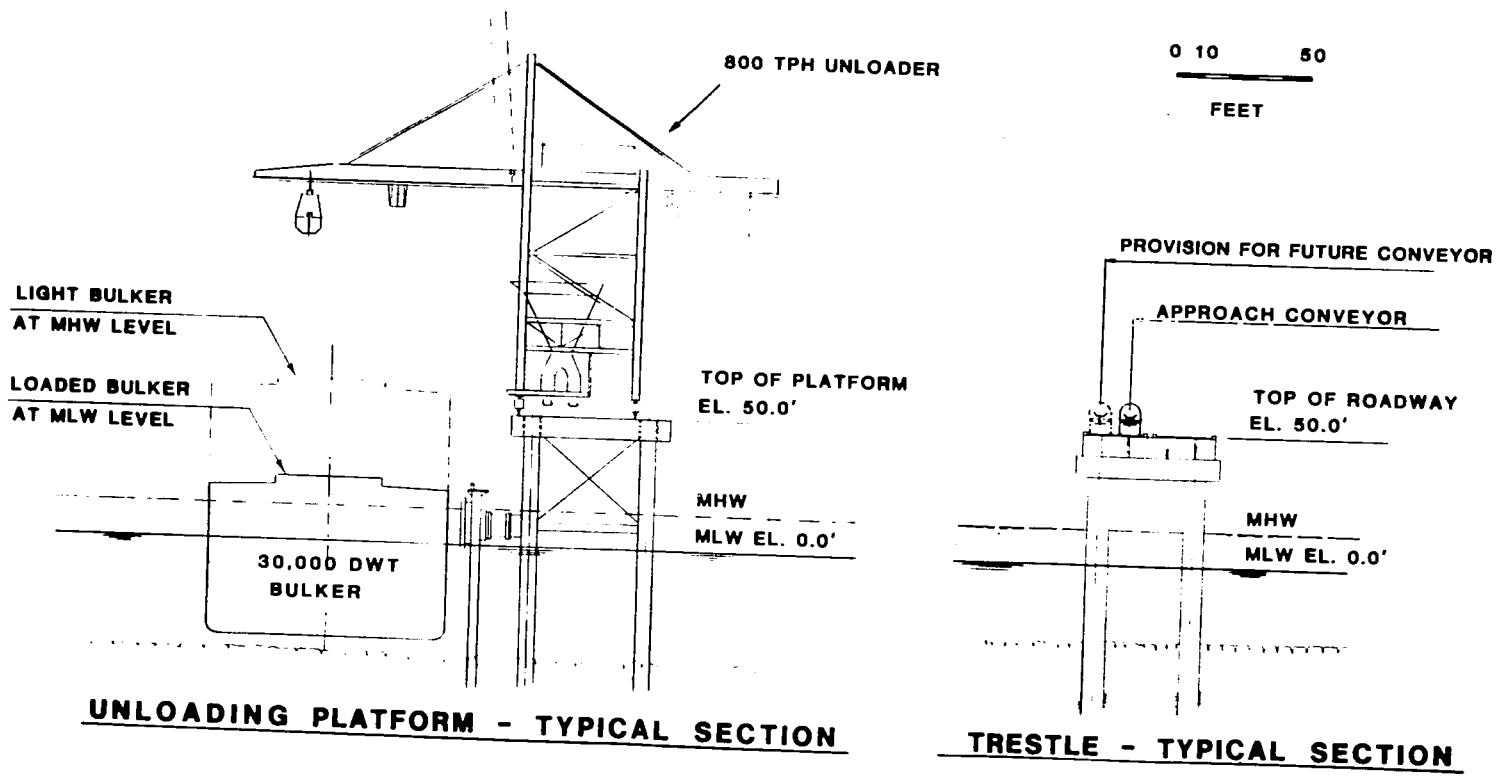


FIGURE 7-10: OFFSHORE PLATFORM TYPICAL SECTIONS

SECTION 8

CHALNA PORT

8.1 EXISTING PORT DESCRIPTION

Figure 1-1 shows the relative position of Chalna Port to the other major cities of Bangladesh. Chalna Port consists of an open anchorage and a marginal jetty with seven berths on the east bank of the Pusur River just north of the Mongla River junction. Port Chalna is approximately 70 miles north of the bar at the mouth of the Pusur river. Figure 8-1 shows the Pusur river, Port Chalna and Khulna, which is a port on the Rupsa river approximately 25 miles north of Chalna Port. The Port of Khulna is discussed in Section 9 of this report.

The channel from the sea to Chalna Port varies in width from approximately 1000 feet to 3 miles. A bar, about 5 miles wide with a least depth of 17 feet, lies in the approach to the Pusur river between 5 and 10 miles south of the entrance. Following pilot instructions, a depth of 24 feet can be carried over the bar at high water and vessels can then proceed to the Chalna Port Anchorage without severe draft restrictions at mean sea level. The Chalna Port Anchorage is adequate at all states of the tide.

The Chalna Port Authority is presently constructing a permanent port, to the north of the anchorage area on the east bank of the Pusur river. This is shown in Figure 8-2.

Under the present construction program seven marginal wharves are being built. There are five 600 foot long berths scheduled for completion by February 1979. The two other berths have piles driven and are partially complete. The tentative schedule for finishing this part of the work is mid 1979. Dockside mechanical equipment is not yet available, and although this is reported to be on order, it is anticipated that some two years will elapse before Chalna Port can be considered to be fully operational.

8.2 SITE ALTERNATIVES

8.2.1 General

The minimum requirements for the bulk import of fertilizers at Chalna Port are:

- A single 600 foot long ship berth with a minimum depth of 25 feet.
- Grab bucket unloading equipment.
- Bulk material handling conveyors.
- A bagging plant.
- Barge loading wharf.

Two suitable sites are available at the existing wharf. These are shown on Figure 8-2.

Site No. 1 includes the berth, Jetty No. 3, at the south end of the existing marginal wharf.

Site No. 2 includes the berth, Jetty No. 9, at the northern extremity of the existing marginal wharf.

8.2.2 Site No. 1

At Site No. 1, it was envisaged that the bagging plant would be located behind the wharf and that bagged fertilizer would then be hauled by truck to a barge loading wharf situated on the Mongla river, some ½ mile distant. Under this condition the barge dock would be isolated from the main wharves, and thus would not occupy or interfere with the main wharf face, which is better utilized for ocean going vessels. It was felt that the bank of the Pusur river to the south of Jetty No. 3 should be left free, since the area behind it is well suited for port administration buildings as indicated on the port master plan.

The distance from bag storage to the barge dock on the Mongla river is rather large and a disadvantage. Bag loadout traffic, which is forecasted to be in the order of 900,000 tons per year, may interfere with other road oriented movement in the general port area.

8.2.3 Site No. 2

Site No. 2 offers a better orientation in that the barge loading wharf can be an integral part of the fertilizer plant bagging system. The use of trucks for bag haul will not be necessary. In addition, with the prevailing wind from the southwest, any dust generated in fertilizer unloading will not be blown across the entire port complex.

It is recommended that Jetty No. 9, at the north end of the marginal wharf, be dedicated to fertilizer. The arrangements available are discussed in Article 8.3.

8.3 ALTERNATIVE PLANT ARRANGEMENTS

Figure 8-2 shows two possible arrangements of a bagging facility with an associated barge loading wharf, at the north end of the marginal wharf system, using Jetty No. 9 as the ship berth.

Alternative A shows the bagging plant oriented so as to feed a barge loading wharf which is parallel to the Pusur river. This wharf is arranged to load up to four 1000 ton barges simultaneously.

Alternative B also has the bagging plant facing a barge loading wharf, which is created by dredging a slip perpendicular to the Pusur River. The slip must be approximately 200 feet wide to allow free circulation of full and empty barges under tow. Provision can be made to load up to four 1000 ton barges simultaneously.

Alternative A is considered preferable since no dredging is required. It is recognized that 900 feet of river front is used up rather than the 200 feet required by Alternative B. However, since any port expansion to the north is far in the future, this is not judged to be a serious problem.

8.4 RECOMMENDED FACILITY DESCRIPTION

Reference is made to Figure 8-3 which shows the physical layout of the proposed fertilizer handling system at Chalna Port. This figure shows an enlarged view of Site Alternative A as described in Article 8.3 above.

Delivery vessels, which have been partially unloaded at Chittagong will moor to Jetty No. 9. Ship unloading will be accomplished with two gantry type, rail mounted, travelling clamshell rigs which are rated at 650 metric tons per hour. Fertilizer will be fed onto the jetty conveyor at a regulated rate from each of the unloaders. Sufficient surge hopper capacity will be furnished on the unloaders to ensure continuous belt loading. The material will be carried to the north end of Jetty No. 9 and transferred to belt A. Provision will be made on belt A to weigh all incoming material for inventory control and comparison with vessels' manifests. Material will then be transferred to belt B, which will carry the material to the center of the bulk storage area of the bagging plant. At the center of the bagging plant the material will be dumped and fed to a reversible shuttle conveyor, C, which travels on a runway under the ridge of the storage building. Incoming bulk material will be stacked in one of three discrete storage spaces. The conveyor system is rated at a capacity of 1400 tons per hour.

Material will be reclaimed from bulk storage with front end loaders. There are four front end loaders in the recommended equipment list. One loader will operate in each of the three storage bays and one will serve as a spare to allow preventive maintenance to be carried out.

A single bucket elevator is provided in each product bay. The boot of these elevators will be fed by a front end loader. The elevated material passes onto a screen deck which removes oversize lumps and lets the granulated product pass through into a surge hopper. Lumped material can be collected for crushing.

From the surge hopper granulated product is distributed to each of three bagging lines by positive feed screw conveyors. Each bagging line is provided with an automatic bag filling system which has an accuracy of plus or minus one half of one percent. After bagging, a short conveyor carries the filled bag through a sewing head. From the bag conveyor the bag is deposited onto a bag distribution conveyor which carries the bag to the barge loading apron on the west side of the bagging plant. Each bag distribution conveyor will be equipped with a movable, adjustable plow. This arrangement will allow a

bag to be removed on either side of the bag distribution conveyor at any point along its length. Thus a bag can be carried to the extreme end of the conveyor and for loading directly to a barge or removed at intermediate points and placed in any of the designated storage areas.

Mooring space is provided for four 1000 ton barges, which can be loaded simultaneously. It is recommended that the barge loading operations be carried out manually. The arrangement of a series of floating pontoons, connected to land by bridge type loading ramps, allows loading to be done expeditiously without congestion. Barge loading rates up to 4000 tons per day are predicted and required to handle the anticipated annual throughputs of 900,000 tons per year.

8.5 RECOMMENDED SYSTEM CAPACITY

The forecast of fertilizer throughput at Chalna Port is 900,000 metric tons per year. Of this total, 470,000 tons are forecast for the Khulna District and the remaining 430,000 tons to the Barisal, Dacca areas.

The loading rate for each barge is 1000 tons per day. Loading will be carried out manually. A combined laoding rate of 4000 tons per day requires 225 operating days to achieve a 900,000 ton per year throughput. This is the equivalent of nine 25 day months. Considering ship arrivals and the interruptions due to rain and the monsoon season, this is a reasonable handling rate for the plant. Each bagging line is capable of handling fifteen 50 kilo bags per minute or 45 metric tons per hour. On a daily basis this instant capacity must be derated to 25 tons per hour. Thus each line is good for 500 tons per day on a three shift twenty hour day. Two lines must be dedicated to loading each of four barges. Eight lines are required and nine lines are provided.

It is recognized that at times there may be more than one bulk storage bay dedicated to a single material. Operation of this plant will require careful control of ship arrival schedules in order to make the most efficient use of the installed equipment.

8.6 ESTIMATED FACILITY COSTS

Appendix D has an estimate of the capital costs for the Chalna facility. It has been assumed that Jetty No. 9 is available at no cost and that there is no substantial cost associated with site development.

In addition, it has been assumed that electrical power will be available to service the fertilizer complex. Therefore the capital costs presented herein do not include any allowance for electrical power generation.

The capital cost for the Chalna Port fertilizer complex is estimated to be in the order of $33,200,000.

8.7 SCHEDULE

It is anticipated that the Chalna facility can be made operational within three years of approval to proceed, given the availability of funds. A discussion of the entire program schedule including engineering and construction is to be found in Section 13 of this report.

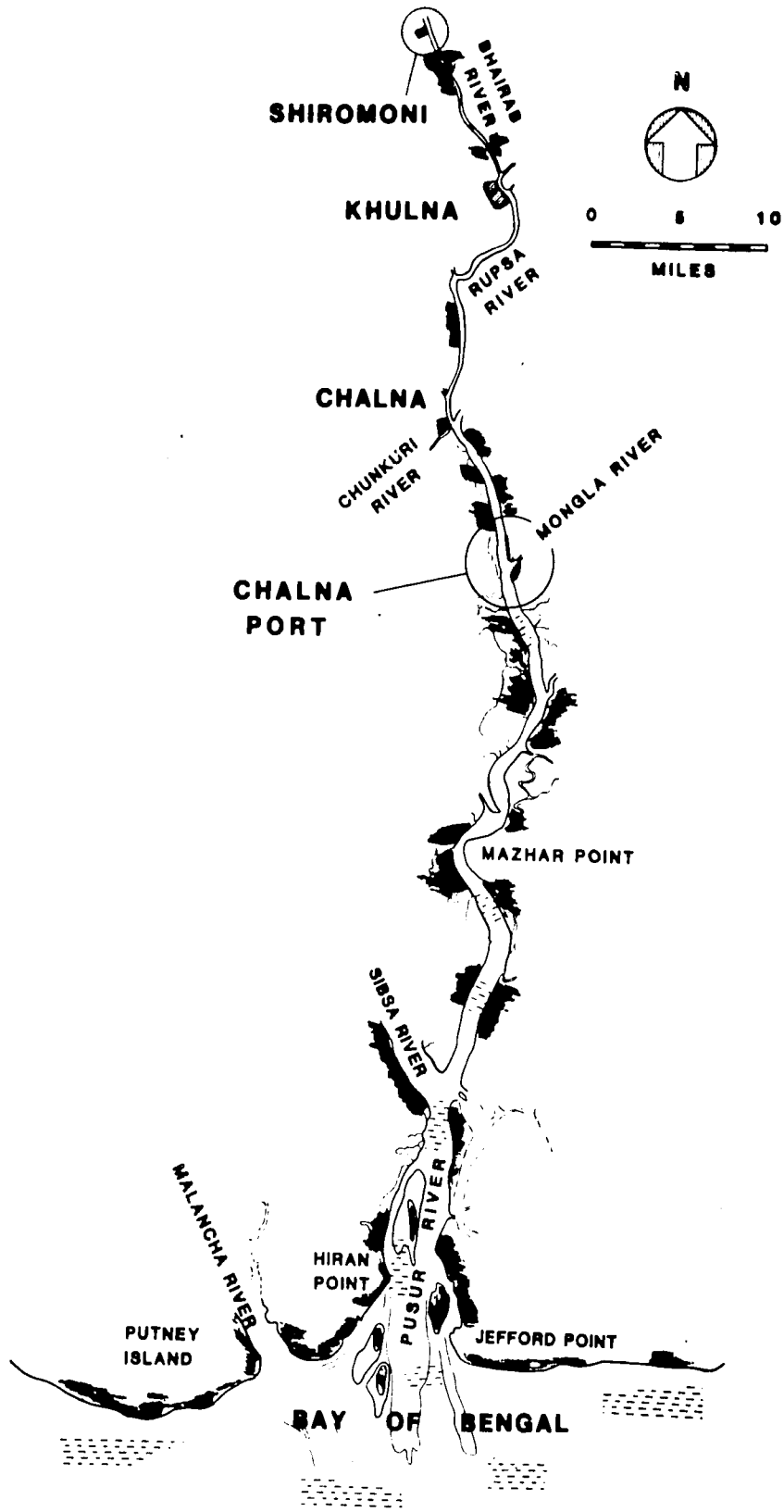


FIGURE 8-1
APPROACHES TO CHALNA PORT AND KHULNA

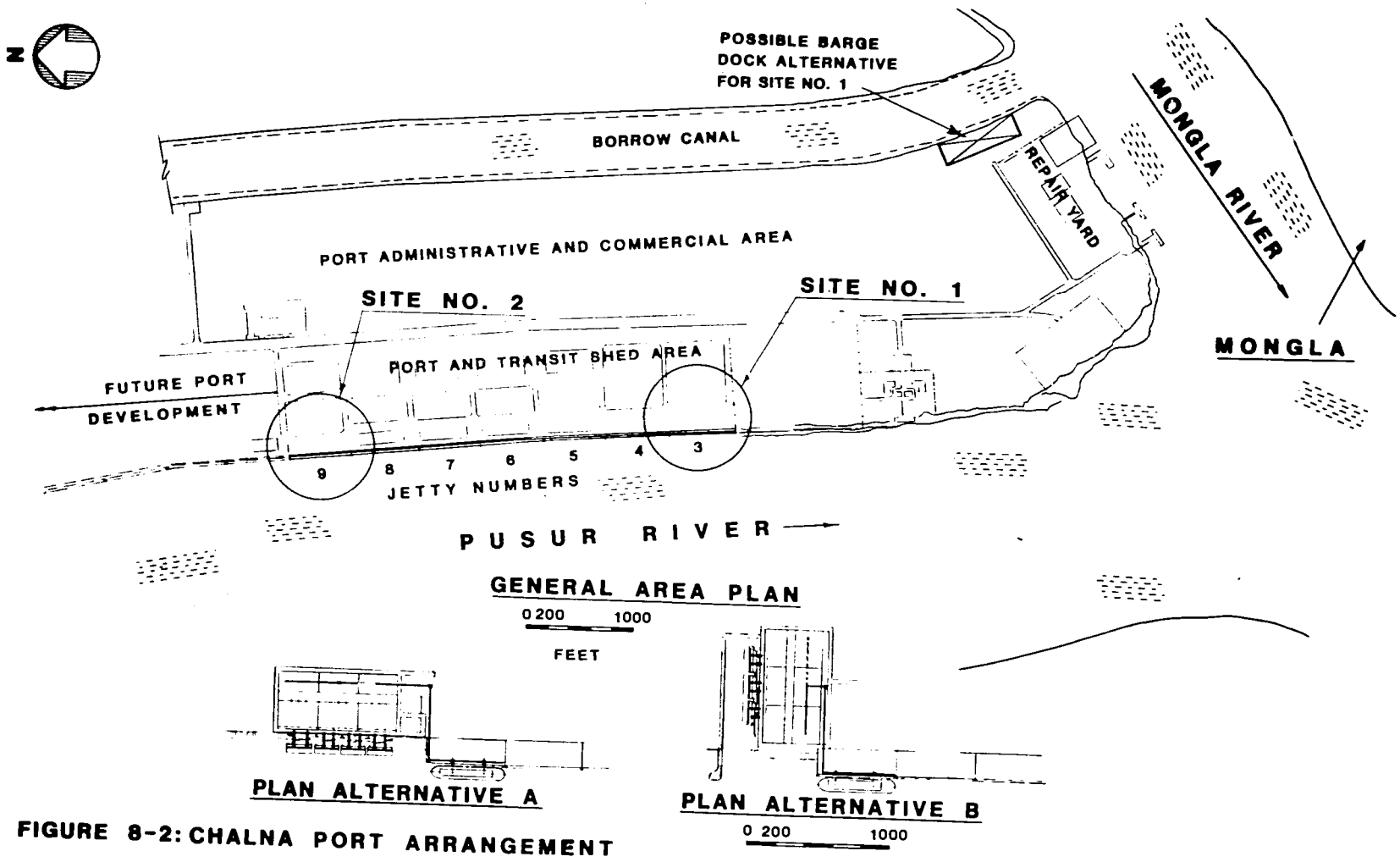


FIGURE 8-2: CHALNA PORT ARRANGEMENT

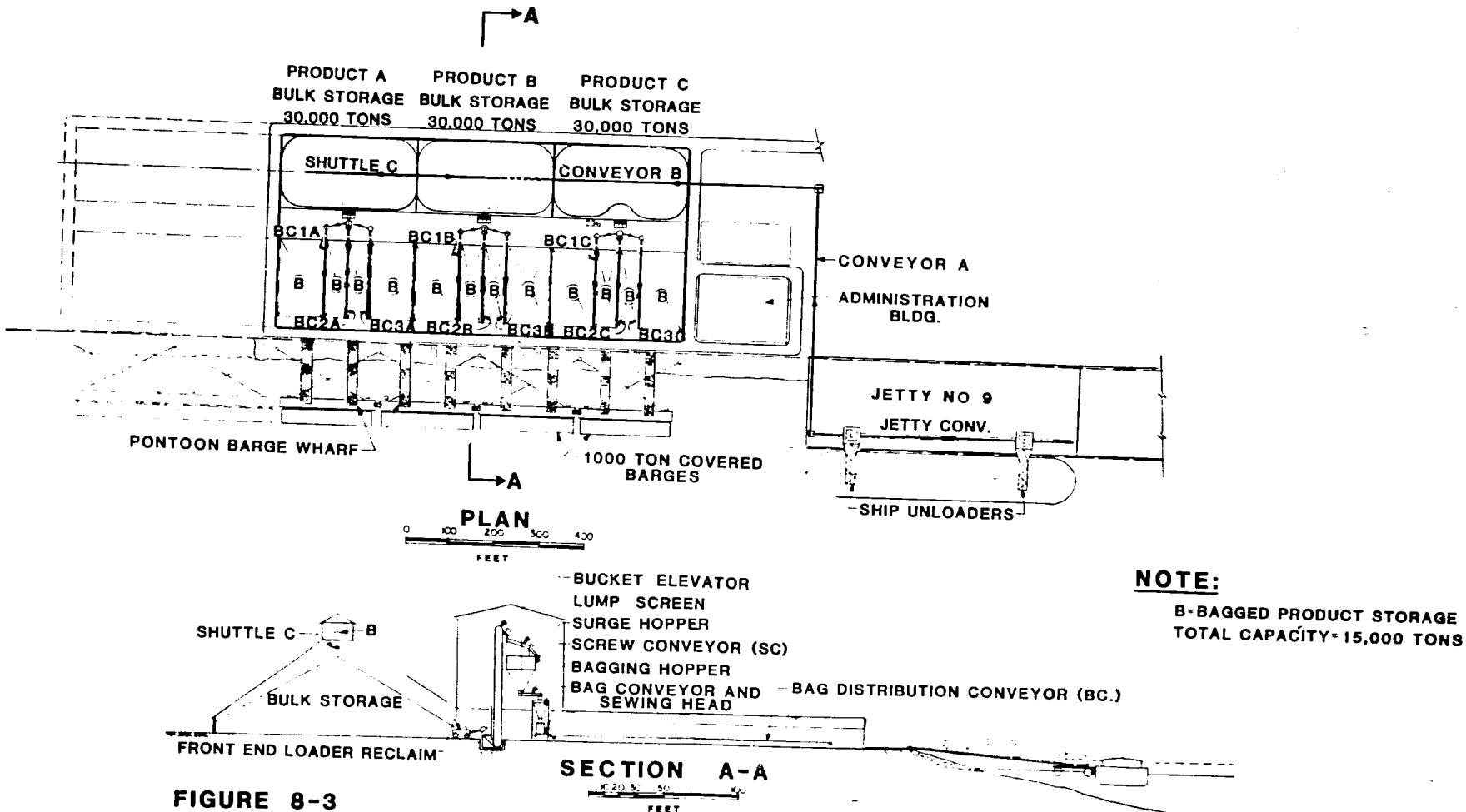


FIGURE 8-3
RECOMMENDED ARRANGEMENT-CHALNA PORT FERTILIZER COMPLEX

SECTION 9

THE KHULNA DISTRICT TRANSSHIPMENT TERMINAL

9.1 EXISTING PORT DESCRIPTION

Figure 8-1 in Section 8 of this report shows the location of Khulna and Shiromoni with respect to Chalna Port. The Pusur, Rupsa and Bhairab rivers are the waterways between Chalna Port and Shiromoni. Shiromoni is a river front community on the Bhairab River approximately 10 miles north of Khulna. They are designated as Class A waterways with a minimum available depth of not less than 12 feet. The rivers are wide enough to permit two way traffic.

Khulna is a city on the Rupsa river approximately 25 miles north of Chalna Port. Khulna is the southern terminus of the broad gauge railroad that serves the western portions of Bangladesh. At present, cargoes received at Chalna Port are brought to Khulna by barge and dispatched to the interior by rail, truck and barge. The primary internal distribution of product is by rail, especially to the northwest sector. In the 1977/78 year the distribution of fertilizer cargo from Khulna by transport mode breaks down as shown in Table 9-1.

TABLE 9-1

FERTILIZER DISTRIBUTION FROM KHULNA - 1977/78
(1000's MT)

Transport Mode	Destination Sector NW		SW		TOTAL	
Rail	100.7	47%	37.7	17%	138.4	64%
Truck			40.0	19%	40.0	19%
Water			37.7	17%	37.7	17%
TOTAL	100.7	47%	115.4	53%	216.1	100%

The barge traffic moving to the southwest sector is assumed to be carrying fertilizer cargoes originating at domestic fertilizer production facilities in the north, or very small scale shipments for local usage. Considering rail and truck shipments

only, 77% or 138,000 tons was handled by rail and 23% or 40,000 tons by truck. Therefore, it is a prime requirement that railroad loading facilities be made available at the Khulna District fertilizer transshipment terminal.

Khulna is an industrial center with jute mills, sawmills, flour mills, an oil depot, small engineering works, and a shipyard. It has its own independent power station which serves the entire Khulna district. Water borne traffic is heavy in Khulna and to the south; but, the northwest hinterland, due to lack of navigable waterways, will always be heavily dependent on road and rail transport with particular emphasis on railroads.

Khulna is classed as an inland port and is expected to have increasing importance as the Chalna Port development becomes operational.

Figure 9-1 shows Khulna and the waterfront facilities available for the transfer of cargo from barges to landside for loading onto rail or truck for delivery to inland warehouses.

Roosevelt Jetty, labeled as Site A on Figure 9-1, is the single existing public facility for handling general cargo from barges in Khulna. The main jetty is 750 feet long and there are two wing wharves each 400 feet long. The jetty is suitable for manual or light mechanical barge loading and unloading. A 12 foot depth of water, which is necessary for large barges, can be maintained along the face of the jetty. The width of the channel in front of the jetty is sufficient to enable all docking and barge maneuvering operations to be carried out. The tidal range is substantial, 6 feet, but the changes in water level due to tides is less than at Chalna Port. The current is reversible with velocities of about 3 knots downstream and 2 knots upstream.

The Roosevelt jetty is suitable for the unloading and loading of barges up to 3000 DWT with little or no restriction as to draft. However, this jetty is severely congested with barges moored in five rows, together with more barges waiting to unload elsewhere in the river. Transit shed space on the jetty is limited.

There are two other sites in Khulna, which have the potential of development for a fertilizer handling facility. These are labeled B and C on Figure 9-1. Though separated by existing railroad spurs, which from a modest railroad yard, sites B and C could be combined. Together they would form an area of 400 yard deep by 400 yards on the river front. There are no existing mooring facilities for barges at these sites. Approximately one half of the site is subject to flooding during the monsoon period. This area would require filling to bring it above flood level. The existing trackwork is in an advanced state of decay and would require complete replacement to be used as an effective intermodal cargo transfer operation. Presently these two sites are occupied. Cite C, is used for storage of bulk coal. Site B is used for storing raw logs.

Figure 9-2, a sketch of the BADC property at Shiromoni located on the west bank of the Bhairab river, shows the relationship of the property to existing railroads and highways. There is no existing railraod spur on the site. However, the mainline railroad and the main highway between Jessore and Khulna are within 0.7 miles to the west. The Bhairab river is 400 feet wide and 12 feet deep all the way to Khulna. There is an existing riverfront pontoon barge dock on the property. A single barge can be unloaded at one time. All fertilizer arrives bagged, in barges of mixed size ranging from 300 to 750 tons. Materials are handled manually. A godown with a storage capacity of 6000 tons exists on the site. In addition to the fertilizer godown, BADC also has a seed godown and facilities of their M & P Division on this site. The existing structures on the site are identified on Figure 9-2.

Other industries in the immediate area of the fertilizer compound are a jute mill to the north, and a telephone communications training center immediately to the south. All are served by a hardtop branch road which connects to the main road.

The general area to the west of the site is cultivated and is above flood level. It was reported that the area between the godown and the river was flooded in 1974. The godown,

being on higher ground, was not affected. To make effective use of the area between the existing godown and the river front, an average of some 4 feet of fill will be required.

Presently, ocean going ships unload bagged fertilizer into barges at the Chalna Port anchorage. The barges proceed to Shiromoni under tow and are unloaded manually at the BADC facility. The different bagged fertilizer products, are stacked in the existing 6000 ton capacity godown. The material is removed from the site in 5 ton stake body trucks. Fertilizer for delivery to godowns within 50 miles of Khulna, is carried directly by truck. Material to more distant points is presently trucked to the Daulatpur rail terminal for loading on railcars. From there the fertilizer is carried to destinations outside the 50 mile radius.

9.2 SITE ALTERNATIVES

Investigation of the general Khulna area revealed four potential sites for use as reception centers for fertilizer transshipped from Chalna Port. Sites A, B and C are shown on Figure 9-1 and Site D is shown on Figure 9-2. All cargo is assumed to be received in barges as recommended in Article 4.5. Furthermore, a throughput volume of up to 470,000 metric tons of bagged fertilizer per year will have to be handled through the Khulna district for dispatch to the western regions of the country. This amount is approximately 52% of the estimated fertilizer to be handled thorugh the Chalna Port. It represents an increase of 117% over that handled through the Khulna Port area in the 1977/78 operating year.

Alternative A: Roosevelt Jetty, is considered too crowded and overloaded with its present cargo throughputs to handle any additional load. Being a public facility, there is no assurance for priority on fertilizer handling.

Alternatives B and C: These spaces are presently occupied by separate tenants. Coal and raw logs are now stored there. The trackwork is in disrepair and would require complete replacement. New waterfront facilities would have to be provided to handle barge traffic. Another serious problem would be that of establishing BADC operational custody of the area. This would probably require a good bit of time.

Alternative D: The property at Shiromoni described in Article 9.1 and shown in Figure 9-2 is already under BADC operational control. The site consists of a total area of approximately 2500 square yards. An existing 6000 ton godown exists with an area of 7400 square yards available for fertilizer handling. A barge unloading wharf exists. However, improvements would have to be made to accommodate the greatly increased throughput demands in the future.

9.3 RECOMMENDED FACILITY

Considering all of the above, it is recommended that the BADC [illegible] Shiromoni be developed as the Khulna District Intermodal Transshipment Terminal for bagged fertilizer.

Figure 9-2 shows the general path of the rail connection from the mainline to the site. The final routing of this line is subject to approval by local authority since it traverses property allocated to industrial companies. The exact path of this spur will be established as part of the final engineering program. Figure 9-3 shows the recommended layout of the rehabilitated site.

An open sided, roofed structure to the east of the existing godown is recommended to provide increased shelter from the elements. The newly roofed area and the existing godown form the new bag handling transit shed. Three motorized bag handling conveyors will carry bags which have been unloaded from barges, into the transit shed. This will allow parking for approximately 26 rail cars. A truck loading area is provided on the north side, convenient to one of the bag conveyors. All conveyors in the shed will be elevated to allow walk space underneath in the north-south direction. The east end of the conveyors will be at a low level convenient for loading. Two barge berths are provided on the riverfront.

The cargo handling process will start with barge unloading. It is planned that each barge will be unloaded manually with two lines of circulating, manual bag carriers. Ramps from the barge mooring pontoon wharf are provided for this movement. Bags will be deposited on bag conveyors which will carry the bags into the transit shed. Movable discharge plows will be mounted on each

conveyor line. These will be arranged to allow discharge to either side of a conveyor. In addition they will be set up to allow a preselected number of bags to pass underneath before discharging a bag. With this arrangement a number of bag handling crews within the transit shed can operate simultaneously. Bag storage areas with a total capacity of 10,000 tons are provided. The objective of the operation is to load directly onto rail or truck. Thus the building will serve as a transit shed and not a godown. The bag storage areas will be filled only when there are no rail cars or trucks to carry the material away.

9.4 RECOMMENDED SYSTEM CAPACITY

This transshipment station must handle 470,000 metric tons of bagged material per year. To establish a design basis it is assumed that 80% of this annual volume will be delivered in an 8 month period. This results in an average monthly thorughput of 47,000 metric tons. Assuming 25 working days per month, the system must handle about 2000 tons on any given day. Using 1000 ton barges, 2 barges per day must be received, unloaded and dispatched. Twenty hours are allowed for barge unloading and four hours for barge maneuvering.

Barges will be unloaded manually, using two lines of bag carriers on each barge, it is estimated that an unloading rate of ten 50 kilo bags per minute per line can be maintained, if sufficient manpower is available to relieve personnel often. At this rate, 2000 tons can be unloaded from barges in 17 hours.

There are three bag conveyors provided to serve the transit shed. Each conveyor will be designed to handle 20 bags per minute or 1000 tons per day. Therefore two of the three conveyors will handle the largest required daily barge unloading rate.

It is estimated that up to 50% of the daily cargo could be dispatched by truck and up to 75% by rail. This gives a required loading rate for trucks of 1000 tons per day and 1500 tons per day for rail cars. However, the total maximum daily throughput will not exceed 2000 tons.

It is estimated that a 5 ton truck could be loaded with 50 kilo bags in 10 minutes. This is a handling rate of ten bags per minute.

Assuming that a total of 20 minutes is required to park, load and move a truck out, each loading spot has the capacity to handle 15 tons per hour. Thus only four loading spots are required in a 20 hour day. A continuous truck loading dock approximately 200 feet long is provided along the north side of the open transit shed. The existing truck scale is to be used for loaded truck checkout.

Each rail spur within the transit shed will hold 12 to 13 rail cars. Each car having a capacity of 20 tons. In order to handle 1500 tons a total of 75 cars will be required. Thus, three 25 car trains per day must be moved into and off of the site. A train must be loaded with 500 tons in six and two thirds hours or at a rate of 75 tons per hour. Rail cars can be loaded from the transit shed at the rate of 30 tons per hour per gang. Since there is adequate spur length, four gangs loading a train can work comfortably and achieve the required loading rate. Eight gangs could also be employed when the transit shed is full and barges are being unloaded at full rate. Arrangements must be made with the railroad to remove filled trains and furnish empty cars. It will require advance scheduling to ensure the expeditious delivery and removal of three 25 car trains per maximum day.

9.5 ESTIMATED FACILITY COSTS

Appendix D has a summary estimate of capital costs for the Shiromoni facility. The estimated capital cost for the recommended site modernization is $ 5,973,000.

9.6 SCHEDULE

It is estimated that new construction at the Shiromoni transshipment facility will require 9 months. This is based upon a phased program that will minimize the effect of new construction upon everyday operations. Since the total volume of throughput is increasing annually, it is crucial that the recommended improvements be made as quickly as is feasible.

A complete program schedule for Shiromoni is discussed in Section 13 of this report.

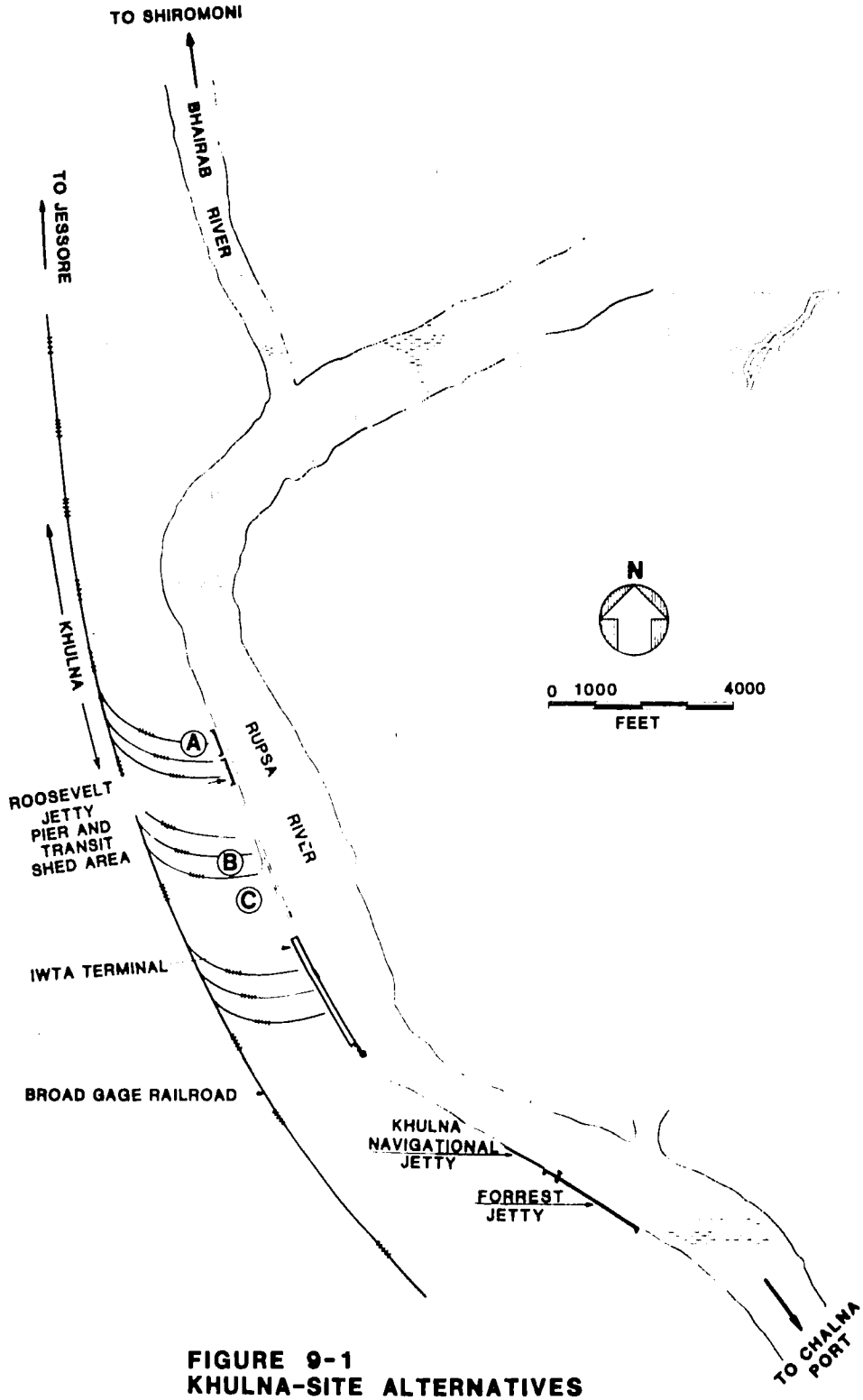
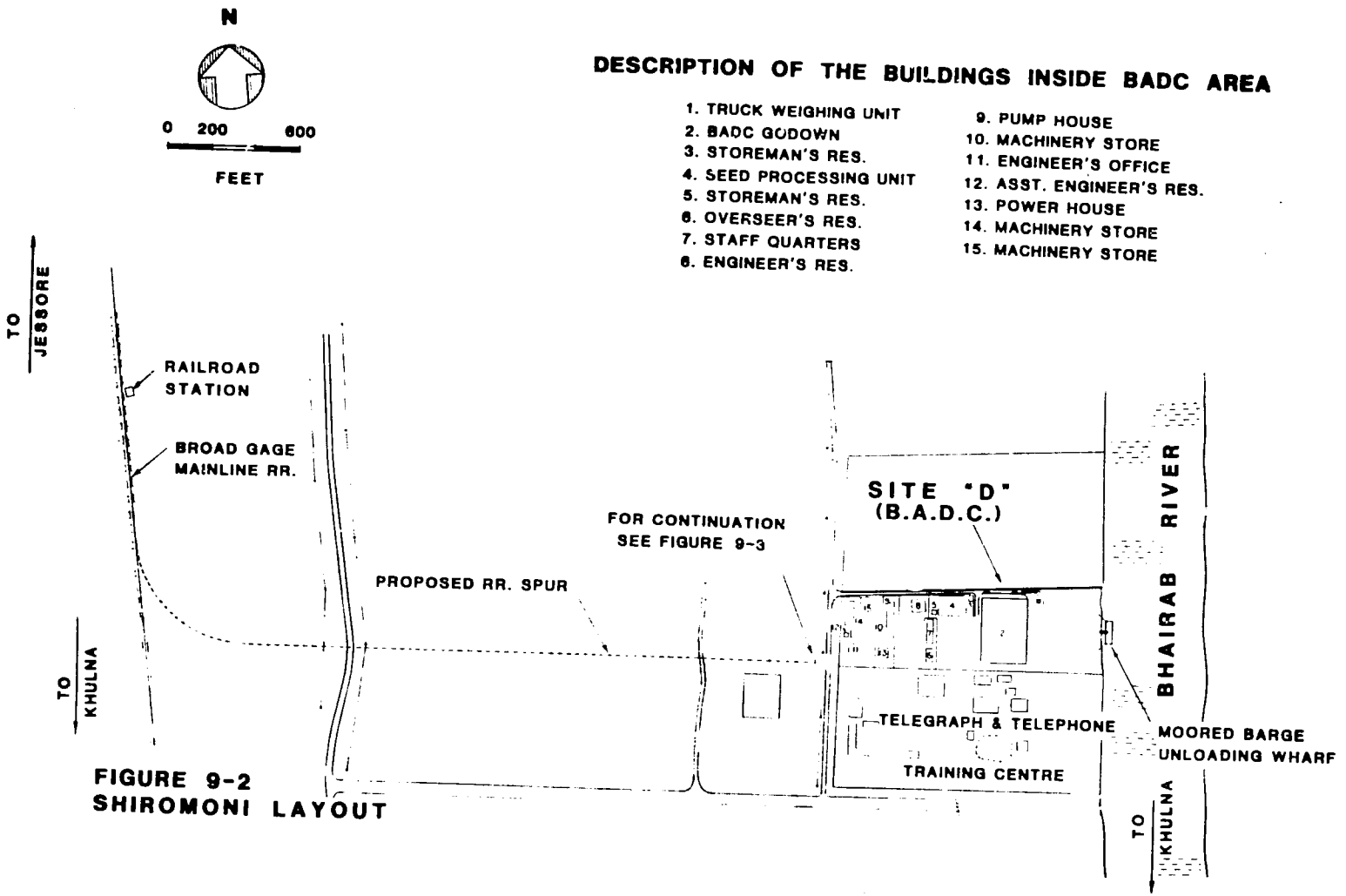


FIGURE 9-1
KHULNA-SITE ALTERNATIVES



DESCRIPTION OF THE BUILDINGS INSIDE BADC AREA

1. TRUCK WEIGHING UNIT
2. BADC GODOWN
3. STOREMAN'S RES.
4. SEED PROCESSING UNIT
5. STOREMAN'S RES.
6. OVERSEER'S RES.
7. STAFF QUARTERS
8. ENGINEER'S RES.
9. PUMP HOUSE
10. MACHINERY STORE
11. ENGINEER'S OFFICE
12. ASST. ENGINEER'S RES.
13. POWER HOUSE
14. MACHINERY STORE
15. MACHINERY STORE

FIGURE 9-2
SHIROMONI LAYOUT

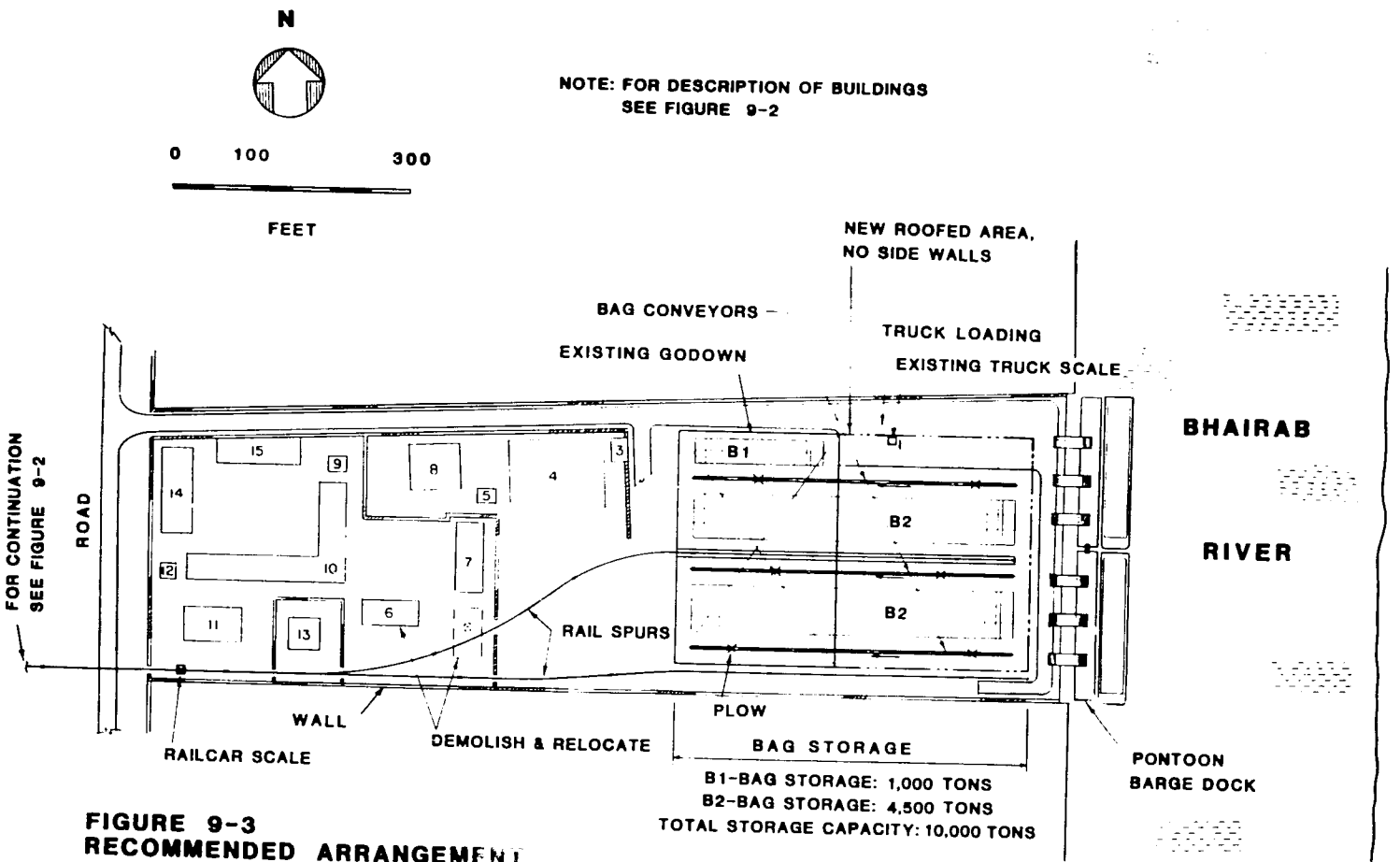


FIGURE 9-3
RECOMMENDED ARRANGEMENT
SHIROMONI FERTILIZER COMPLEX

SECTION 10

CHALNA PORT TO KHULNA DISTRICT TRANSPORT

10.1 GENERAL

As stated in Article 4.5, barges will be the transport media for all bagged fertilizer transshipped from the Chalna Port bagging plant.

For a forecast of 470,000 tons of fertilizer per year going to the Khulna District, it is projected that 47,000 tons would have to be transported to Khlulna as the maximum for one month. For a 70-mile round trip at 7 kts, with two 1000 ton barges per tow, the elapsed time is 10 hours. Loading and unloading take one day each. With 2 hours allowed for miscellaneous side effects it will take 2½ days for a round trip for a pair of barges.

24 round trips are required per month, to deliver 48,000 tons. This requires 60 tandem barge operating days. Using 25 days per month, six barges are required. To account for contingency eight 1000 ton barges are identified as the fleet requirement.

Tugs can make the round trip in 10 hours. Thus a tug can deliver 2 barges and return two barges each day, that is one round trip per day. Since 25 trips per month per tug are required, one tug is sufficient. The tug will operate 235 days per year to handle this cargo volume. This leaves sufficient time for maintenance.

10.2 TRANSPORT FLEET

Barges having a nominal capacity of 1000 DWT are recommended. Figure 10-1 shows the outline dimensions of these barges. They are sized for easy handling in the crowded waterways in the vicinity of Khulna and the narrower water passage afforded by the Bhairab River north of Khulna. The barges have completely covered cargo areas for protection of the bagged fertilizers from the elements. The general outline description of the recommended barge is as follows:

LOA	195'0"
Beam	35'0"
Draft	8'0"

The tug, which should be a pusher type, river towboat is sized at 1700 shaft horsepower to handle the specified tows upstream.

Since barges and the tug are important elements in the fertilizer distribution system, they should be procured as part of the capital investmetn program.

10.3 ESTIMATED COST

The estimated cost of the transport system is as follows:

Capital Cost

8 - 1000 DWT Barges	$3,200,000
1 - 1700 SHP Tug	$1,200,000
TOTAL	$4,400,000

Annual Operating Cost

1 tug with crew	$1,040,000

10.4 SCHEDULE

Delivery of barges of this type can be made in 6 to 9 months from notice to proceed with fabrication.

Delivery on tugs of this size in the world market is in the order of 18 months.

This fleet could be used productively at the present time. Therefore, orders should be placed for this equipment as soon as funding is approved.

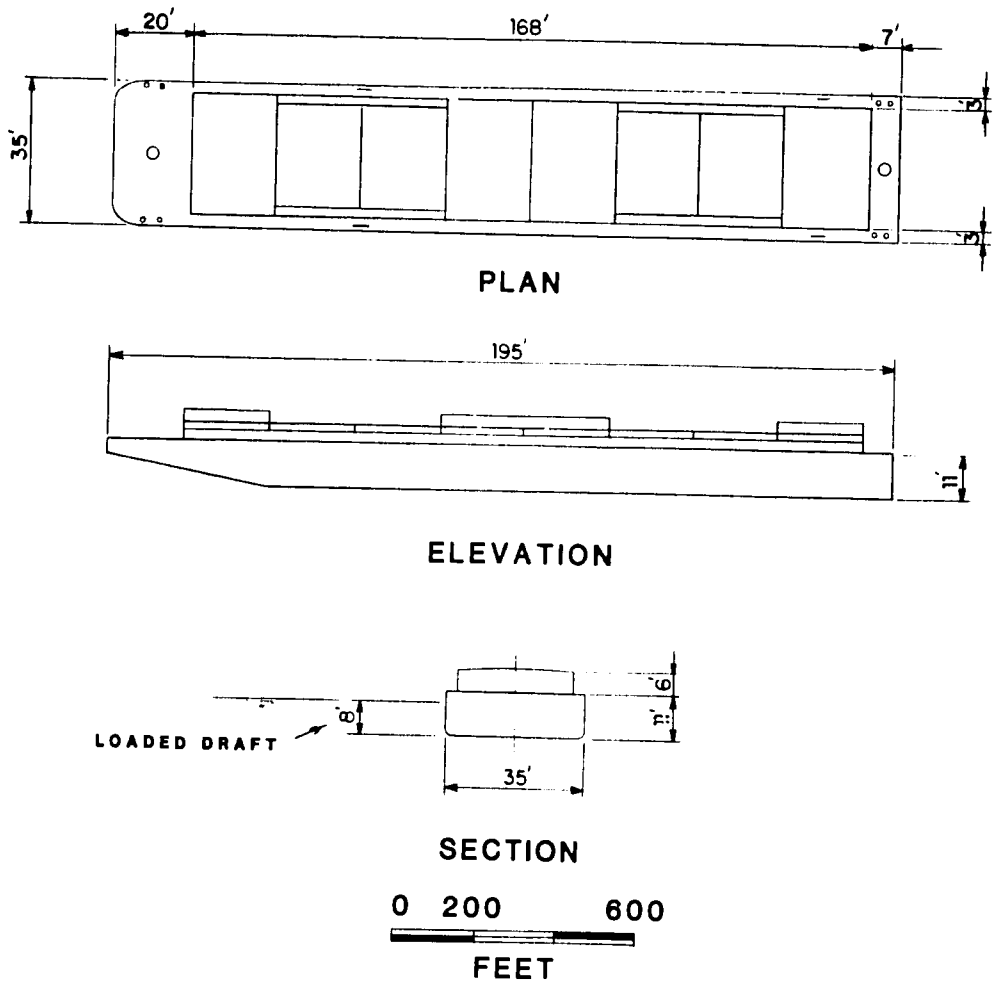


FIGURE 10-1
TYPICAL 1000 DWT BARGE

SECTION 11

CAPITAL INVESTMENT AND OPERATING COSTS

11.1 GENERAL

This section discusses the development of the annual operating costs for the base case of importing bagged fertilizer and the various optional conditions for bulk fertilizer import as well as other bulk commodities import. These costs were developed from historical operating cost records under present conditions and from cost estimates of capital investment required for future options. Foreign exchange (FX) portions of the total costs are also indicated where applicable.

11.2 CARGO HANDLING AND STORAGE COSTS - BASE CASE (BAGGED CARGO)

11.2.1 Stevedoring

Stevedoring rates are based on actual quotations received by BADC in response to tender notices issued in November 1978 to handle charter vessels carrying bagged fertilizer. The terms of tender were generally to provide for lightering a portion of the cargo at the Chittagong outer anchorage and deliver in lighters at a CPA jetty, unload the delivery vessel directly at a CPA jetty and unload the balance of the cargo from the delivery vessel into lighters at the Chalna Anchorage. Bids received ranged from $1.80 to $2.40 per ton, or an average of $2.00 per ton over the delivery vessel's total tonnage. This rate is broken down to reflect $1.40 per ton at Chittagong and $0.60 per ton at Chalna Port.

11.2.2 Clearance From CPA Jetty to Transit Godown at Chittagong: This is performed by trucks at an average of $1.60 per ton.

11.2.3 Storage at Chittagong Transit Godowns: This is based on figures derived by the EIU study at TK 7 per ton or $0.50 per ton, not including losses.

11.3 CARGO HANDLING AND STORAGE COSTS - INITIAL STAGE OPTIONS (BULK CARGO)

11.3.1 Stevedoring

Bulk handling rates should be slightly lower than for bag handling however, the difference is felt to be negligable therefore the same rates as for bagged are used at $1.40/ton for Chittagong and $0.60/ton for Chalna Port.

11.3.2 Delivery to Bulk Storage, Bagging and Bagged Storage

At Chittagong this would be performed at the existing TSP plant using the existing jetty conveying system, bagging lines and storage facilities. Therefore, the costs of these facilities are considered to be sunk.

11.3.3 Delivery from Bulk Storage to Bagging Lines

Because of the time element, new conveying equipment could not be installed to meet the 79/80 shipping schedule. Therefore, it is assumed that local trucking contracts can be made to perform a dedicated service within the TSP complex at TK 18/ton or $1.20/ton.

11.4 CAPITAL INVESTMENT CARGO HANDLING AND STORAGE COSTS - INTERIM AND FINAL STAGES

For the options at the interim and final stages, the major operating cost elements are as follows:

- Capital Investment: Marine and civil work, buildings, materials handling, bagging and electrical equipment. These were developed from cost estimates, which are summarized in Appendix D.

- Spare parts requirements for two years were taken as 10% of machinery and electricals investment cost.

- Captial Recovery: Depreication and interest factors were calculated on the basis of: 20 years depreciation of capital investment at 8% interest per year.

- Insurance: Taken at ½% of investment cost per year.

- Maintenance and Repair Costs: These average out to be: For marine and civil work - approximately 1% of investment cost per year. For materials handling, bagging and electrical equipment - approximately 3% of investment cost per year.

- Electric Power: This is based on a rate of U.S. $0.04 per KWH as advised by BADC.

11.4.2 Local Operating Labor Including Administrative Staff, Overheads and Allowances

This is based on review of labor rates in Bangladesh and an analysis of cost of production at the TSP plant as prepared by BCIC, on October 14, 1978. This analysis shows that the average cost of personnel is U.S. $1,000 per man per year.

It is assumed that the final plants at Chittagong and Chalna will each require a 1,000 man operation from unloaders through to bagged storage, thereby giving an operating cost of $1,000 X 1000 = $1,000,000 per year at each location.

For the temporary portable bagging operation at Chalna an additional 500 man labor force is required to handle the tonnage giving an operating cost of $1,500,000 per year.

For the barge unloading through storage operation at Shiromoni, a staff of 500 men has been assumed giving an operating cost of $500,000 per year.

11.4.3 Foreign Operating Costs

For Ship Unloaders: This is based on utilizing a crew of 4 expatriots to man the two unloaders at the offshore platform at Chittagong and a similar crew for Chalna Port. An average of $100,000 per man per year was used as a basis.

For Portable Conveyors: This will require one man expert in the operation and maintenance of the equipment at $100,000 per year.

11.4.4 Shuttle Bulker Charter

This was based on discussions with Klaveness Chartering of Oslo, Norway and Gotaas-Larsen, Inc. of the U.S.A. and is for a complete charter

including all operators, fuel and provisions. Total charter per vessel is indicated at $5,000,000 per year.

11.4.5 Items Not Included

The following items were not included in the cost compilation:

- Land acquisition,
- Interest during construction,
- Import duties,
- Local taxes,
- Escalation.

11.4.6 Price Base Year

The cost summary is based on prices current as of March, 1979 and no attempt has been made to project escalation over the comming years.

11.5 OPERATING COST TABLES

Annual operating costs as derived from capital investment are summarized on separate tables which follow. Foreign exchange portions of operating costs are also shown where relevant. Tables for Chittagong and Chalna are developed separately for the various options and must be added together for each corresponding option number to arrive at a national two port total. Subsequent Tables are as follows:

Table No.	Description
11-1	ANNUAL OPERATING COSTS (BASE CASE)-CHITTAGONG
11-2	ANNUAL OPERATING COSTS (BASE CASE)-CHALNA PORT
11-3	ANNUAL OPERATING COSTS (OPTION 1A)-CHITTAGONG
11-4	ANNUAL OPERATING COSTS (OPTION 1A) CHALNA PORT
11-5	ANNUAL OPERATING COSTS (OPTION 1B) - CHITTAGONG
11-6	ANNUAL OPERATING COSTS (OPTION 1C) - CHITTAGONG

Table No.	Description
11-7	ANNUAL OPERATING COSTS (OPTIONS 2A & 2B) - CHITTAGONG
11-8	ANNUAL OPERATING COSTS (OPTION 2C) - CHITTAGONG
11-9	ANNUAL OPERATING COSTS (OPTION 3A) - CHITTAGONG
11-10	ANNUAL OPERATING COSTS (OPTION 3B) - CHITTAGONG
11-11	ANNUAL OPERATING COSTS (OPTION 3C) - CHITTAGONG
11-12	ANNUAL OPERATING COSTS (OPTION 3D) - CHITTAGONG
11-13	ANNUAL OPERATING COSTS (OPTIONS 3E & 3F) - CHITTAGONG
11-14	ANNUAL OPERATING COSTS (OPTION 3E) - CHITTAGONG
11-15	ANNUAL OPERATING COSTS (OPTION 3F) - CHITTAGONG
11-16	ANNUAL OPERATING COSTS (OPTIONS 3E & 3F) - CHITTAGONG
11-17	ANNUAL OPERATING COSTS (OPTIONS 3E & 3F) - CHITTAGONG
11-18	ANNUAL OPERATING COSTS (OPTIONS 1C & 2A) - CHALNA PORT
11-19	ANNUAL OPERATING COSTS (OPTIONS 2B, 2C AND 3A THROUGH 3F) - CHALNA PORT
11-20	ANNUAL OPERATING COSTS- KHULNA DISTRICT (SHIROMONI)
11-21	CHALNA PORT TO KHULNA DISTRICT TRANSPORT

TABLE 11-1 ANNUAL OPERATING COSTS
(BASE CASE)

Location: CHITTAGONG

Stage: PRESENT - UP TO FY 78/79

Condition: BAGGED CARGO - SHIPS GEAR TO LIGHTERS AND GENERAL CARGO CRANES AT CPA JETTIES

Cargo: BAGGED FERTILIZER

CAPITAL INVESTMENT (U.S.$): USE EXISTING CPA FACILITIES

ANNUAL OPERATING COSTS:

Stevedoring	1.40 $/TON
Delivery to CPA Storage	1.60 $/TON
Port Storage Charges	0.50 $/TON
TOTAL	3.50 $/TON

TABLE 11-2 ANNUAL OPERATING COSTS
(BASE CASE)

Location: CHALNA PORT

Stage: PRESENT - UP TO FY 78/79

Condition: BAGGED CARGO - SHIPS GEAR TO BARGES AND RIVER CRAFT

Cargo: BAGGED FERTILIZER

CAPITAL INVESTMENT (U.S.$): USE EXISTING FACILITIES

ANNUAL OPERATING COSTS:

Stevedoring to barges/river craft at Mongla anchorage for dispatch to up-country destinations	0.60 $/TON

TABLE 11-3 ANNUAL OPERATING COSTS
(OPTION 1A)

Location: CHITTAGONG

Stage: INITIAL - OPERATIONAL BY FY 79/80

Condition: SPECIAL BULK CHARTER - BAG-ON-SHIP - SHIPS GEAR TO LIGHTERS AND GENERAL CARGO CRANES AT CPA JETTIES

Cargo: BULK FERTILIZER

CAPITAL INVESTMENT (U.S.$): USE EXISTING CPA FACILITIES

ANNUAL OPERATING COSTS:

Stevedoring	INCLUDED IN CHARTER
Delivery to CPA Storage	1.60 $/TON
Port Storage Charges	0.50 $/TON
TOTAL	2.10 $/TON

TABLE 11-4 ANNUAL OPERATING COSTS
(OPTION 1A)

Location: CHALNA PORT

Stage: INITIAL - OPERATIONAL BY FY 79/80

Condition: SPECIAL BULK CHARTER - BAG-ON-SHIP - SHIPS GEAR TO BARGES AND RIVER CRAFT

Cargo: BULK FERTILIZER

CAPITAL INVESTMENT (U.S.$): USE EXISTING FACILITIES

ANNUAL OPERATING COSTS:

Stevedoring to barges/river craft at Mongla anchorage for dispatch to up-country destinations	INCLUDED IN CHARTER

TABLE 11-5 ANNUAL OPERATING COSTS
(OPTION 1B)

Location: CHITTAGONG

Stage: INITIAL - OPERATIONAL BY FY 79/80

Condition: SHIPS GEAR AND MOBILE CRANE TO PRESENT TSP PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 200,000 TONS (CHITTAGONG ONLY)

CAPITAL INVESTMENT (U.S.$): USE EXISTING FACILITIES

ANNUAL OPERATING COSTS:

Maintenance of Existing Equipment	$ 100,000
Stevedoring @ 1.40 $/TON	$ 280,000
Delivery to Bulk Storage - Existing Conveyor System Electric Power 350,000 KWH @ 0.04	$ 14,000
Local Truck Rental for Delivery from Bulk Storage to Bagging Lines @ 1.20 $/TON	$ 240,000
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000
PER ANNUM -	$1,634,000

at 200,000 TONS = 8.17 $/TON

TABLE 11-6 ANNUAL OPERATING COSTS
(OPTION 1C)

Location: CHITTAGONG

Stage: INITIAL - OPERATIONAL BY FY 80/81

Condition: SHIPS GEAR AND MOBILE CRANE TO PRESENT TSP PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 465,000 TONS

CAPITAL INVESTMENT (U.S.$): USE EXISTING FACILITIES

ANNUAL OPERATING COSTS:

Maintenance of Existing Equipment	$ 100,000
Stevedoring @ 1.40 $/TON	$ 651,000
Delivery to Bulk Storage - Existing Conveyor System Electric Power 350,000 KWH @ 0.04	$ 14,000
Local Truck Rental for Delivery from Bulk Storage to Bagging Lines @ 1.20 $/TON	$ 558,000
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000
PER ANNUM -	$2,323,000

at 465,000 TONS = 5.00 $/TON

TABLE 11-7 ANNUAL OPERATING COSTS
(OPTION 2A & 2B)

Location: CHITTAGONG

Stage: INTERIM - CAN BE OPERATIONAL BY FY 81/82
SCHEDULED FOR FY 82/83

Condition: ONE SHUTTLE BULKER TO MODIFIED TSP PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 740,000 TONS FY 81/82,
800,000 TONS FY 82/83

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$ 3,890,000
Machinery and Electricals	3,559,000
Spare Parts	356,000
SUB-TOTAL	$ 7,805,000
Engineering and Contract Management	781,000
	$ 8,586,000
Contingency at 10%	854,000
TOTAL CAPITAL INVESTMENT	$ 9,440,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 961,000	961,000
Insurance at ½% of 9,440,000	47,000	47,000
Maintenance at 1% of 3,890,000	39,000	20,000
at 3% of 3,559,000	107,000	50,000
Electric Power 2,500,000 KWH @ 0.04	100,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000	
Charter of One Shuttle Bulker Including Expatriot Operators, Fuel and Provisions	$ 5,000,000	5,000,000
PER ANNUM -	$ 7,254;000	6,078,000
at 740,000 TONS =	9.80 $/TON	8.21 $/TON
at 800,000 TONS =	9.07 $/TON	7.60 $/TON

TABLE 11-8 ANNUAL OPERATING COSTS
(OPTION 2C)

Location: CHITTAGONG

Stage: INTERIM - OPERATIONAL BY FY 82/83

Condition: ONE SHUTTLE BULKER TO NEW STORAGE AND BAGGING PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 800,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$19,689,000
Machinery and Electricals	5,388,000
Spare Parts	539,000
SUB-TOTAL	$25,616,000
Engineering and Contract Management	2,562,000
	$28,178,000
Contingency at 10%	2,812,000
TOTAL CAPITAL INVESTMENT	$30,990,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 3,156,000	3,156,000
Insurance at ½% of 30,990,000	155,000	155,000
Maintenance at 1% of 19,689,000	197,000	95,000
at 3% of 5,388,000	162,000	80,000
Electric Power 5,500,000 KWH @ 0.04	220,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000	
Charter of One Shuttle Bulker Including Expatriot Operators, Fuel and Provisions	$ 5,000,000	5,000,000
PER ANNUM -	$ 9,890,000	8,486,000
at 800,000 TONS =	12.36 $/TON	10.61 $/TON

TABLE 11-9 ANNUAL OPERATING COSTS
(OPTION 3A)

Location: CHITTAGONG

Stage: FINAL - CAN BE OPERATIONAL BY FY 82/83
SCHEDULED FOR FY 84/85

Condition: TWO SHUTTLE BULKERS TO MODIFIED TSP PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,400,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$ 7,299,000
Machinery and Electricals	4,600,000
Spare Parts	460,000
SUB-TOTAL	$12,359,000
Engineering and Contract Management	1,236,000
	$13,595,000
Contingency at 10%	1,355,000
TOTAL CAPITAL INVESTMENT	$14,950,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 1,523,000	1,523,000
Insurance at ½% of 14,950,000	75,000	75,000
Maintenance at 1% of 7,299,000	73,000	30,000
at 3% of 4,600,000	138,000	65,000
Electric Power 3,000,000 KWH @ 0.04	120,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000	
Charter of Two Shuttle Bulkers Including Expatriot Operators, Fuel and Provisions	$10,000,000	10,000,000
PER ANNUM -	$12,929,000	11,693,000
at 1,400,000 TONS =	9.24 $/TON	8.35 $/TON

TABLE 11-10 ANNUAL OPERATING COSTS
(OPTION 3B)

Location: CHITTAGONG

Stage: FINAL - CAN BE OPERATIONAL BY FY 82/83
SCHEDULE FOR FY 84/85

Condition: TWO SHUTTLE BULKERS TO NEW STORAGE AND BAGGING PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,400,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$20,139,000
Machinery and Electricals	5,388,000
Spare Parts	539,000
SUB-TOTAL	$26,066,000
Engineering and Contract Management	2,607,000
	$28,673,000
Contingency at 10%	2,867,000
TOTAL CAPITAL INVESTMENT	$31,540,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 3,212,000	3,212,000
Insurance at ½% of 31,540,000	158,000	158,000
Maintenance at 1% of 20,139,000	201,000	100,000
at 3% of 5,388,000	162,000	80,000
Electric Power 5,500,000 KWH @ 0.04	220,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$1,000,000	
Charter of Two Shuttle Bulkers Including Expatriot Operators, Fuel and Provisions	$10,000,000	10,000,000
PER ANNUM -	$14,953,000	13,550,000
at 1,400,000 TONS =	10.68 $/TON	9.68 $/TON

TABLE 11-11 ANNUAL OPERATING COSTS
(OPTION 3C)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: OFFSHORE PLATFORM TO MODIFIED TSP PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,600,000 T

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$38,792,000
Machinery and Electricals	17,976,000
Spare Parts	1,798,000
SUB-TOTAL	$58,566,000
Engineering and Contract Management	5,857,000
	$64,423,000
Contingency at 10%	6,447,000
TOTAL CAPITAL INVESTMENT	$70,870,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 7,218,000	7,218,000
Insurance at ½% of 70,870,000	354,000	354,000
Maintenance at 1% of 38,792,000	388,000	190,000
at 3% of 17,976,000	539,000	270,000
Electric Power 6,700,000 KWH @ 0.04	268,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,000,000	
Expatriot Operators, - Unloading System	$ 400,000	400,000
PER ANNUM -	$10,167,000	8,432,000
at 1,600,000 TONS =	6.35 $/TON	5.27 $/TON

TABLE 11-12 ANNUAL OPERATING COSTS
(OPTION 3D)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: OFFSHORE PLATFORM TO NEW STORAGE AND BAGGING PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,600,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$51,044,000
Machinery and Electricals	16,253,000
Spare Parts	1,625,000
SUB-TOTAL	$68,922,000
Engineering and Contract Management	6,892,000
	$75,814,000
Contingency at 10%	7,586,000
TOTAL CAPITAL INVESTMENT	$83,400,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 8,494,000	8,494,000
Insurance at ½% of 83,400,000	417,000	417,000
Maintenance at 1% of 51,044,000	510,000	250,000
at 3% of 16,253,000	488,000	240,000
Electric Power 9,500,000 KWH @ 0.04	380,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,000,000	
Expatriot Operators, - Unloading System	$ 400,000	400,000
PER ANNUM -	$11,689,000	9,801,000
at 1,600,000 TONS =	7.31 $/TON	6.13 $/TON

TABLE 11-13 ANNUAL OPERATING COSTS
(OPTION 3E & 3F)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: OFFSHORE PLATFORM, TRESTLE TO SHORE CONNECTION AND 18,000 FEET CONVEYOR AS COMMON FACILITY

Cargo: BULK FERTILIZER, FINISHED CEMENT, AND FOODGRAINS

Annual Throughput Capability: 2,000,000 TONS (CHITTAGONG ONLY)

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$31,493,000
Machinery and Electricals	13,376,000
Dust Collection and Pneumatic Clean-Up Equipment for Cement and Grain	3,000,000
Spare Parts	1,638,000
SUB-TOTAL	$49,507,000
Engineering and Contract Management	4,951,000
	$54,458,000
Contingency at 10%	5,442,000
TOTAL CAPITAL INVESTMENT	$59,900,000

ANNUAL OPERATING COSTS:

		FX PORTION
Capital recovery at 0.10185 CRF	$ 6,101,000	6,101,000
Insurance at ½% of 59,900,000	300,000	300,000
Maintenance at 1% of 31,493,000	315,000	150,000
at 3% of 16,376,000	491,000	240,000
Electric Power 4,200,000 KWH @ 0.04	168,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 100,000	
Expatriot Operators, - Unloading System	$ 400,000	400,000
PER ANNUM -	$ 7,875,000	7,191,000
at 2,000,000 TONS =	*3.94 $/TON	*3.60 $/TON

* Fertilizer pays this rate for 7/16 of its total national import therefore actual cost to fertilizer is:

	1.72/ $/TON	1.58 $/TON

TABLE 11-14 ANNUAL OPERATING COSTS
(OPTION 3E)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 82/83

Condition: MODIFICATION TO EXISTING TSP PLANT AS DEDICATED FACILITY

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,600,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$ 6,849,000
Machinery and Electricals	4,600,000
Spare Parts	460,000
SUB-TOTAL	$11,909,000
Engineering and Contract Management	1,191,000
	$13,100,000
Contingency at 10%	1,300,000
TOTAL CAPITAL INVESTMENT	$14,400,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 1,467,000	1,467,000
Insurance at ½% of 14,400,000	72,000	72,000
Maintenance at 1% of 6,849,000	68,000	30,000
at 3% of 4,600,000	138,000	65,000
Electric Power 2,500,000 KWH @ 0.04	100,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,000,000	
PER ANNUM -	$ 2,845,000	1,634,000
at 1,600,000 TONS =	1.78 $/TON	1.02 $/TON

TABLE 11-15 ANNUAL OPERATING COSTS
(OPTION 3F)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: CONSTRUCTION OF NEW STORAGE AND BAGGING PLANT AS DEDICATED FACILITY

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 1,600,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$19,689,000
Machinery and Electricals	5,388,000
Spare Parts	539,000
SUB-TOTAL	$25,616,000
Engineering and Contract Management	2,562,000
	$28,178,000
Contingency at 10%	2,812,000
TOTAL CAPITAL INVESTMENT	$30,990,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 3,156,000	3,156,000
Insurance at ½% of 30,990,000	155,000	155,000
Maintenance at 1% of 19,689,000	197,000	95,000
at 3% of 5,388,000	162,000	80,000
Electric Power 5,500,000 KWH @ 0.04	220,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,000,000	
PER ANNUM -	$ 4,890,000	3,486,000
at 1,600,000 TONS =	3.06 $/TON	2.18 $/TON

TABLE 11-16 ANNUAL OPERATING COSTS
(OPTION 3E & 3F)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: CONSTRUCTION OF FINISHED CEMENT STORAGE AND BAGGING FACILITIES AS DEDICATED FACILITIES

Cargo: FINISHED CEMENT IN BULK

Annual Throughput at Platform: 500,000 TONS

CAPITAL INVESTMENT (U.S.$):

Civil Work, Silos and Structural Supports	$ 7,000,000
Machinery and Electricals	3,000,000
Spare Parts	300,000
SUB-TOTAL	$10,300,000
Engineering and Contract Management	1,030,000
	$11,330,000
Contingency at 10%	1,170,000
TOTAL CAPITAL INVESTMENT	$12,500,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 1,273,000	1,273,000
Insurance at ½% of 12,500,000	63,000	63,000
Maintenance at 1% of 7,000,000	70,000	35,000
at 3% of 3,000,000	90,000	45,000
Electric Power 5,000,000 KWH @ 0.04	200,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 550,000	
PER ANNUM -	$ 2,246,000	1,416,000
at 500,000 TONS =	4.49 $/TON	2.83 $/TON

TABLE 11-17 ANNUAL OPERATING COSTS
(OPTION 3E & 3F)

Location: CHITTAGONG

Stage: FINAL - OPERATIONAL BY FY 84/85

Condition: ADDITION OF FOODGRAIN CONVEYOR SYSTEM AS DEDICATED FACILITY

Cargo: FOODGRAINS (WHEAT IN BULK)

Annual Throughput at Platform: 800,000 TONS

CAPITAL INVESTMENT (U.S.$):

Civil Work, and Structural Supports	$ 2,400,000
Machinery and Electricals	600,000
Spare Parts	60,000
SUB-TOTAL	$ 3,060,000
Engineering and Contract Management	306,000
	$ 3,366,000
Contingency at 10%	334,000
TOTAL CAPITAL INVESTMENT	$ 3,700,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 377,000	377,000
Insurance at ½% of 3,700,000	19,000	19,000
Maintenance at 1% of 2,400,000	24,000	12,000
at 3% of 600,000	18,000	9,000
Electric Power 500,000 KWH @ 0.04	20,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	INCLUDED WITH PRESENT PLANT	
PER ANNUM -	$ 458,000	417,000
at 800,000 TONS =	0.57 $/TON	0.52 $/TON

TABLE 11-18 ANNUAL OPERATING COSTS
(OPTION 1C & 2A)

Location: CHALNA PORT

Stage: INITIAL - OPERATIONAL BY FY 80/81

Condition: SHIPS GEAR TO PORTABLE BAGGING UNITS AT ONE OR TWO MONGLA JETTIES

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 465,000 TONS - FY 80/81
740,000 TONS - FY 81/82

CAPITAL INVESTMENT (U.S.$):

9 Portable Bagging Units	$ 1,000,000
Temporary Storage and Barge Loading	100,000
Spare Parts	100,000
SUB-TOTAL	$ 1,200,000
Engineering and Contract Management	120,000
	$ 1,320,000
Contingency at 10%	130,000
TOTAL CAPITAL INVESTMENT	$ 1,450,000

ANNUAL OPERATING COSTS:

		FX PORTION
Capital recovery 10 years at 8% = 0.1493 CRF	$ 216,000	199,000
Insurance at ½% of 1,450,000	7,000	7,000
Maintenance at 10% of 1,450,000	145,000	70,000
Electric Power 200,000 KWH @ 0.04	8,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,500,000	
Expatriot Operators, - Portable Baggers	$ 100,000	100,000
PER ANNUM -	$ 1,976,000	376,000
at 465,000 TONS =	4.25 $/TON	0.81 $/TON
at 740,000 TONS =	2.67 $/TON	0.51 $/TON

TABLE 11-19 ANNUAL OPERATING COSTS
(OPTIONS 2B, 2C AND 3A THROUGH 3F)

Location: CHALNA PORT

Stage: INTERIM - OPERATIONAL BY FY 82/83

Condition: TWO SHIP UNLOADERS TO NEW STORAGE AND BAGGING PLANT

Cargo: BULK FERTILIZER

Annual National Throughput Capability: 800,000 TONS - 2B/2C
1,400,000 TONS - 3A/3B
1,600,000 TONS - 3C THRU 3F

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$16,708,000
Machinery and Electricals	8,936,000
Spare Parts	894,000
SUB-TOTAL	$26,538,000
Engineering and Contract Management	2,654,000
	$29,192,000
Contingency at 10%	2,918,000
TOTAL CAPITAL INVESTMENT	$32,110,000

ANNUAL OPERATING COSTS:		FX PORTION
Capital recovery at 0.10185 CRF	$ 3,270,000	3,270,000
Insurance at ½% of 32,110,000	160,000	160,000
Maintenance at 1% of 16,708,000	167,000	80,000
at 3% of 8,936,000	268,000	130,000
Electric Power 6,200,000 KWH @ 0.04	248,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	$ 1,000,000	
Expatriot Operators, Unloading system	400,000	400,000
PER ANNUM -	$ 5,513,000	4,040,000
at 800,000 TONS =	6.89 $/TON	5.05 $/TON
at 1,400,000 TONS =	3.94 $/TON	2.88 $/TON
at 1,600,000 TONS =	3.45 $/TON	2.53 $/TON

TABLE 11-20 ANNUAL OPERATING COSTS

Location: KHULNA DISTRICT (SHIROMONI)

Stage: OPERATIONAL BY FY 81/82

Condition: BARGE UNLOADING TO STORAGE, RAIL AND TRUCK

Cargo: BAGGED FERTILIZER

Annual National Throughput Capability: 470,000 TONS

CAPITAL INVESTMENT (U.S.$):

Marine Work, Civil Work, Buildings and Structural Supports	$ 4,277,000
Machinery and Electricals	599,000
Spare Parts @ 10% of 599,000	60,000
SUB-TOTAL	$ 4,936,000
Engineering and Contract Management	494,000
	$ 5,430,000
Contingency at 10%	543,000
TOTAL CAPITAL INVESTMENT	$ 5,973,000

ANNUAL OPERATING COSTS:

		FX PORTION
Capital Recovery at 0.10185	$ 608,000	608,000
Insurance at ½% of 5,973,000	30,000	30,000
Maintenance at 1% of 4,277,000	43,000	20,000
at 3% of 599,000	18,000	9,000
Electric Power 170,000 KWH at 0.04	7,000	
Local Operating Labor Including Administrative Staff, Overheads and Allowances	500,000	
PER ANNUM -	$ 1,206,000	667,000
at 470,000 TONS =	2.57 $/TON	1.42 $/TON

TABLE 11-21 CHALNA PORT TO KHULNA DISTRICT TRANSPORT

Barge Transportation Costs:

These were developed from actual quotations of capital costs and discussions with various tug/barge operators.

Capital Investment

One Tugboat, 1700 BHP	$ 1,200,000
Eight Barges, 1000 DWT each	3,200,000
	$ 4,400,000

ANNUAL OPERATING COSTS:			FX PORTION
Capital Recovery 20 years at 8% interest 0.10185 CRF X 4,400,000	=	$ 488,000/yr	488,000
Insurance at 3% of 4,400,000	=	132,000	132,000
Maintenance and Repairs			
Tug 4% of 1,200,000	=	48,000	12,000
Barges 2% of 3,200,000	=	64,000	
Inspection and other fees at 0.3% of 4,400,000	=	13,000	
Manning Costs (See Breakdown)	=	36,000	
Fuel and Lubricating Oil (See Breakdown)	=	150,000	150,000
		891,000	
Administration and Overhead at 6% of 891,000	=	54,000	
		$ 945,000	720,000
Contingency at 10%	=	95,000	74,000
TOTAL BARGE TRANSPORTATION COST	=	$ 1,040,000/yr	$ 816,000/yr
At Average 470,000 tons/year	=	2.21 $/TON	1.74 $/TON

Manning Costs - 5 man crew

Basic Wage:	Captain	$ 6,000/yr
	First Officer	4,000
	Engineer	5,000
	Deck Hand	1,500
	Deck Hand	1,500
		$18,000

(CONTINUED)

TABLE 11-21 (CONTINUED)

Fringes and Social Costs	
Projected Overtime	
Vacation for Every Two Days On Board One Day Off at 100%	$18,000
TOTAL MANNING COST	$36,000/yr

Fuel and Lubricating Oil Costs

The average cost for 1700 HP Tug is $50.00/hour. The tug will be in service approximately 10 hours per day. Therefore for a 300 day/year the costs are:

Running - $50.00 X 10 hours X 300 days = $150,000/yr.

SECTION 12

ECONOMIC AND TECHNICAL EVALUATION AND RECOMMENDED PROGRAM

12.1 GENERAL

The preceeding sections have described a step by step approach toward the development of an integrated - high speed bulk unloading program at the ports of Chittagong and Chalna.

Section 4 has demonstrated the considerable savings to be [illegible] 1 by a mere transition from bagged to bulk cargo imports.

In Section 5, the PORTLOG model develops the further savings that can be realized by utilizing high speed modern unloading equipment in conjunction with large size vessels. The PORTLOG model further demonstrates the ability to handle 2,000,000 tons per year of bulk commodities over an offshore platform at Chittagong alone.

Section 6 discusses the offshore platform as a means to relieve congestion in the port of Chittagong by using it as a multi-product berth.

The study has considered many options that could be implemented to realize a bulk fertilizer program. This multitude of options has been analyzed. As a result of this analysis a program is presented from initial through interim and final stages for a phased program of facility improvements and additions along with the capital investment program which is required.

This section deals with the economic and technical evaluation of the various options with the objective of selecting a recommended program by combining, for each option, the capital and operating costs, as developed in Section 11, with the C & F costs as developed in Section 5 and calculating the savings that could be realized over the base case. The savings are then represented in tabular form.

In all cases, the present method of importation for each commodity is used as the base case for comparison.

12.2 EVALUATION OF PROGRAM OPTIONS

Table 12-1 represents the delivered in bag cost of imported bulk, DAP fertilizer for the various program options, including local bagging and transit storage, ready for local distribution to inland districts. The net savings are shown as a result of comparison to the base case of bagged imports.

12.2.1 Initial Stage

An analysis of the initial stage options shows that with the availability of the TSP plant a combined system of delivering 200,000 tons/year of bulk fertilizer to the TSP properties combined with bag-on-ship of the remaining cargo (Options 1A/1B) will result in an average total cost of $203.87/ton over the three year initial phase. This is about equal in cost to the portable bagging option 1C which will not handle the forecasted tonnage. Further, the degree of shrinkage associated with the portable bagging scheme because of inadequate storage facilities at Chalna Port makes portable bagging a questionable solution in any event. Therefore, the recommended system for the initial three year stage is a bag-on-ship charter combined with using the existing TSP facilities. Bulk ships would be lightered of bulk at the Chittagong anchorage until they could enter the port. Ships and lighters would discharge their cargo in bulk at the TSP jetty. The bulk ship would then proceed to Chalna Port where the remainder of its cargo would be bagged on ship and discharged to lighters in bags for dispatch into the interior.

12.2.2 Interim Stage

Option 2A which uses portable bagging at Chalna Port would be used only if a "bag-on-ship" charter could not be negotiated. Volume II of this report presents the analysis of present TSP factory facilities and recommends that these facilities be made available as a bulk import station. Therefore, the recommended interim stage system is to deploy one shuttle bulker delivering to a modified TSP plant at Chittagong and utilize the new facilities at Chalna (option 2B). The interim stage will run for two years from FY 82/83 through FY

STAGE OPERATIONAL BY Condition	BASE CASE PRESENT FY 78/79	OPTION 1A INITIAL FY 79/80	OPTION 1B INITIAL FY 79/80	OPTION 1C INITIAL FY 80/81	OPTION 2A INTERIM FY 81/82	OPTION 2B INTERIM FY 82/83	OPTION 2C INTERIM FY 83/84	OPTION 3A FINAL FY 84/85	OPTION 3B FINAL FY 84/85	OPTION 3C FINAL FY84/85	OPTION 3D FINAL FY 84/85	OPTION 3E FINAL FY 84/85	OPTION 3F FINAL FY 84/85
Chittagong	Lighter to General Cargo	Bag on Ship	Ships Gear and Mobile Crane to Present TSP Plant	Ships Gear and Mobile Crane to Present TSP Plant	One Shuttle Bulker to Modified TSP Plant	One Shuttle Bulker to Modified TSP Plant	One Shuttle Bulker to New Plant	Two Shuttle Bulkers to Modified TSP Plant	Two Shuttle Bulkers to New Plant	Offshore Platform to Modified TSP Plant	Offshore Platform to New Plant	Offshore to Modified TSP Plant and Others	Offshore to New Plant and Others
Chalna	Lighter at Mongla Anchorage	Bag on Ship		Portable Bagging Units At Two Jetties	Portable Bagging Units At Two Jetties	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant	Two Unloaders to New Plant
Cargo	All Bagged	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer	Bulk Fertilizer Plus Other Bulk Commodities	Bulk Fertilizer Plus Other Bulk Commodities
Fertilizer Maximum Annual Thruput (MT)			200,000 (Chittagong Only)	455,000	740,000	800,000	800,000	1,400,000	1,400,000	1,600,000	1,600,000	1,600,000 Plus Other Bulk	1,600,000 Plus Other Bulk
(1) Charter Terms	1000/750	2000/1200	2000/1000	2000/1000	6000/5000	6000/5000	6000/5000	6000/5000	6000/5000	6000/10000	6000/10000	6000/10000	6000/10000
(2) Costs $/Ton Product FOB Loading Port	183.20	158.09	158.09	158.09	158.09	158.09	158.09	158.09	158.09	158.09	158.09	158.09	158.09
(3) Ocean Freight	34.91	46.50	30.29	30.29	24.44	22.51	22.51	19.19	19.19	18.41	18.41	18.73	18.73
C & F Cost	218.11	204.59	188.38	188.38	182.53	180.60	180.60	177.28	177.28	176.50	176.50	176.82	176.82
(4) Operating Costs Chittagong	3.50	[illegible].10	8.17	5.00	9.80	9.07	12.36	9.24	11.04	6.35	7.31	3.50	4.78
Chalna	.60	(Included in Charter	-	4.25	2.67	6.89	6.89	3.94	3.94	3.45	3.45	3.45	3.45
2 Port Average	4.10	2.10	8.17	9.25	12.47	15.96	19.25	13.18	14.98	9.80	10.76	6.95	8.23
Total Cost FAS Golden	222.21	206.69	196.55	197.63	195.00	196.56	199.85	190.46	192.26	186.30	187.26	183.77	185.05
(5) Additional Shrinkage at Chalna				5.63	5.56								
				203.26	200.56								
Savings Over Bagged		15.52	25.66	18.95	21.65	25.65	22.36	31.75	29.95	35.91	34.95	38.44	37.16

TABLE 12-1

TABLE 12-1

ESTIMATED DELIVERED COST OF BULK PRODUCTS FOR VARIOUS OPTIONS (CONTINUED)

LEGEND

(1) Charter terms are for standard load/discharge cadences as developed by Gotaas-Larsen, Inc. for the most common type of charter (see Appendix A).

(2) FOB costs as developed in Sections 4.2.3 and 4.3.3.

(3) Ocean freight taken from Gotaas-Larsen development and as refined for dispatch and demurrage in Section 5, Table 5-3.

(4) Operating costs for Chittagong and Chalna as developed in Section 11.

(5) Generally, under similar conditions, a shrinkage factor of ½% for bagged cargo and 1% for bulk cargo would be accounted for. However, the condition of the existing godowns at Bangladesh and the present method of handling bagged cargo with hooks, have resulted in excessive losses on bagged cargo. Therefore, shrinkage will be considered as the same for bulk and bagged except under extremely primitive storage conditions such as a temporary program at Chalna Port. In such case, an additional shrinkage factor of 5% at Chalna has been added as losses at any temporary storage facilities at Chalna.

83/84 at which time the offshore platform and approach conveyor at Chittagong will become operational for the final stage.

12.2.3 Final Stage

The final stage shows the six options which were considered but these are reduced to three (options 3A, 3C and 3E) by the conclusion that the TSP plant be used as a bulk import station rather then to continue to manufacture TSP.

Table 12-2 is offered for comparison of savings of final stage alternate programs (shuttle bulker vs. offshore platform) on a pure fertilizer only basis and is compared based on throughput of the final stage only. Here the offshore platform shows an eleven year cumulative savings advantage of $30 million over the shuttle bulker.

The shuttle bulker system requires less initial capital investment than the offshore platform scheme, but its annual operating costs are higher and its annual FX charter cost of $10 million can never be amortized. Since the shuttle bulker system is limited in capacity to 600,000 tons per year, it will be incapable of carrying the forecast of fertilizer beyond FY 88/89, therefore a purchase of two shuttle bulkers was not considered.

From an operating standpoint, shuttle bulkers will add to congestion on the Karnaphuli River, whereas the offshore platform will greatly relieve congestion.

Therefore, the shuttle bulker scheme is not recommended as a final stage system.

Option 3C uses the offshore platform for fertilizer only and as shown in Section 5, the 18 percent upper limit berth occupancy when handling fertilizer only is not a full utilization of the platform.

Therefore, the multi-product offshore platform scheme with approach conveyor connection to the TSP plant, grain silo and new cement storage is the recommended system for the final stage program.

FISCAL YEAR	(84/85	85/86	FINAL STAGE 86/87	87/88	88/89	) 89/90
ANNUAL THROUGHPUT (1000 LT)						
Chittagong	340	412	484	556	628	700
Chalna	460	548	636	724	812	900
TOTAL	800	960	1,120	1,280	1) 1,440	1,600
Total Cost Bagged Cargo Present Operation @ 222.21 $/TON	177,768	213,322	248,875	284,430	319,982	355,536
Option 3A-Two Shuttle Bulkers to Modified TSP plant						
C&F Cost @ 177.28 $/TON	141,824	170,189	198,554	226,918	255,283	2) 255,283
Operating Costs						
- Chittagong	12,929	12,929	12,929	12,929	12,929	12,929
- Chalna	5,513	5,513	5,513	5,513	5,513	5,513
TOTAL COST - 3A	160,266	188,631	216,996	245,360	273,725	273,725
NET SAVINGS - 3A	17,502	24,691	31,879	39,070	46,257	46,257
CUMULATIVE SAVINGS 3A	17,502	42,193	74,072	113,142	159,339	205,656
Option 3C - Offshore Platform to Modified TSP Plant - Fertilizer Only						
C&F Cost at 176.60 $/TON	141,200	169,440	197,680	225,920	254,160	282,400
Operating Costs						
- Chittagong	10,167	10,167	10,167	10,167	10,167	10,167
- Chalna	5,513	5,513	5,513	5,513	5,513	5,513
TOTAL COST-3C	156,880	185,120	213,360	241,600	269,840	298,080
NET SAVINGS-3C	20,888	28,202	35,515	42,830	50,142	57,456
CUMULATIVE SAVINGS 3C	20,888	49,090	84,605	127,435	177,577	235,033

LEGEND

1) Maximum for option 3A
2) Based on option 3A maximum annual throughput of 1,440,000 Tons

TABLE 12-2

SAVINGS SUMMARY - FINAL STAGE ALTERNATIVE PROGRAMS
(U.S.$ X 1000)

12.3 RECOMMENDED PROGRAM

The overall recommended program is therefore as follows:

Initial Stage - Three year program to begin FY 79/80. "Bag-on-Ship" charter and use of existing TSP facilities.

Interim Stage - Two year program to begin FY 82/83. Single shuttle bulker charter, and modified TSP facilities at Chittagong. Complete final fertilizer handling facilities at Chalna.

Final Stage - Begin FY 84/85. Offshore platform and approach conveyor to existing industrial complex at Chittagong and full fertilizer facilities at Chalna.

12.4 ANALYSIS OF OTHER BULK COMMODITIES

Table 12-3 represents the net savings or losses that would result for various other bulk commodities by using the offshore platform at Chittagong as a multi-product berth. In order of decreasing benefits, these products are finished cement, foodgrain, cement clinker and coal. Oil shows a loss and the raw materials for TSP manufacture are irrelevant since it is recommended that TSP manufacture be discontinued.

Coal savings are negligible and in view of declining usage of this commodity it would be best to continue importing from India in small vessels under present conditions.

Crude oil would actually be handled at a loss when compared to present operations and it is recommended that no investment be made to handle crude oil at the platform facility.

Phosphate rock and sulphur cost savings were developed only for use in the analysis of manufacture versus import. As stated above these savings are only of acedemic interest.

Commodity	Forecasted Throughput (Long Tons X 1000)	Operating Cost Common Facility (Platform)	Operating Cost Of New Dedicated Facilities	Other Costs	Total Operating Costs	C & F Savings Over Present Imports	Net Savings (Loss) Commodity
Finished Cement	500	3.94	4.49	NONE	8.43	29.03	20.60
Foodgrains	800	3.94	0.57	NONE	4.51	12.34	7.83
Clinker	250	3.94	NONE	1.60 Local Trucking	5.54	11.05	5.51
Coal	550	3.94	NONE	1.00 Premium for Sized Coal	4.94	5.06	0.12
Crude Oil	780	3.94	0.96	NONE	4.90	1.20	(3.70) Loss
Phosphate Rock and Sulphur	300	3.94	NONE	NONE	3.94	6.30	2.36

TABLE 12-3

NET SAVINGS (LOSSES) OF OTHER BULK COMMODITIES USING OFFSHORE PLATFORM
(U.S.$/LONG TON)

Clinker could be handled over the new finished cement conveyor to be stored on the ground just past the cement silos. However, steady handling of this commodity is not recommended because of vessel clean-up problems as described in Section 7.5.

Of the three commodities recommended for handling at the platform, the forecast for finished cement has been fixed at 500,000 tons/year. The capital investment required to construct the facilities required to store and bag this tonnage has been included in the operating costs used to derive the savings.

Fertilizer imports at Chittagong are forecast at 340,000 tons per year in 1984/1985 over the platform. They will gradually increase to a maximum 700,000 tons per year 5 years later. Therefore, it is recommended that foodgrain imports be maximized during this period to use all excess platform capacity over the fertilizer, cement usage. Initially it would be 1,160,000 tons per year and gradually decline to 800,000 tons per year when fertilizer reaches its maximum. The fact that a 100,000 ton grain storage elevator exists at Chittagong makes foodgrain handling at the platform very attractive.

Table 12-4 shows the finished cement and foodgrains program recommended to maintain a yearly platform throughput of 2,000,000 tons and the net savings that would accrue on these commodities from this program.

12.5 CAPITAL INVESTMENT VERSUS SAVINGS

Table 12-5 summarizes the Capital Investment as developed in Section 11 for the recommended program.

Table 12-6 represents the cost savings that are realized by the recommended program as compared to the present import program. The eleven year cumulative savings are $450 million. This compares to a total capital investment of $122.6 million. The cumulative savings of the program exceed the total program investment at the end of the first year of operation of the platform or year six of the program.

FISCAL YEAR	84/85	85/86	86/87	87/88	88/89	89/90
FINISHED CEMENT						
Annual Throughput (LTX1000)	500	500	500	500	500	500
C&F Savings @ 29.03 $/TON	14,515	14,515	14,515	14,515	14,515	14,515
OPERATING COSTS						
Platform @ 3.94 $/TON	1,970	1,970	1,970	1,970	1,970	1,970
New Facilities	2,246	2,246	2,246	2,246	2,246	2,246
NET SAVINGS - CEMENT	10,299	10,299	10,299	10,299	10,299	10,299
FOODGRAINS						
Annual Throughput (LTX1000)	1,160	1,088	1,016	944	872	800
C&F Savings @ 12.34 $/TON	14,314	13,105	12,130	11,500	10,711	9,872
OPERATING COSTS						
Platform @ 3.94 $/TON	4,570	4,287	4,003	3,720	3,436	3,152
New Facilities	458	458	458	458	458	458
NET SAVINGS - FOODGRAINS	9,286	8,360	7,669	7,322	6,817	6,262

TABLE 12-4

SAVINGS AT PLATFORM FOR FINISHED CEMENT AND FOODGRAINS
(U.S.$ X 1000)

- INITIAL STAGE - none required

	RECOMMENDED PROGRAM
- INTERIM STAGE	
TSP Facility Modifications	9,440
Chalna Port Fertilizer Facilities (Interim and Final Stages)	32,110
TOTAL INTERIM STAGE	41,550
- FINAL STAGE	
Offshore Platform and Apporach Conveyor	59,900
TSP Final Modifications	4,960
Finished Cement Storage and Bagging Facilities	12,500
Foodgrain Conveyor Connection to Approach Conveyor	3,700
TOTAL FINAL STAGE	81,060
TOTAL FULL PROGRAM	122,610
- OTHER EXPENDITURES	
Shiromoni Fertilizer Facilities	5,973
Chalna to Shiromoni Tug & Barge Transport Fleet	4,400

TABLE 12-5

SUMMARY OF CAPITAL INVESTMENT - RECOMMENDED PROGRAM
(U.S.$ X 1000)

FISCAL YEAR	(INITIAL PHASE)			(INTERIM STAGE)		(FINAL STAGE)					
	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
ANNUAL THROUGHPUT (1000 LT)											
Chittagong	300	308	316	324	332	340	412	484	556	628	700
Chalna	400	412	424	436	448	460	548	636	724	812	900
TOTAL	700	720	740	760	780	800	960	1,120	1,280	1,440	1,600
Total Cost Bagged Cargo Present Operation @ 222.21 $/TON	155,547	159,991	164,435	168,880	173,324	177,768	213,322	248,875	284,430	319,982	355,536
Combined Option 1A/1B											
Option 1A - Bag-on-Ship - TPY	500	520	540								
Cost @ $206.69/TON	103,345	107,480	111,613								
Option 1B - Ships Gear to TSP Plant - Fixed at 200,000 TPY @ 196.55 $/TON	39,310	39,310	39,310								
TOTAL COST-1A/1B	142,655	146,790	150,923								
Option 2B - One Shuttle Bulker to Modified TSP Plant											
C&F Cost @ 180.60 $/TON				137,256	140,868						
Operating Costs -											
Chittagong				7,254	7,254						
Chalna				5,513	5,513						
TOTAL COST-2B				150,023	153,635						
Option 3E - Offshore Platform to Modified TSP Plant Fertilizer Only											
C&F Cost @ 176.82 $/TON						141,456	169,747	198,038	226,330	254,621	282,912
Operating Costs -											
Chittagong Common @ 3.94 $/TON						1,340	1,623	1,907	2,190	2,474	2,758
Chittagong Dedicated						2,845	2,845	2,845	2,845	2,845	2,845
Chalna						5,513	5,513	5,513	5,513	5,513	5,513
Option 3E - TOTAL COST FERTILIZER ONLY						151,154	179,728	208,303	236,878	265,543	294,028
Option 3E - NET SAVINGS											
Fertilizer						26,614	33,594	40,572	47,552	54,529	61,508
Finished Cement						10,299	10,299	10,299	10,299	10,299	10,299
Foodgrains						9,286	8,360	7,669	7,322	6,817	6,262
TOTAL ANNUAL SAVING OVER PRESENT OPERATION	12,892	13,201	13,512	18,857	19,689	46,199	52,253	58,540	65,173	71,645	78,069
TOTAL CUMULTAIVE	12,892	26,093	39,605	58,462	78,151	124,350	176,603	235,143	300,316	371,956	450,030

TABLE 12-6

SAVINGS SUMMARY - RECOMMENDED PROGRAM VS. PRESENT OPERATION (U.S.$ X 1000)

Figure 12-1 summarizes the annual cost savings of the recommended program in chart form. The shuttle bulker savings are also shown for comparison to the recommended option over the final stage beginning FY 84/85.

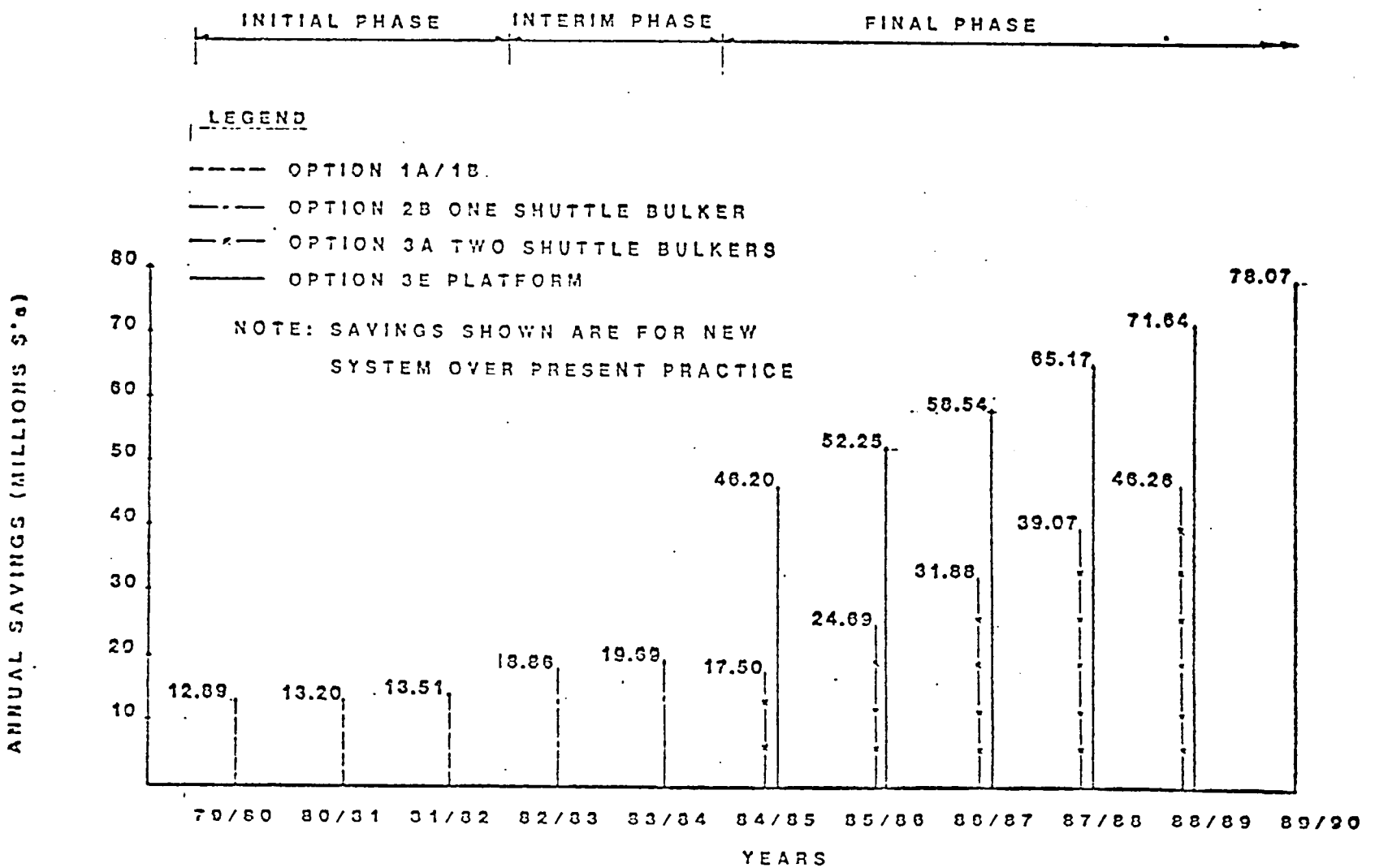


FIGURE 12-1 ANNUAL SAVINGS

SECTION 13

PROGRAM SCHEDULE

13.1 INTRODUCTION

This section presents the schedules which are proposed for execution of the recommended program.

Separate schedules are shown for each major element of the program.

The division of construction contracts and the breakdown proposed for purchase of major equipment is designed to maximize the opportunities for funding by a wide range of nations and international lending agencies.

Immediately after notice to proceed, key members of the project team will visit the various job sites as part of a familiarization program. In addition, initial steps will be taken to specify and issue subcontracts for the specialty engineering field work, which is comprised of soils exploration, topographic surveys, hydrographic surveys and oceanographic data collection.

13.2 INITIAL PROGRAM

The initial program is scheduled on Figure 13-1 and includes all elements to start the bulk import programs at Chittagong and Chalna Port. If is contemplated that operation plans be developed for each port. The initial program at Chittagong is expected to start with the first bulk ship arriving in November, 1979.

The import scheme recommended for this phase consists of the delivery ship being lightered at the Chittagong anchorage until it can enter the port of Chittagong, where unloading would be completed with its own gear. It would then proceed to Chalna Port with the remainder of its cargo, which would be bagged on ship and discharged in bags.

If satisfactory charter terms for this type of delivery system cannot be arranged, portable bagging units will be deployed at Chalna Port to handle the bagging of the bulk material ashore. The schedule shown on Figure 13-1 illustrates the sequence if the portable bagging program must be implemented since it would take longer, however, it is not recommended as the best choice. The earliest that bagging units could be in operation is estimated to be April of 1980. If the transit sheds presently under construction at Chalna Port are not ready for use as bag storage buildings at that time, it is planned to deploy a large tent as temporary shelter. Temporary barge loading facilities will be designed and built for use during this initial period.

13.3 SHIROMONI PROGRAM

The Shiromoni schedule is shown on Figure 13-2. It is planned that the final design work be executed by the Bangladeshi associate of the Consultant in accord with definitive designs and criteria prepared by the Consultant. This work will be let for bidding by Bangladeshi contractors. The station must continue to function during construction. This requirement will be an integral element of the construction program. Mechanical equipment, such as the bag conveyors, will be designed by the Consultant and procured under international tender for delivery to the contractor. It is planned to have the construction at Shiromoni completed by April 1981. A total of 9 months has been allowed for construction.

13.4 INTERIM PROGRAM AT CHITTAGONG

The interim program at Chittagong is scheduled on Figure 13-3 and consists of retrofitting the existing TSP factory facilities to serve as a bulk fertilizer reception and bagging center. An entirely new high capacity belt conveyor system will be installed from the TSP jetty to the several rock storage buildings at the plant to handle the shuttle bulker. In addition, new bagging lines will be installed. The work will be executed by an international general contractor. All conveying machinery will be procured under

separate order and furnished to the contractor. Since the conveyors will be installed in existing structures, the Consultant will make a detailed structural survey of all buildings, which will have new conveyors installed, in the first few months after notice to proceed.

The shuttle bulker interim program at Chittagong is scheduled for startup approximately three years after notice to proceed after a construction program of 15 months. The Chittagong interim system is scheduled to startup at the same time as Chalna Port, which is covered in Article 13.5. Though the amount of interim phase construction effort at Chittagong is less than at Chalna Port the time required for engineering is greater due to the need for an intensive field survey of the existing structures and their capacity to support new machinery loads.

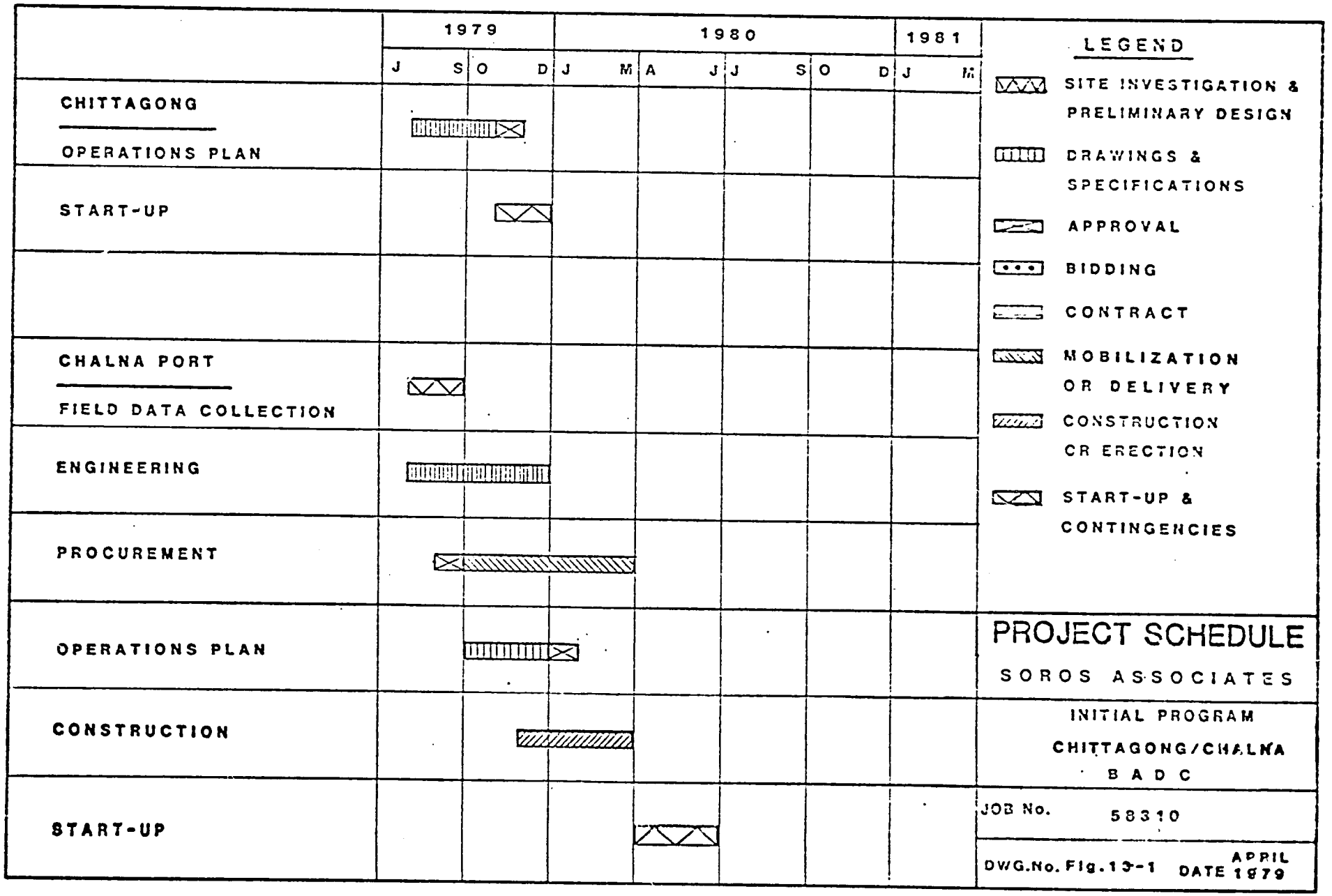
13.5 INTERIM/FINAL PROGRAM AT CHALNA PORT

The Chalna Port schedule is shown on Figure 13-4. This facility includes an entirely new, "Grass Roots" bagging plant with ship unloaders and a belt conveying system. The entire design will be executed by the Consultant. Ship unloaders and conveyors are to be procured under international tender and furnished to the general contractor for erection along with the remainder of the facility. This work is scheduled for completion approximately three years after notice to proceed. A construction program lasting 18 months is contemplated.

13.6 FINAL PROGRAM AT CHITTAGONG

This schedule is shown on Figure 13-5. The work covered under this program includes the offshore platform, connecting overwater and overland conveyor trestle, ship unloaders, conveying mancinery, extension to an existing building at the TSP factory site and connection of the new conveying system into the system installed as part of the Chittagong interim program. A small portion of the interim conveyor system will not be needed after the platform system is put in operation. This machinery will be used as spare maintenance parts for the new system. The offshore platform program is a large marine construction effort.

It is scheduled for startup approximately five years after notice to proceed. A period of 33 months is allowed for construction. Ship unloaders and all conveying machinery will be procured separately and furnished to an international general contractor, who will erect this equipment as well as the remainder of the facility.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PROJECT SCHEDULE
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INITIAL PROGRAM
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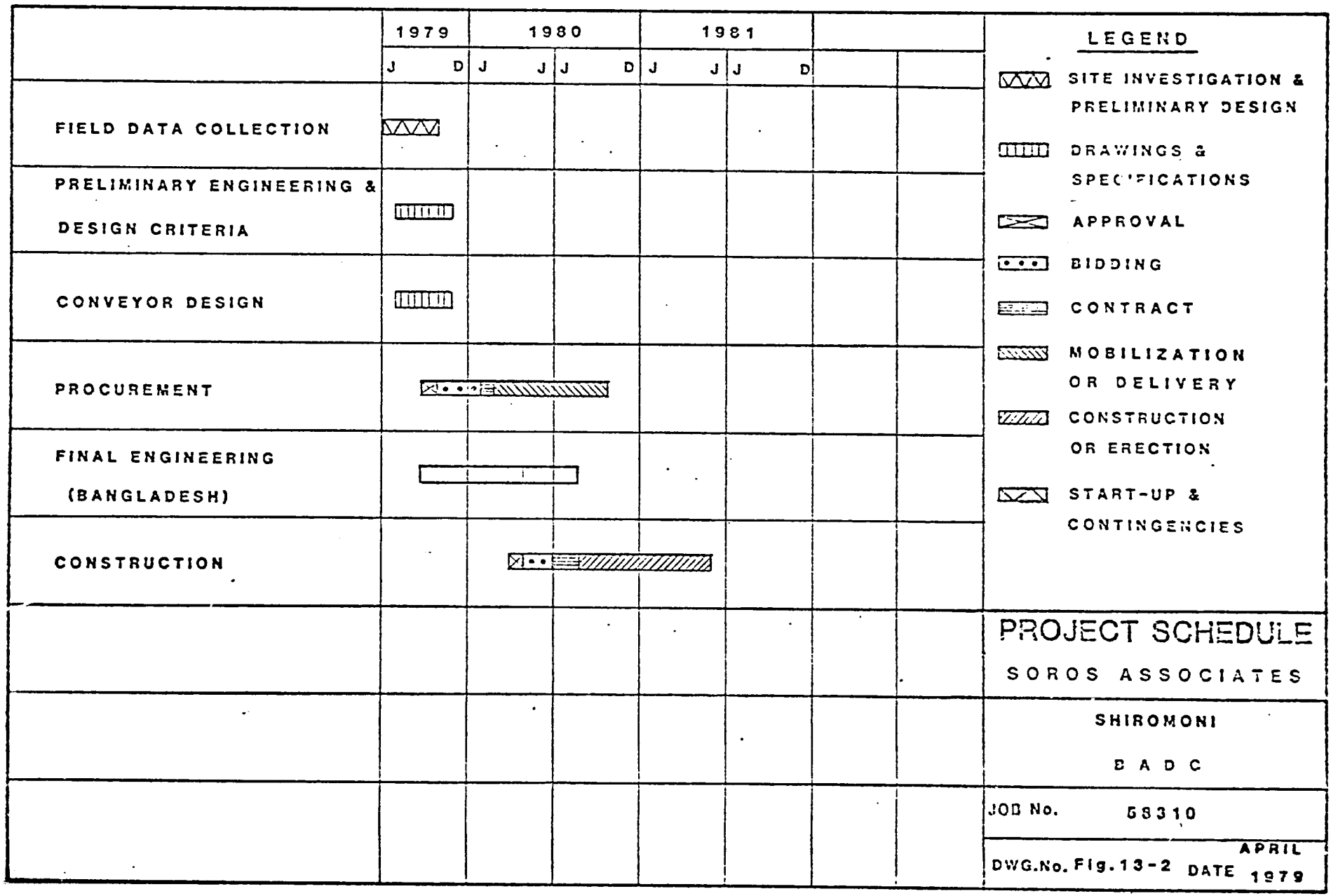
DATE APRIL 1979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B A D C
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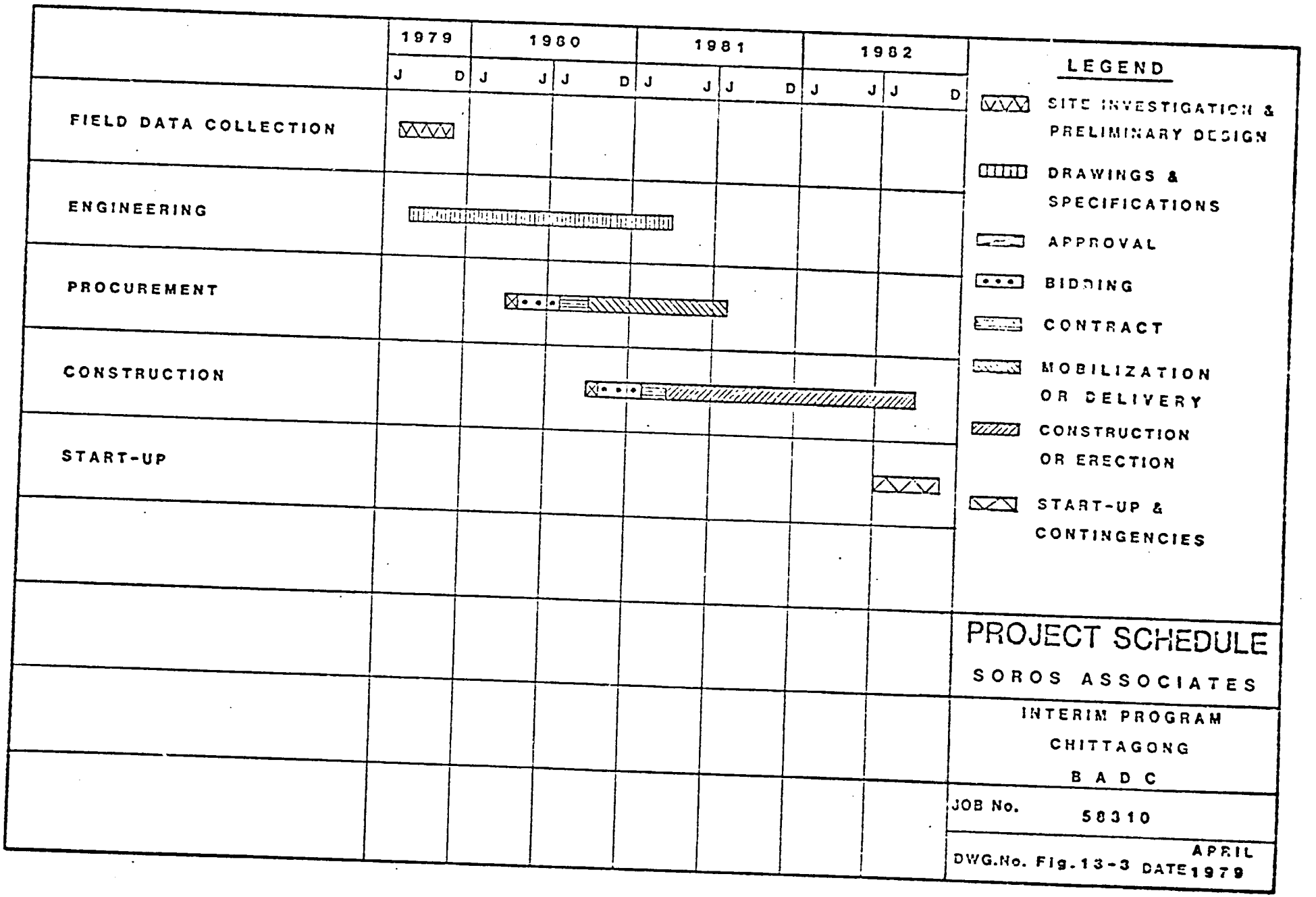
DATE APRIL 1979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CONSTRUCTION OR ERECTION
START-UP & CONTINGENCIES
PROJECT SCHEDULE
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INTERIM PROGRAM
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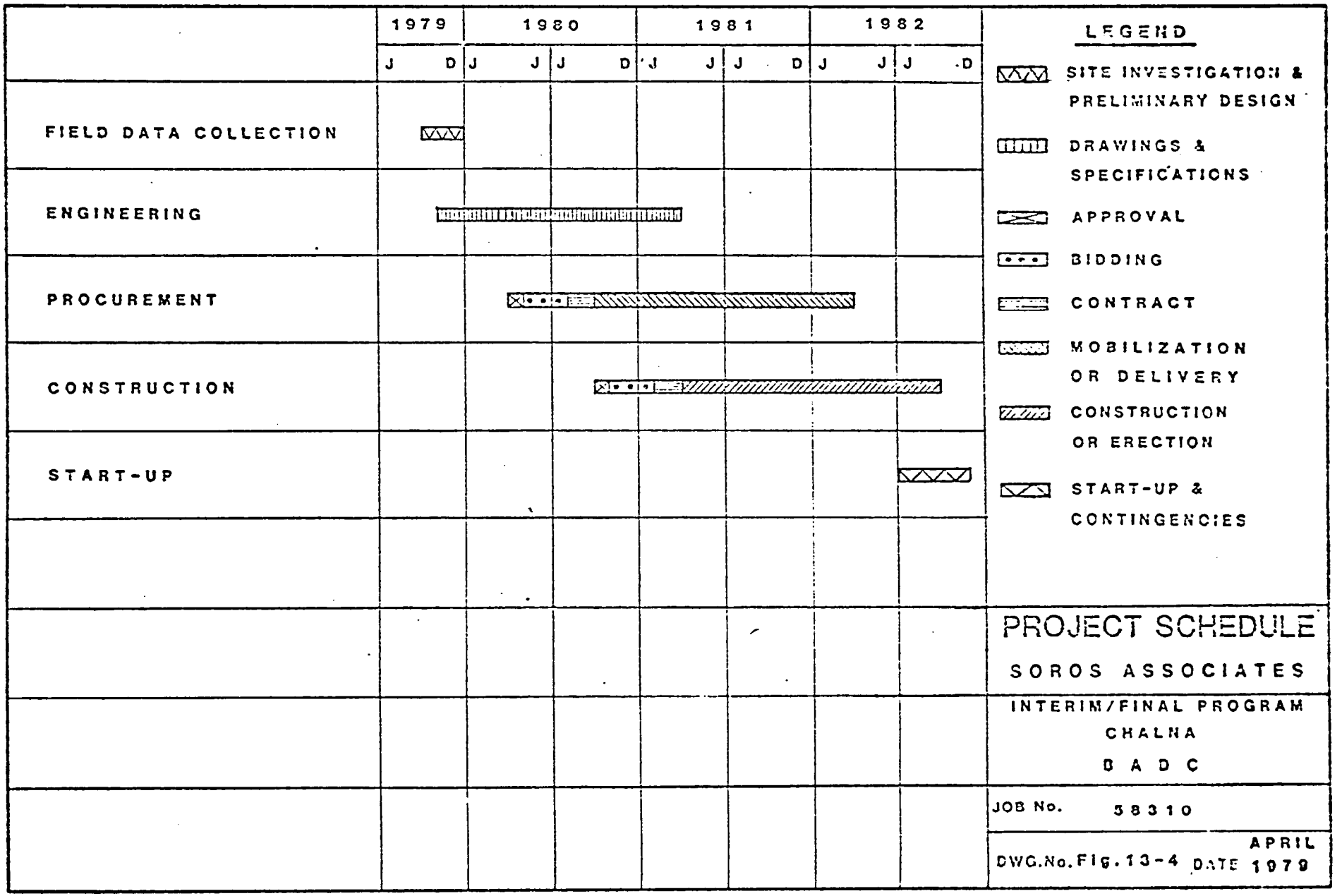
B A D C
JOB No. 58310
DWG.No. Fig.13-3
DATE APRIL 1979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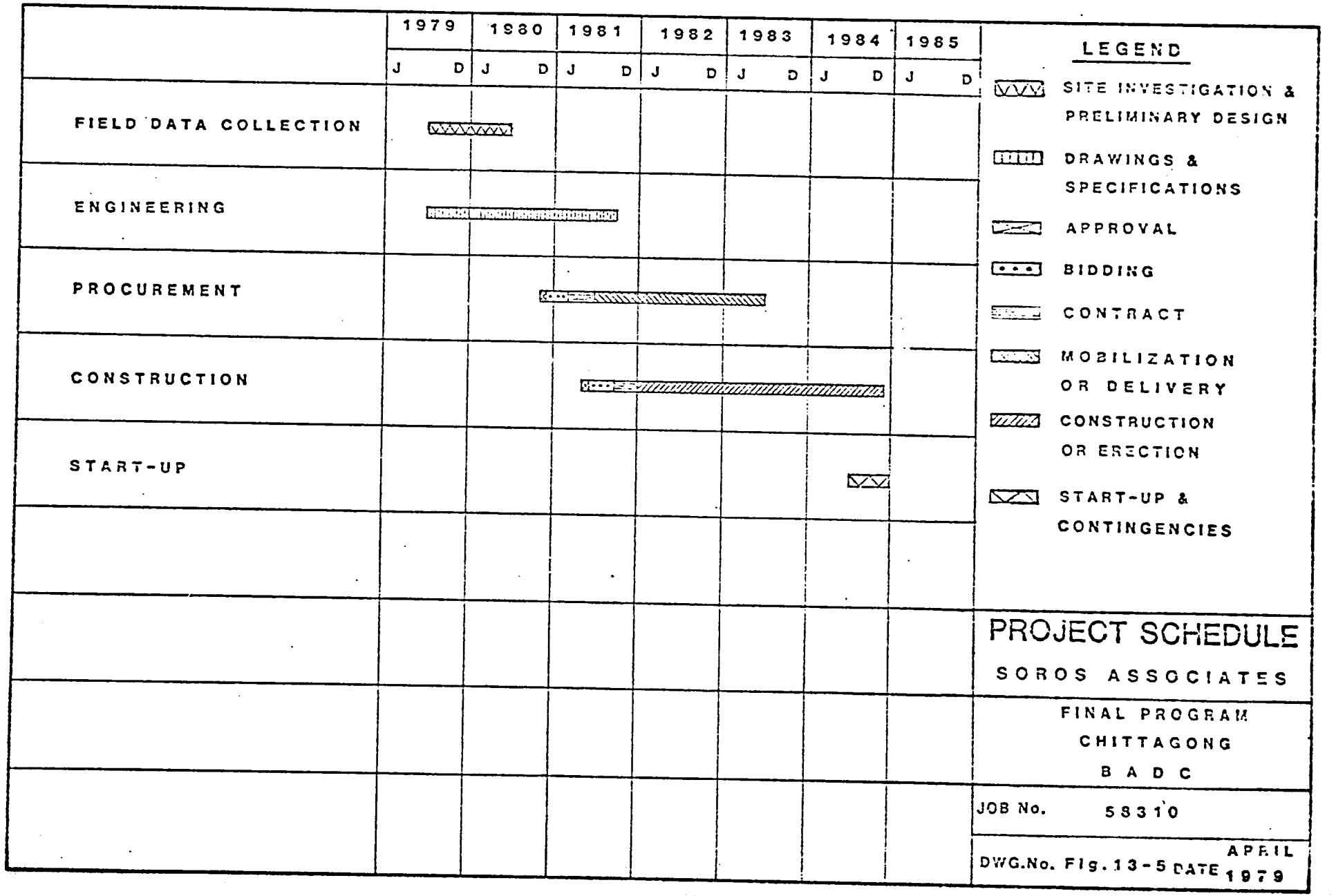
MOBILIZATION OR DELIVERY
CONSTRUCTION OR ERECTION
START-UP & CONTINGENCIES
PROJECT SCHEDULE
SOROS ASSOCIATES
INTERIM/FINAL PROGRAM
CHALNA
B A D C
JOB No. 58310
DWG.No. Fig. 13-4
DATE APRIL 1979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APPROVAL
BIDDING
CONTRACT
MOBILIZATION OR DELIVERY
CONSTRUCTION OR ERECTION
START-UP & CONTINGENCIES
PROJECT SCHEDULE
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FINAL PROGRAM
CHITTAGONG
B A D C
JOB No. 58310
DWG.No. Fig. 13-5
DATE APRIL 1979