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ECONOMIC FEASIBILITY AND PRELIMINARY ENGINEERING STUDY

for

PROPOSED GRAIN STORAGE COMPLEX PORT OF AQABA

for

NATIONAL PLANNING COUNCIL
AMMAN, JORDAN

PREPARED BY
BLACK & VEATCH INTERNATIONAL

OCTOBER, 1976

BLACK & VEATCH INTERNATIONAL
CONSULTING ENGINEERS

TEL. (913) 967-2000
TELEX 4-2523
CABLE ADDRESS BLACVEATCH

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

October 28, 1976

H. E. Dr. Hanna Odeh, President
National Planning Council
P.O. Box 555
Amman, Jordan

Dear Dr. Odeh:

We are pleased to submit twenty (20) copies of the Final Draft of the Economic Feasibility and Preliminary Engineering Study for the Proposed Grain Storage Complex, Port of Aqaba.

You will note that we have included an Executive Summary as a preface to the report for quick reference on the study findings and recommendations. In addition we are enclosing four (4) copies of the Dames & Moore report entitled "Soils and Foundation Investigation, Proposed Grain Storage Complex, Aqaba, Jordan" for your use and information.

Black & Veatch International representatives will be in Amman for an oral presentation approximately November 2 and will be pleased to meet with you and your staff at your convenience to provide any clarification regarding the Study. We will proceed with the revisions and submittal of the Final Report as soon as we have received all the written comments pertaining to this draft.

We would like to take this opportunity to thank you and your staff, as well as other officials of the Government of Jordan, for all the courtesies and assistance extended to our personnel during our visits to Jordan.

Yours very truly,

BLACK & VEATCH INTERNATIONAL

William D. Duanne
Project Director

lmg

Enclosures

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ECONOMIC FEASIBILITY AND PRELIMINARY ENGINEERING STUDY FOR A PROPOSED GRAIN STORAGE COMPLEX PORT OF AQABA

EXECUTIVE SUMMARY

The investigations made and the findings and recommendations resulting therefrom are discussed in detail in the text of the report. For convenience, the principal findings and recommendations are summarized below.

RECOMMENDED FACILITY

The study has demonstrated the economic feasibility of construction and operating a 30,000 MT vertical concrete silo facility with individual free standing bins to be constructed in the Port of Aqaba. It meets all the objectives of a grain import facility as follows:

a. Reduce berthing time from 21 to 5 days while offloading a 30,000 MT shipment.

b. Reduce to a minimal amount the disruption of general cargo activity in the area.

c. Reduce grain losses on receipt and shipment by approximately 1 per cent.

d. Provide a means of adequately measuring the quality and quantity of grain being received and shipped.

e. Provide sufficient surge storage capacity to allow for an orderly control of grain transport to inland points.

f. Encourage bulk handling and transport of grain by truck and rail.

The recommended facility would include two mobile pneumatic ship unloaders mounted on General Cargo Berth 1, which would have a maximum combined discharge

capacity of 400 MT of wheat per hour. The grain would be carried on an elevated belt conveyor system to the storage facility located east of the main railway line and occupying the southwest corner of the area designated for the Free Trade Zone. The grain would be stored in vertical free standing concrete bins. A headhouse at the northern end of the facility would receive the grain, weigh, sample and distribute it into chain conveyors running longitudinally over the storage bins. The bins would be emptied by gravity onto belt conveyors carrying back into the headhouse and either loaded out in bulk to trucks or railway cars, or bagged and shipped either by rail or trucks to inland points.

A soils investigation study carried out as part of this study has shown that all the major structures can be supported with shallow mat foundations without the use of piling. All structures proposed can be designed to be within the limitations of the allowable soil bearing pressures recommended in the soils report.

ECONOMIC FEASIBILITY

Projections of grain production in Jordan are based on an historical 10-year cycle, which includes three poor crops, three good crops and four average crops. The resulting projection indicates average annual wheat and maize importation over the next decade of 210,000 MT, a maximum of 378,000 MT, and a minimum of 146,000 MT which is approximately the amount imported in 1975. Included in the above figures is a wheat equivalent of 39,000 MT, which the Government of Jordan [illegible] the form of flour for the consumption of displaced persons. [illegible] ticipated that bulk wheat will be substituted for this requirement once the planned flour mill goes into operation in 1978.

Using the 210,000 MT average annual throughput as a basis, various technical alternatives have been specified and designed in sufficient depth to provide cost estimates. The economic trade-offs between cost and performance for the components of these alternatives are then analyzed in a cost-effectiveness analysis. The objectives of the cost-effectiveness analysis are to determine the proper capacity sizing for the major components of the bulk grain handling facility and determine the least cost configuration. This analysis shows that 400 MT/hr pneumatic offloading, 30,000 MT of surge storage capacity, and a bagging and reshipping capability of about 1,728 MT/day (which is assumed to be the near-term maximum capacity within the limits of labor and transportation constraints) is the preferred combination of facilities for bulk grain handling.

There are alternative configurations which can provide the recommended surge storage capacity of 30,000 MT. These alternatives are evaluated to provide data for internal rate of return calculations. Preliminary designs are used as the basis for estimating capital and operating costs for each of these facility configurations. Estimated total costs for these facilities (including offloading, bagging, and reshipping) are estimated as follows:

ANNUAL OPERATING COST - THROUGHPUT

Facility Plan	Minimum JD	Average JD	Maximum JD	Total Capital Costs JD
A	151,723	216,473	388,257	4,108,764
B	162,155	231,417	415,170	4,047,077
C	172,586	246,360	442,082	4,012,814
D	151,723	216,473	388,257	4,141,998
E	151,723	216,473	388,257	4,036,490

The study projects annual savings, as shown in the following table, to the Government of Jordan and to the private sector from construction and operation of the recommended bulk grain handling facility.

ANNUAL SAVINGS WITH THE PROPOSED FACILITY

SECTOR	THROUGHPUT		
	Minimum	Average	Maximum
	JD	JD	JD
Government	278,780	464,175	717,651
Private	151,993	253,071	391,268
Total	430,773	717,246	1,108,919

The sources of these savings (benefits) are:

a. Reduction in ships' idle time and/or demurrage charges resulting from a quicker unloading time.

b. Relieving the dock phase at Berth No. 1 by as much as 16 days per ship and reducing lightering costs.

c. Reduction of grain losses through an improved, more efficient off-loading procedure.

Similar savings to the private sector on the importation of maize could also materialize.

The Government can also recover a portion of the operating costs by charging the private sector for receiving, storing and outloading maize shipments. It is recommended that a charge per metric ton be assessed for handling and storing. Additional bagging costs should also be assessed if the importers are unable to receive in bulk.

The economic feasibility analysis concludes by combining the costs and savings for each of the five plans and calculating the internal rate of return (IRR)

associated with each plan. The internal rate of return provides the basis for a reliable rank ordering of the five plans. As shown in the following table, the plans all generate internal rates of return in excess of 10% at an average annual throughput of 210,000 MT during a 30 year period of analysis.

IRR BY ANNUAL GRAIN THROUGHPUT

Plan	Facility 30,000 MT	Minimum %	Average %	Maximum %
A	Vertical Concrete	5.38	11.75	17.40
B	Horizontal Warehouse, Vertical Concrete	5.18	11.55	16.99
C	Horizontal Warehouses	4.90	11.26	16.45
D	Vertical Steel	5.31	11.65	17.25
E	Vertical Concrete, Separate Bins	5.54	11.99	17.72 ✓

RECOMMENDED PLAN OF EXECUTION

It is recommended that the silo be designed by a competent consulting engineer familiar with the proposed type of facility, who would be delegated to specify and assist the Government of Jordan in tendering for the equipment to be installed. It is also recommended that the construction be carried out by a Class 1 Jordanian general civil contractor who would subcontract the mechanical and electrical installation phases to competent firms in their respective fields. The civil contractor should also seek assistance in the form of a joint venture or a subcontract for the slipform phase construction of the vertical storage. If it is anticipated that an extended period of time will be required to complete construction funding arrangements for the

project, then the Government of Jordan could consider proceeding with the design phase with funds from their regular fiscal budget. This could result in an earlier completion of the overall project. The facility could be placed in operation within 33 months if construction funding can be arranged within an eight-month period.

INTRODUCTION

The Hashemite Kingdom of Jordan depends on imports to provide a substantial portion of its grain requirements. This dependence appears unlikely to change in the next decade, although a concerted and ambitious effort to foster economic development and greater self-reliance is currently under way.

The development of the port facilities at Aqaba is recognized as an essential element of Jordan's future prosperity. The port area is located at the head of the Gulf of Aqaba on a barren strip of land, with a rocky range of mountains rising to 1,500 meters forming a picturesque backdrop. The waters in the Gulf are generally calm, but storms caused by southerly winds occur occasionally for periods of one to three days. The prevailing winds in the area are from the north, and there is often a fine dust in the air. Powdered phosphate is received and loaded by conveyors onto ships to the south of the general cargo berths. The phosphate operation causes fine phosphate dust to be blown by the prevailing winds in a southeasterly direction from the general cargo berths. The draft of the general cargo berths is 11 meters with a tide fluctuation of approximately one meter.

The Port has become increasingly important since the reopening of the Suez Canal in 1975, which provides convenient access to European and American ports. In the short period since the canal reopened, ships' arrivals at Aqaba have increased from 25 to 90 per month, a rate far

exceeding projections in earlier reports. Port activity at Aqaba shows every indication of continuing to increase, although perhaps at a slower rate. Construction of adequate port facilities at Aqaba is also likely to attract traffic from increasingly congested Mediterranean and Mid-eastern ports. It is imperative that port congestion at Aqaba and the resulting economic inefficiency be minimized if the country is to achieve its development goals.

Although grain imports are a major commodity import, offloading and storage facilities at Aqaba are virtually non-existent. During 1974 and 1975, bulk grain shipments received at Aqaba averaged 20,260 metric tons (in excess of 764,000 bushels) and required 20 days or more for offloading. The lack of storage space requires on-the-spot bagging and immediate transport to inland mills or storage facilities. The long offloading time results in high allowances in shipping contracts for idle ships' time while unloading and contributes siginificantly to port congestion. Therefore, inclusion of modern bulk grain handling and storage facilities in Aqaba's port development plan is highly important.

This report is divided into two sections. Section I, Economic Study, serves as the foundation for Section II, the Engineering Study. Section I is concerned with six main topics as follows:

A. Agricultural Production and Consumption
B. Grain Distribution and Storage
C. The Grain Processing Industry
D. Ship Offloading of Grain at Aqaba
E. Economic and Financial Analysis
F. Environmental Impact of the Proposed Facility

Section II presents an engineering study presented in ten main topics as follows:

A. Design Parameters
B. Design Logic
C. Site Considerations
D. Capabilities of Jordanian Contractors
E. Construction Materials and Methods
F. Project Schedules
G. Estimated Capital Investment Costs
H. Recommended Facility
I. Organization and Training Program
J. Preliminary Layout Drawings

SECTION I - ECONOMIC STUDY

A. AGRICULTURAL PRODUCTION AND CONSUMPTION

1. GENERAL. Agricultural development is a primary concern of the Jordanian Government. The country has never reached self-sufficiency in food projection and, according to Government officials, is unlikely to achieve complete independence from imports. However, reduction of the dependence on imports is a primary goal of the Government. Considerable resources are being devoted to improving agricultural efficiency and the means for handling and storing foodstuffs.

The problems confronting the country in its attempts to improve its food situation are those common to all developing nations. They include the following:

- o Limited Funds. Limited funds for improving and expanding a sound capital base for food production and processing.
- o Small Farms. The average farm size in Jordan is about 47 dunums (11.6 acres). Approximately one-third of the total land holdings, however, are less than 10 dunums, and another third range in size between 10 and 50 dunums.[1] Small farms limit the productivity of the land because mechanical equipment costs cannot be justified.
- o Private Farmers. There is a reluctance of private farmers to adopt modern production practices.
- o Soil Composition. There is a lack of information about soil composition and geographic soil variations.

Much of the land in Jordan is not suitable for crop production. Table 1 provides a breakdown of land areas by average annual rainfall. As

1 Kanaan and Attieh, "Agricultural Development," Ministry of Culture and Information, The Hashemite Kingdom of Jordan, undated.

shown in Table 1, only 10 per cent of the total land area is suitable for cultivation because of insufficient rainfall. Of this, 6 per cent of the total land area could be considered marginally suitable.

TABLE 1

PERCENTAGE OF TOTAL LAND AREA BY RAINFALL CLASSIFICATION

Average Annual Rainfall (in millimeters)		Per Cent of Land Area
Arid	- less than 200 mm	90.0
Marginal	- 200 mm to 350 mm	6.0
Semiarid	- 350 mm to 500 mm	1.5
Semihumid	- 500 mm to 800 mm	1.5
High-humid	- more than 800 mm	1.0
		100.0

Source: 1974 Report of Symposium on Agricultural Development, Hashemite Kingdom of Jordan, Ministry of Agriculture.

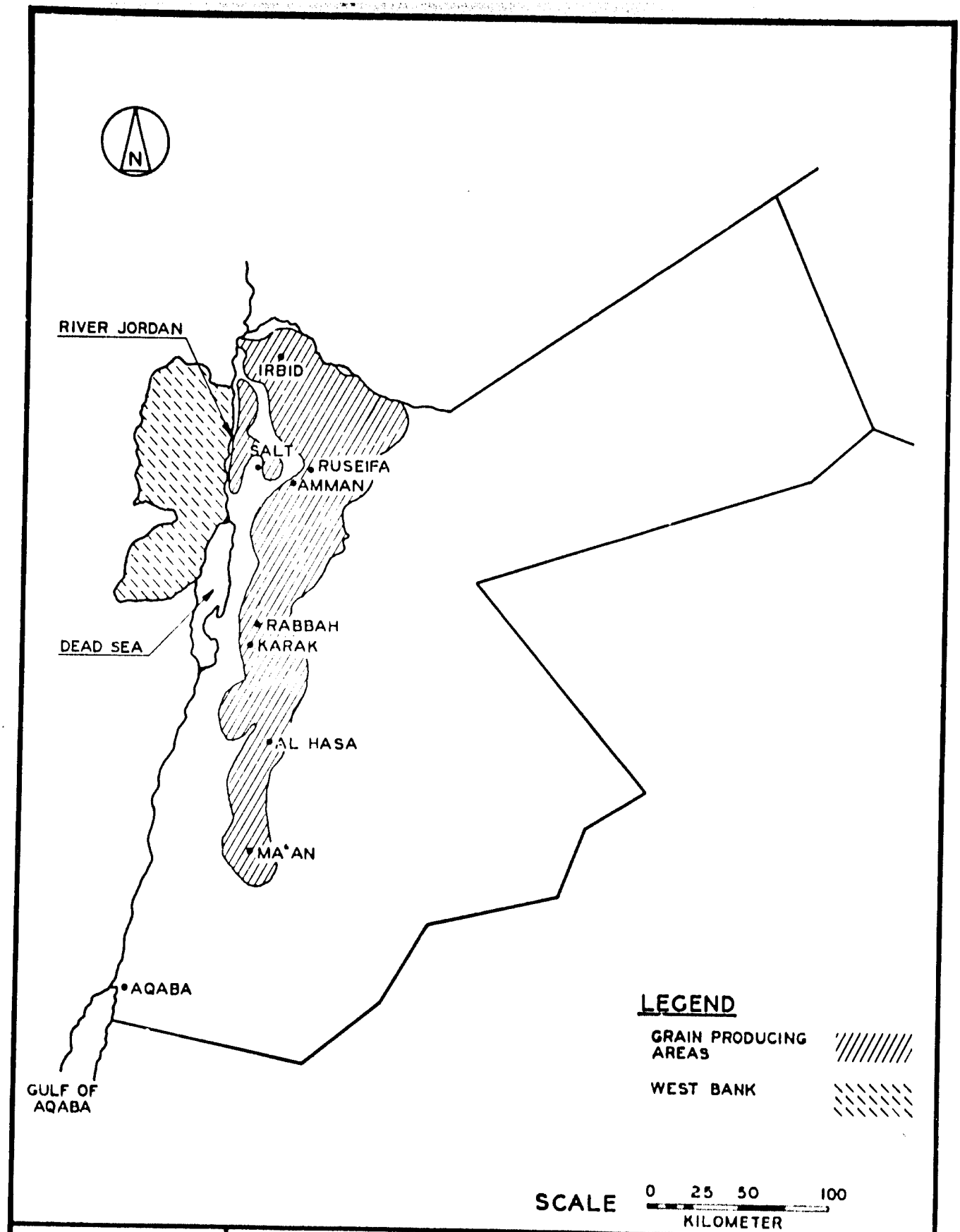
Figure 1 illustrates the area of Jordan in which cereal grains are produced. As shown, most of the area lies in the northwestern quadrant of the country. This same area and the nonshaded area along the Dead Sea and northward along the Jordan River constitutes the land suitable for cultivation.

Crop yields vary greatly from year to year, due to drastic variations in rainfall. Nearly all of the wheat and much of the maize is not irrigated. Irrigated lands and those fed by artesian springs are devoted to more profitable crops, particularly vegetables.[1]

2. WHEAT.

a. Historical. Wheat is Jordan's largest crop in terms of land cultivated and tonnage produced, and is the most important grain to the economy. It is also a major import. In analyzing the feasibility of

1 Ministry of Agriculture



BLACK & VEATCH CONSULTING ENGINEERS PROJECT	HASHEMITE KINGDOM OF JORDAN	DATE NOV. 1975
	MAJOR CEREAL GRAIN PRODUCING AREAS	FIGURE 1

grain handling and storage facilities, wheat imports are the determining factor.

Annual cropland planted in wheat averages some 2 million dunums, about one-third of total cultivated land. This total varies widely, according to precipitation during the October through December planting season. Wheat production varies from over 200,000 metric tons in good years to about 50,000 metric tons in poor years, averaging around 131,000 metric tons. Table 2 shows annual production for years 1969 through 1975.

TABLE 2

ANNUAL WHEAT PRODUCTION IN JORDAN
1969-1975

Crop Year	Production (Metric Tons)
1969	201,000
1970	54,100
1971	168,100
1972	211,400
1973	50,400
1974	180,000
1975	54,400

Source: Ministry of Agriculture

Table 3 shows a statistical comparison of wheat production, average yields, and amount of land planted by district.

TABLE 3

WHEAT PRODUCTION DATA BY DISTRICT

District	Average Area in dunums (000 omitted)	Per Cent of Land Area in the District	Average Yield kg/dunum	Average Production (000 MT)	Per Cent of Total
Irbid	695	35.0	78	54.1	40
Amman	609	30.0	71	43.5	32
Balqa	105	5.5	85	8.9	6
Karak	380	20.0	24	19.0	14
Ma'an	119	6.5	21	4.5	3
Jordan Valley	50	3.0	150	7.5	5
Totals	1,958	100.0		137.5	100

Source: Ministry of Agriculture, "Summary of Wheat Production Development Project in Jordan". 1975

Because of wheat's importance to the economy, particularly as an essential source of food, the Government of Jordan has adopted a major policy position and incorporated the policy into a five year work plan project.[1] The plan has four primary stages, as follows:

(1) The establishment of two Government operated production stations, each with 200,000 dunums. One will be located in the Irbid District, the other in the Amman District. Location of the stations will be restricted to areas where the average annual rainfall exceeds 250 mm. These two stations are expected to produce about 500 MT of registered wheat seed annually for distribution to farmers.

(2) Continuation of the demonstration program for expanding the adoption of modern farming practices for increasing wheat production.

1 "Summary of Wheat Production Development Project in Jordan", Ministry of Agriculture, The Hashemite Kingdom of Jordan, 1975.

(3) Continued economic assistance to Jordan's six agricultural cooperative associations for the improvement of wheat yields through better farm management.

(4) Continued research efforts to improve wheat and barley varieties specifically suited to the Jordanian climate and soil conditions.

Part of the five year plan includes an attempt by the Government to discourage wheat production in areas where the average annual rainfall is less than 200 mm. The loss of production from these areas is expected to be regained by the improvement of yields from areas which have a higher level of rainfall. Efforts will also include attempts to stimulate the use of fertilizers and pesticides and improved farming practices (e.g., summer fallowing, crop rotation).

The thrust of this ambitious program is expected to increase total wheat production by 2.5 per cent each year over the five year period covered in the plan. This modest goal should be realized unless the country experiences an extended drought during the period.

As previously noted, wheat production is highly dependent upon weather variations. Historical data and Ministry of Agriculture officials indicate that each 10 year period has approximately three good years, three poor years, and four average years. In a good year, production has exeeeced 200,000 MT. In poor years, production levels have dropped to 50,000 MT. Average years have resulted in production levels of between 150,000 MT and 180,000 MT. Aside from the above, there is no other discernible pattern.

The lack of a historical pattern, other than as noted, makes it difficult to establish projections for the future. Subjecting the historical data of the previous 10 years to least squares linear regression results in an improbable negative trend line caused by two poor years falling in the latter part of the decade. Also important is the policy of the Ministry of Agriculture to attempt to increase total agriculture output by 2.5 per cent annually, a goal which appears to be reasonable and attainable.

b. Projected. One method of developing projected wheat production data is the calculation of an arithmetic average for the previous 10 years and increasing that amount by 2.5 per cent annually. Use of this methodology, however, does not recognize the extreme variations in domestic production that will ultimately affect import requirements. Variations in imports, both minimum and maximum, are critical to the size and design of the proposed grain facility at Aqaba and cannot be ignored. On the other hand, there has been no historical relationship between domestic production and imports. Efforts to determine why this is the case were unsuccessful.

Nevertheless, the extreme variations in production and their long term effect upon import requirements are still essential to the proposed grain facility. Consequently, the projection methodology used for this study incorporates the historical "3 good - 3 poor - 4 average" pattern with annual increases in production levels of 2.5 per cent over similar

production levels of the previous decade. Selection of the year in which the level of production was to occur was done on a strictly random basis. The results are as follows:

Average years - 1976, 1978, 1980, and 1983

Good years - 1977, 1982, and 1984

Poor years - 1979, 1981, and 1985

It is important to emphasize that this procedure was used only to establish minimum and maximum levels of imports likely to be required. The years in which these levels are reached are immaterial, except for determining these probable upper and lower limits for future wheat imports. Needs for imported wheat affect the functional design of the proposed facilities and also impact the composition of imports. Given a fixed flour milling capacity, years in which import needs are maximum may require a trade-off between bulk wheat and flour. Reliance on flour imports instead of wheat, in turn, affects the feasibility of the bulk grain facility in terms of volume throughputs.

Using the latter approach for projecting wheat production results in an average annual domestic production of 164,000 metric tons. The previous method discussed just above results in an average of 161,200 metric tons annually. Hence, the two approaches are not significantly different. The resultant production data derived using the random approach are shown in Table 4.

TABLE 4

PROJECTED DOMESTIC WHEAT PRODUCTION
1976-1985
(Metric Tons)

Year	Production
1976	103,300
1977	237,300
1978	186,000
1979	59,500
1980	189,000
1981	58,000
1982	248,400
1983	216,000
1984	246,200
1985	68,000

Source: BVI/MRI

c. Bulk Wheat and Flour Imports, Exports and Reexports. Nearly all Government imports of grain are wheat. Because of limited flour milling capacity previously discussed, the Government has also been an importer of flour. Private interests are not known to import wheat. Government imports are handled by the Ministry of Supply, which was created in 1973 to replace the Supply Import-Export Department (S.I.E.D.).

The Government of Jordan has adopted a policy which requires the Ministry of Supply to maintain sufficient wheat stocks to meet consumption needs of the country for a period of approximately six months. At present, annual carryover stocks are expected to average about one-fourth of the country's total annual needs once the grain storage facilities under construction are completed. By the end of the first quarter, officials state that domestic wheat production for the year can be

determined with a fair degree of accuracy, allowing adequate time to negotiate purchase of sufficient quantities to offset the anticipated deficit. Internal harvest, even in a poor year, would allow sufficient time for delivery of purchases to meet domestic requirements during the last half of the year. This buying pattern is expected to be established after completion of the additional grain storage facilities now under construction or in the planning stage.

Government imports have historically included both bulk wheat and flour, due to inadequate domestic flour milling capacity. In addition, the United Nations has contributed significant quantities of flour for distribution in the country.

Flour for relief purposes is imported by the United Nations Relief and Welfare Agency (UNRWA) and by the Government of Jordan's Supreme Ministerial Committee for Displaced Persons (SMCDP). The UNRWA imports approximately 42,000 metric tons annually for distribution to 301,000 displaced persons. The SMCDP imports an additional 30,000 metric tons per year for distribution to 243,000 refugees from the West Bank. Distribution of SMCDP flour is handled by UNRWA, with the Government paying half of the distribution costs.

Until recently, the relief flour was donated by various countries, principally the United States of America. Present policy, according to UNRWA and USAID officials, is toward cash donations with which flour or grain could be purchased. The UNRWA Superintendent for Jordan states that up to 20,000 metric tons of flour may arrive in a single shipment

which takes three months or more to distribute. Storage facilities are inadequate, and substantial infestation and deterioration of the flour often occurs during the storage period. The superintendent stated that he would much prefer to receive bulk grain shipments, which could be stored and milled locally at an approximate rate of 6,000 tons per month. This procedure would eliminate the existing flour storage problems and provide adequate monthly supplies of fresh flour. It would also stimulate the Jordanian flour milling industry and provide better utilization of existing and proposed grain handling and storage facilities. Using a flour-to-bulk grain ratio of 1.0:1.3, some 93,600 tons of bulk grain would be required each year.

While there is no guarantee that relief operations will continue indefinitely at present levels, it appears likely that no substantial reduction of requirements will occur until a permanent political settlement is reached.

Historically, agricultural imports have entered the country via several alternative routes. Table 5 provides a general view of agricultural import volumes via the principal border posts.

TABLE 5

AGRICULTURAL IMPORTS THROUGH JORDAN'S MAIN BORDER POSTS
1972-1974
(in 000 Metric Tons)

Year	Ramtha (road)	Mafraq (rail)	H-4 (road)	Aqaba (sea)
1972	93.2	29.0	19.3	311.2
1973	169.6	16.9	10.0	220.0
1974	264.9	37.3	41.5	62.9

Source: Rendel, Palmer and Tritton, Jordan Imports and Exports Transport Study, June, 1975.

The table does not provide a breakdown of the volume of imports received at Mediterranean ports and trans-shipped into Jordan. Ministry of Supply officials state that limited grain shipments arrive through the ports of Beirut, Lebanon and Latakia, Syria.

The opening of the Suez Canal in 1975 has resulted in a major shift from other points of entry to Aqaba. According to the Harbor Master for the Port of Aqaba, traffic at Aqaba has increased dramatically since the Suez Canal reopened; far exceeding the increases anticipated by Rendel, Palmer and Tritton and TAMS/DAR, which were based largely on the 20 per cent ad valorem surcharge imposed on imports via Beirut and Latakia.[1,2] A strong preference for routing all bulk grain imports through Aqaba was voiced by both Government officials and private interests, especially if grain handling and storage facilities are available.

Exact import and export figures are difficult to obtain. Shipments are known to cross the border illegally when price differentials make such activities profitable. However, the amounts involved are not believed to be significant relative to total imports and exports, and are disregarded in this analysis.

Reexports of bulk grains may play a significant role in the feasibility of a grain facility at Aqaba. Obtaining concrete information about future volumes, however, is difficult. Contacts with the Iraqi Consulate in Aqaba revealed no plans to use Aqaba as an alternate port to Basra, Iraq. An official with the Ministry of Supply in Amman, however, advised that two shipments of grain (20,000 MT each) were scheduled to arrive in Aqaba late in 1975 for subsequent trans-shipment to Iraq.

1 Rendel, Palmer and Tritton, Jordan Imports and Exports Transport Study, June 1975.

2 Tippetts-Abbett-McCarthy-Stratton and Dar Al Handasah Consultants, Aqaba Port Study, May 1975.

In addition to Iraq, the Port of Aqaba is ideally situated to serve as a port of entry for Northern Saudi Arabia. Some sources believe that Saudi Arabia's projected 30 per cent annual growth in imports will require additional port facilities beyond Saudi Arabia's existing and planned port capacities. This may be particularly true for bulk grains, since Jordan's neighboring allies are importers of bulk grains.

Reliance on additional throughput of reexported bulk grain to enhance the economic justification of the proposed facility at Aqaba is not advisable under the circumstances. There is no historic basis for a reasonable projection, and the potential use of Aqaba as an alternate port facility is restricted by the limited land transportation available from the port area.

Grain exports seldom exceed 1,000 metric tons per year, and are generally significant only in years when domestic production is well above average. Table 6 shows import-export data for wheat and flour, over a seven year period.

TABLE 6

WHEAT AND FLOUR IMPORTS AND EXPORTS
1969-1975
(Metric Tons)

Year	Wheat		Flour	(1)
	Imports	Exports	Imports	Wheat Equivalent
1969	6,139	1,125	45,000	58,500
1970	23,708	394	92,000	119,600
1971	22,679	914	77,500	100,800
1972	46,348	2,120	117,000	152,100
1973	71,294	62	73,000	94,900
1974	30,529	29	73,000	94,900
1975	94,713	74	73,000	94,900

(1) Wheat Equivalent 1:1.30

Source: Ministry of Supply, Department of Research

Future wheat imports are difficult to project. Historical imports show no correlation with domestic production during the years 1969 to 1975. However, it appears reasonable to expect that future production shortfalls will result in larger import quantities. The matter is further complicated by reliance on flour imports and the capacity of the domestic flour milling industry.

In generating projection of wheat imports, the following assumptions are made:

o Imports of bulk wheat and bagged flour will compensate for shortfalls in domestic wheat production below a 155 kg/year per capita consumption level.

o Operation of a proposed Government-owned flour fill in 1978 can eliminate dependence of flour imports except for UNRWA donations, which are assumed to remain constant.

o Wheat stocks will increase by estimated 38,000 M.T. during the years 1976 and 1977 in order to achieve the Government's policy of maintaining an average annual carryover balance of 45,000 to 50,000 M.T. Current carryover stocks are estimated to be 10,000 M.T.

Based upon these assumptions, projected imports are calculated by working backwards from total apparent consumption figures, adding exports and subtracting domestic production. Exceptions are 1976 and 1977 in which additional imports are necessary to increase carryover stocks.

Using this approach, Table 7 shows the resulting calculations.

TABLE 7

PROJECTED WHEAT IMPORTS
1976-1985
(in Metric Tons)

Year	Imports
1976	113,800
1977	51,000
1978	112,000
1979	228,700
1980	111,300
1981	252,800
1982	74,900
1983	121,000
1984	103,300
1985	292,200

Source: BVI/MRI

The significant variations from year to year are the result of the substantial changes in production which can be expected. As in the case of domestic production figures, the purpose was not to attempt an accurate prediction of imports in each of the years to 1985, but rather to define the maximum and minimum quantities involved.

It is noteworthy that using this approach results in an average annual bulk wheat import total of about 146,100 MT, as compared to projected annual imports developed by TAMS/DAR of 92,000 MT. RPT projects an average of 162,200 MT/year combined bulk wheat and maize imports. Assuming 70 per cent of this total will be wheat, projected wheat imports average 112,800 MT per year. Their figures do not, however, include the wheat equivalent of flour imports (presently

40,300 MT), which the Ministry of Supply will be able to forego upon completion of the Government-owned flour mill in 1978. Inclusion of this amount in their figures brings all three projections much closer to uniformity.

d. Wheat Consumption. There is no available data on total wheat consumption. However, discussions with a variety of sources provided sufficient details for the generation of reasonable data. For purposes of definition, total apparent consumption is used in a broad sense, indicating the total quantity of wheat used as food for human consumption, animal feed, losses sustained during processing and handling, and as seed for replanting crops.

Wheat consumed by humans is assumed to be in the form of flour, used predominately as a source of breadstuffs. In addition, the Jordanian diet includes cereals. The Director of Research at the Ministry of Supply, has calculated an annual wheat consumption figure of 114 kg/person, using straightforward economic analytical techniques. This would indicate that household consumption accounts for approximately 73 per cent of the total apparent consumption of wheat.

Bran, a by-product of the flour milling industry, is often consumed as cereals by humans and is also used in the manufacture of animal feeds. One source in the flour milling industry indicated that a unit of wheat yields about 18 per cent bran. This same source stated that flour mills typically mill wheat to yield 80 per cent flour, a fact confirmed by a U. S. flour miller who ships flour to the Mid-East. Hence, there is at least a 2 per cent loss factor in the flour industry.

Not all flour mills from which this information was obtained are of the modern type, however. Since the majority of the flour mills in Jordan are of the grist-mill type, it can be assumed that losses occurring during the milling operation are somewhat higher. Consequently, the wheat equivalent for flour used in this study is assumed to be a factor of 1.3, or conversely, a unit of wheat yields 77 per cent flour.

(1) Historical Background. The methodology used in developing historical total apparent consumption figures assumes no change in stocks, which seems reasonable in view of the shortage of grain storage facilities and the significant dependence on imports to meet domestic needs. Another assumption used is that wheat consumption is price inelastic, which means that consumption shows little variation as prices fluctuate.

The first step in generating total apparent consumption is the calculation of a per capita total consumption figure. For this study, a figure of 155 kg/person is used. This figure compares to the 159 kg/person used by the Ministry of Agriculture and 150 kg/person used by USAID officials in Amman for U.S.A. PL-480 loan purposes. The methodology used to derive the 155 kg/person figure is as follows:

$$C = \frac{\sum_{j=1}^{10} \frac{P_j + (I_j - E_j)}{p_j}}{10}$$

where: C_i = per capita consumption in kg/person
P_j = annual domestic production in kg
I_j = annual imports in kg
E_j = annual exports in kg
p_j = population in the jth year

Production, import, export and population data used in the calculation were for the years 1966 through 1975. Changes in stocks were assumed to remain unchanged. Production, import and export data were taken from the Ministry of Agriculture's Agricultural Yearbook for the years 1970 through 1974. Population figures used are those discussed in the following text. Flour imports during the period were converted to a wheat equivalent of 1.30, i. e., 1.3 kg of wheat yeilds 1.0 kg of flour.

(2) Population. Since total apparent consumption is indicative of domestic demand and of prime importance to this study, the methodology used in developing consumption statistics deserves full documentation. Population statistics merit special elaboration.

The Jordanian population has not been enumerated since 1961. Meanwhile, a number of major events has affected population trends. Perhaps the most significant of these events was the 1967 War, which resulted in the loss of the West Bank and an influx of Palestinian refugees. Today, different population estimates abound. There is no consensus regarding the growth rate which has occurred, primarily because of differing interpretations of birth and death registrations. Registered births and deaths are generally believed to be less than actual. Death statistics are particularly subject to question. The Bureau of Statistics estimates that 40 per cent of all deaths may not be registered.

The population data used for this report are based upon the 1961 census and compounded at an annual growth rate of 3.2 per cent. This rate of growth is used by the Department of Statistics and results in a population of 1,950,000 for 1975.

In comparison, the Ministry of Supply uses a population figure of 1,750,000; the Ministry of Agriculture - 1,854,000; USAID - 2,000,000; and the United Nations - 2,500,000. It should be noted that UN data apparently includes the population of the West Bank.

Projected wheat consumption is based on population increases of 3.2 per cent annually multiplied by the 155 kg/capita consumption figure developed earlier in this section. This obviously assumes rigid inelasticity of demand over the projected 10 year period, 1976 through 1985. There is no reasonable method for refuting or substantiating this assumption. Another major assumption is that Jordan's international boundaries will remain unchanged over this period from 1975 positions. The prescribed calculation yields the data shown in Table 8.

TABLE 8

PROJECTED TOTAL APPARENT
CONSUMPTION OF WHEAT
1976-1985
(in Metric Tons)

Year	Total Apparent Consumption
1976	311,900
1977	321,900
1978	331,900
1979	342,700
1980	353,900
1981	365,200
1982	376,800
1983	389,000
1984	401,300
1985	414,200

Source: BVI/MRI

e. Summary Analysis. A summary of the preceding analysis is presented in Table 9, including both historical and projected data on domestic production, imports, exports and total apparent consumption. For the period between 1969 and 1975, it would seem logical that production plus imports (both wheat and flour equivalent) minus exports would equal total consumption. This is not the case, however; total consumption is about 23,300 MT less. The most reasonable explanation is that figures for these years do not consider changes in stocks. If data for all the years between 1961 and 1975 are used, consumption tends to equate with "production plus imports minus exports." From 1976 on, equality is assumed, except for the years 1976 and 1977 wheat stocks are increased 38,000 MT to conform with the stated government policy.

TABLE 9

WHEAT AND FLOUR
PRODUCTION, IMPORTS, EXPORTS AND APPARENT
DOMESTIC CONSUMPTION
1970-1985
(000 Metric Tons)

YEAR	DOMESTIC PRODUCTION[1]	WHEAT IMPORTS[2]	FLOUR IMPORTS EQUIVALENT[2]	WHEAT EXPORTS[2]	TOTAL APPARENT CONSUMPTION[3]
1969	201.0	6.1	58.5	1.1	250.0
1970	54.1	23.7	119.6	0.4	258.3
1971	168.1	22.7	100.8	0.9	266.3
1972	211.4	76.3	152.1	2.1	275.0
1973	50.4	71.3	199.9	0.1	281.0
1974	180.0	48.8	94.9	-	293.0
1975	54.4	105.0	94.9	0.1	302.3
1976	103.3	113.8	94.9	0.1	311.9
1977	237.3	51.0	54.6	2.0	321.9
1978	186.0	112.0	54.6	1.7	331.9
1979	59.5	228.7	54.6	0.1	342.7
1980	189.0	111.3	54.6	1.0	353.9
1981	58.0	252.8	54.6	0.2	365.2
1982	248.4	74.9	54.6	1.1	376.8
1983	216.0	121.0	54.6	2.6	389.0
1984	246.2	103.3	54.6	2.8	401.3
1985	68.0	292.2	54.6	0.6	414.2

1 1969-1975 data source: Statistical Yearbook, Department of Statistics. 1976-1985 projections based on formula shown in Section I-A-2-d-(1).
2 1969-1975 data source: Ministry of Supply, Department of Research. 1976-1985 same as (1) above; includes 19,000 MT additional for 1977 and 1978 additions to stocks.
3 Based on per capita consumption of 155 kg/person.

3. MAIZE. Maize does not rank as one of Jordan's more important crops. However, it is a major source of feed for the growing poultry industry. Government officials in both the Ministry of Supply and the Ministry of Agriculture stated that the country hopes to achieve sulf-sufficiency in egg production within the near future. It is also hoped that Jordan will become a net exporter of poultry to its neighbors.

a. Production. In terms of production, Jordan's maize crop is nominal, generally ranging between 100 and 300 MT annually. The poultry industry consumed an estimated 25,000 to 30,000 MT in 1974. Hence, most of the maize must be imported. Historically, the United States of America was a prominent source of maize. In recent years, however, most of the imports have originated from Thailand, Romania, the Union of South Africa and Mozambique. These sources of supply are closer to Jordan and will likely continue to be the principal suppliers.

Projections for domestic production are calculated by simple least-squares linear regression. This method seems reasonable as a large proportion of the maize crop is grown in areas where irrigation can be accomplished, and is therefore not highly dependent on weather conditions. As with wheat, domestic production of maize is assumed to increase 2.5 per cent annually.

One goal of the Government's 1973-1975 Three Year Plan was to increase maize production from historic levels to 5,000 metric tons annually. Though no target date was established, the goal was not achieved during the current plan. Given the magnitude of the goal and the unsuitability of both the climate and the land for maize production, it seems reasonable to conclude that achievement of the production goal level will not be forthcoming within the next 10 years.

b. Maize Imports, Exports and Reexports. Imports comprise the vast majority of Jordan's supply of maize. In view of the preceding discussion, this situation is expected to continue. Using the available historical data obtained from the Ministry of Supply, projected imports were derived by simple least-squares linear regression. The results conform almost exactly with estimates of future imports obtained from industry and government officials.

While maize exports have been nominal, they appear large in relation to domestic production. Using historical data as a base, exports were projected by the least-squares linear regression technique. The results show a decline in quantities exported, which seems reasonable in view of the increasing importance of maize to the local economy with the anticipated growth of the poultry industry.

While reexports of maize could not be determined, there apparently have been none in the past. Consequently, there is no basis for determining reexport traffic through Aqaba, even if the proposed grain facility is constructed; and it is assumed that no reexport traffic in maize will occur.

c. Apparent Domestic Consumption of Maize. Statistics concerning total domestic consumption of maize are not available. As a consequence, these amounts have been developed by assuming no change in stocks, either historically or in the future, and simply adding domestic production figures to import quantities then subtracting exports. This approach also assumes that maize consumption will continue to be used predominately by the poultry industry in the form of feed.

A summation of the preceding discussion is presented in Table 10. The assumption is that nominal domestic production gains will be achieved, but that any significant increases in total domestic consumption requirements will have to be imported.

TABLE 10

MAIZE PRODUCTION, IMPORTS, EXPORTS
AND APPARENT CONSUMPTION
1969-1985
(Metric Tons)

YEAR	DOMESTIC PRODUCTION	IMPORTS	EXPORTS	APPARENT DOMESTIC CONSUMPTION
1969	300	14,406	146	14,560
1970	100	17,793	-	17,893
1971	800	23,326	257	23,869
1972	300	28,676	135	28,841
1973	200	37,848	-	38,048
1974	300	39,000(est.)	129	39,171(est.)
1975	200	40,000	100	40,100
1976	350	43,000	90	43,260
1977	329	47,800	85	48,044
1978	371	52,600	79	52,892
1979	393	57,400	73	57,720
1980	414	62,200	67	62,547
1981	436	66,900	61	67,275
1982	457	71,700	55	72,102
1983	479	76,500	49	76,930
1984	500	81,300	43	81,757
1985	521	86,000	37	86,484

Source: 1969-1975 data - Department of Research, Ministry of Supply
1976-1986 data - Projected by BVI/MRI.

4. **BARLEY, RICE, AND SOYBEAN MEAL.** Barley ranks as the second most important grain produced in Jordan. Although Jordan has not been self-sufficient in barley, import needs have been small. In 1973 domestic production was at a low figure of 5,900 MT because of the drought, and imports were still only 6,000 MT. The current Government policy is to divert land with annual rainfall of less than 200 mm from wheat production to barley. Conversion of this land should be sufficient to make Jordan self-sufficient in barley requirements.

Discussions with officials of both the Ministry of Supply and the Ministry of Agriculture indicate that barley should not be considered as a future import through Aqaba. Historically, imports of barley have been routed through Mediterranean ports. For these reasons, barley is not considered elsewhere in this report.

Jordan does not produce any rice, relying completely on imports to meet domestic consumption requirements. All imports of rice are received in bags due to the severe kernel breakage resulting from pneumatic grain handling equipment. Ministry of Supply officials foresee no change in this policy. Therefore, rice was not considered in assessing the feasibility of a bulk grain handling facility at Aqaba.

As with rice, Jordan does not produce soybeans domestically. Although statistical information is not available, discussions with Government and private industry officials indicated some interest in soybeans, soybean meal, and soybean oil; including construction of a soybean processing mill. While some Government sources believe the mill would be economically feasible, processing a supply adequate to

meet domestic needs and providing a source of supply for neighboring countries, this opinion is not unanimous. While others agree that imports of soybean meal will continue to increase somewhat, they do not feel that current and foreseeable demand will justify a soybean processing mill or the special facilities required for handling soybean meal in bulk shipments. Estimated current domestic soybean meal consumption is less than 15,000 MT annually. Imports of vegetable oils and animal fats have averaged slightly less than 8,000 MT annually for the years 1972 through 1974.

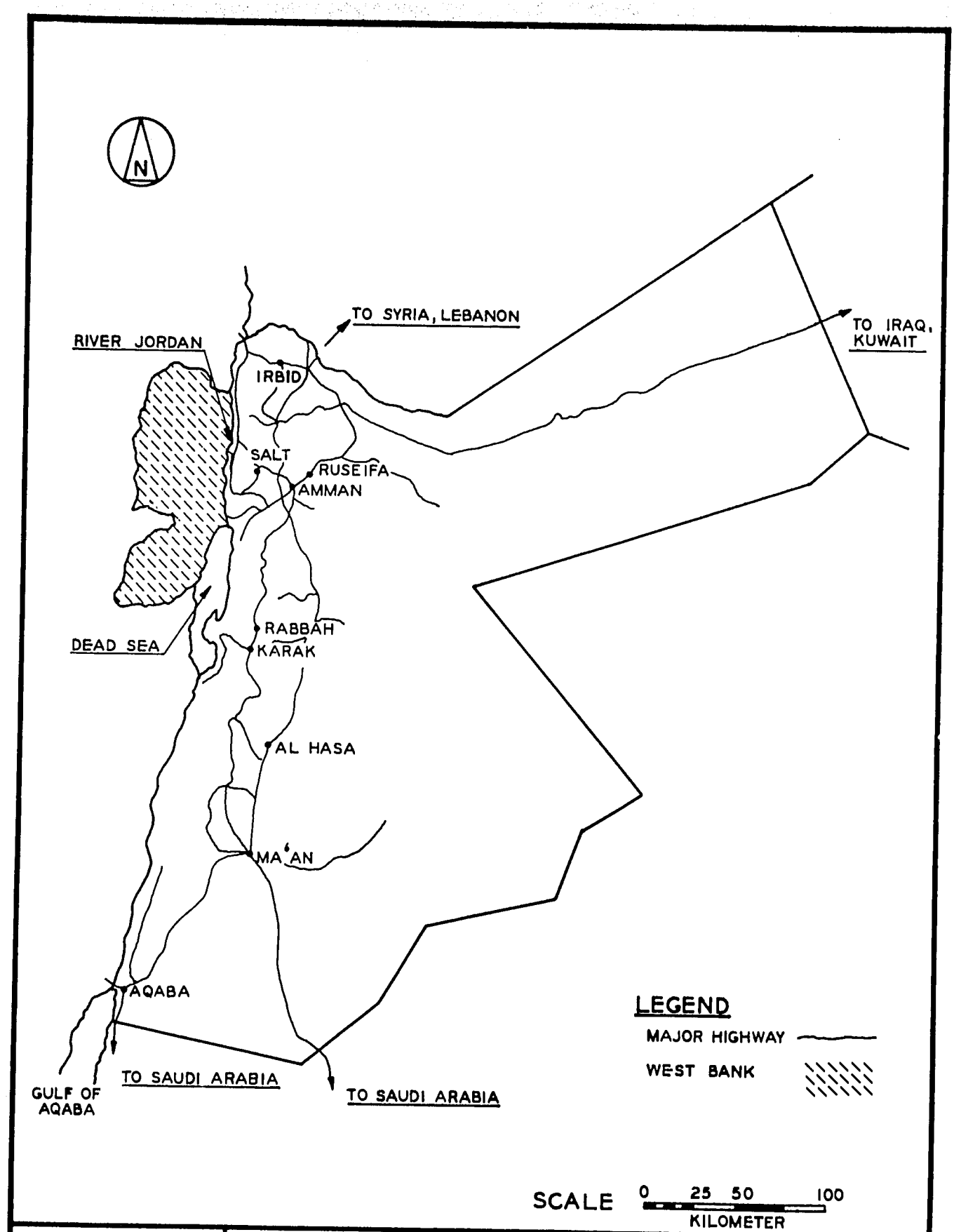
A bulk grain handling facility at Aqaba could easily accommodate the handling of soybeans received in bulk quantities. However, the difficult handling and storing characteristics of soybean meal are not easily accommodated by typical grain handling equipment or storage facilities. It is doubtful whether the additional cost involved in adapting the equipment and storage for soybean meal would result in any savings over current small imports received in bags. The lack of concrete information about future imports of soybeans or soybean meal make it impractical to include them in this analysis.

B. GRAIN DISTRIBUTION AND STORAGE

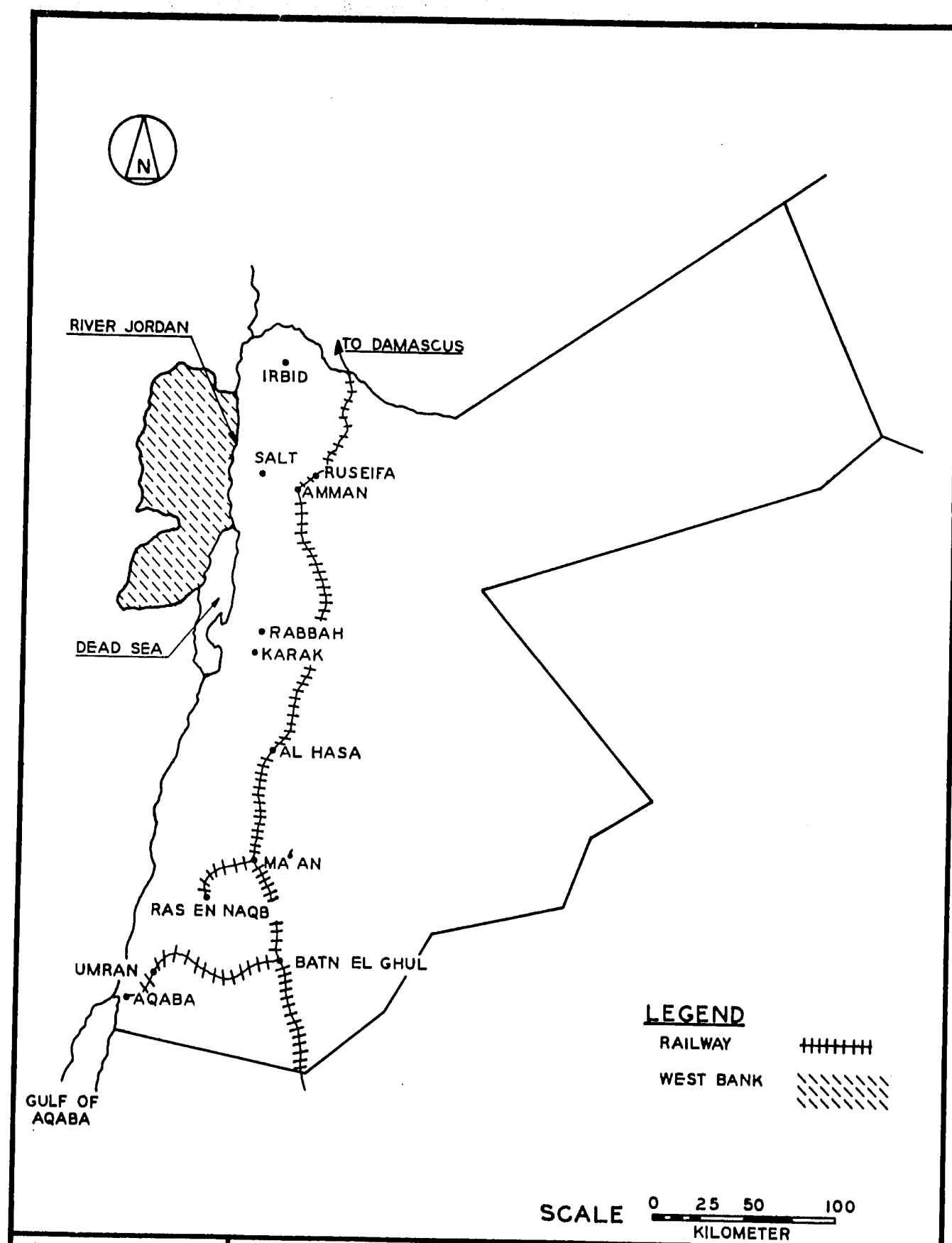
The Government of Jordan is actively engaged in an extensive program to increase the country's food commodity storage capacity. Much of the storage capacity presently under construction, however, will accommodate only bagged or packaged commodities. According to the Ministry of Supply, the decision to concentrate on storage for bagged commodities was based primarily upon the lower cost for this type of facility and its ability to be converted for storage of other goods. In addition, most of the grain processing mills in Jordan are not presently equipped to handle bulk grains.

The distribution of goods in Jordan is accomplished primarily by truck. The only railway line in operation during the past several years has been the Jordan Hedjaz Railway (JHR). This line operates between Amman and Damascus and provides railway access to Beirut through Damascus. In late 1975 the completion of a new rail line between Aqaba and Ma'an opened a rail link between Aqaba and Amman. This link provides critically needed access from the Port of Aqaba to the heavily populated northwestern quadrant of the country, where most of Jordan's industrial capacity is located. Figure 2 illustrates the highway network in Jordan, and Figure 3 shows the existing railway lines.

1. DOMESTIC GRAIN DISTRIBUTION. This section of the report will discuss the grain distribution patterns and transportation methods in Jordan. Considerable reliance on the import-export study by Rendel, Palmer and Tritton is included in the basis for this analysis, with



BLACK & VEATCH CONSULTING ENGINEERS PROJECT	HASHEMITE KINGDOM OF JORDAN	DATE NOV. 1975
	MAJOR HIGHWAY NETWORK	FIGURE 2



BLACK & VEATCH CONSULTING ENGINEERS PROJECT	HASHEMITE KINGDOM OF JORDAN	DATE NOV. 1975
	MAJOR RAILWAY NETWORK	FIGURE 3

additional insights obtained from the Ministry of Transport, the Aqaba Railway Corporation/Jordan Hedjaz Railway, truck operators, and others.

a. The Trucking Industry. The reliance on truck transportation as the primary means of moving goods in Jordan is expected to change somewhat as a result of the completion of the Aqaba-Al Hasa Railway, which became operational in late 1975. This line is expected to be used primarily for the movement of phosphate exports, resulting in continued heavy dependence on trucks. The trucking industry is dominated by private owner-operators; Government trucks are not considered a significant factor in the market. The total fleet composition of the industry is shown in Table 11. Private trucks for a firm's exclusive use (not for hire), tipper trucks used in the construction industry, and vehicles of less than a 10 ton payload are excluded from the Table.

TABLE 11

FLEET COMPOSITION OF VEHICLES
AVAILABLE FOR GENERAL HAULAGE IN 1974

Type	Load Capacity in tons	Number	Per Cent of Total
Rigid	12 - 14	919	52
Rigid with Trailer	24 - 28	280	16
Semitrailer	26 - 30	269	15
Refrigerated	16 - 18	127	7
External Operators	24 - 30	188	10
Totals		1,783	100

Source: Rendel, Palmer & Tritton Study, Jordan Imports and Exports Transport Study, June 1975; and Garages' Union, Amman.

External operators are licensed to haul only import-export traffic between Jordan and other countries. They are not permitted to engage in internal point-to-point traffic.

The transport of goods from the northwestern quadrant south to Aqaba for export consists primarily of phosphate from the mines at Ruseifa and Al Hasa. Return hauls of imported goods from Aqaba are destined primarily for Amman. A syndicate of truckers has been formed for hauling phosphate from Ruseifa and Al Hasa to Aqaba. In return for a monopoly on the traffic, the syndicate has a fixed agreement with the Government on rates. A similar aggrangement exists for the transport of imports from Aqaba northward to Amman. The current rate for truck-transport of grain from Aqaba to Amman is JD 3.5 per metric ton. Other rates over different routes are apparently negotiated between buyer and seller and depend on the supply of trucks and demand for the service at the time.

The flow of goods between Al Hasa and Aqaba is such that approximately three trips carrying phosphate to Aqaba for export are made before a return cargo for delivery to Amman becomes available, indicating a considerable excess capacity for hauling imported goods from Aqaba to Amman. Using traffic data from the Rendel, Palmer & Tritton Study[1], it appears this excess capacity is approximately 2,170 MT per day. Using a 300 day work-year, this is equivalent to about 650,000 metric tons per year. These figures are based upon 1974 phosphate export traffic from the Al Hasa mines to Aqaba and should be considered with discretion. Nevertheless, they clearly indicate that sufficient excess trucking capacity exists to handle increased imports of grain.

1 Rendel, Palmer & Tritton, Jordan Imports and Exports Transport Study, June 1975. pp. 55-62.

A 1968 study of Jordan's grain storage facilities[1] discussed at length the need for the country to convert from handling grains in burlap bags to bulk handling and transport. The cost of bags unquestionably adds to the economic burden of the Jordan economy. However, nearly all existing and under-construction grain storage facilities are suitable for bagged storage only. An engineering cost study performed by the Ministry of Supply in 1973 recognized the savings which would accrue by constructing vertical bulk storage facilities.[2] The higher investment cost of vertical bulk storage was apparently the primary overriding consideration.

The trucks used by owner-operators could be adpated for hauling grain in bulk. Only the lower half of the cargo bed can presently be used for transporting grain, as the top half of the bed sides are slotted. These cargo beds work well for hauling phosphate, since a full-capacity load fits into the bottom half of the truck bed. Since grain is only half of the weight density of phosphate, the slotted top half of the cargo bed would have to be replaced or lined and reinforced to accommodate a full-capacity load. An official of a feed milling company stated that maize is hauled in the same trucks by filling the bottom half of the cargo bed with bulk maize and completing the load by overlaying bagged maize. This same procedure could be adopted in hauling wheat if internal bulk storage and handling facilities become available.

b. The Railway System. The original rail system in Jordan consisted of a 1,050 mm gage rail line extending the length of the country with terminal points at Damascus, Syria and Medina, Saudi Arabia. Major

1 J. L. Pedersen, Grain Storage and Handling in Jordan, September 1968.
2 Ministry of Supply, Engineering Cost Study of Horizontal versus Vertical Grain Storage, 1973.

points served en route were Mafraq, Zerka, Ruseifa, Amman, Al Hasa, and Ma'an. The line was abandoned after World War I south of Ma'an. Although Jordan and Saudi Arabia began reconstruction of the line between Ma'an and Medina, the project was abandoned in December of 1974.

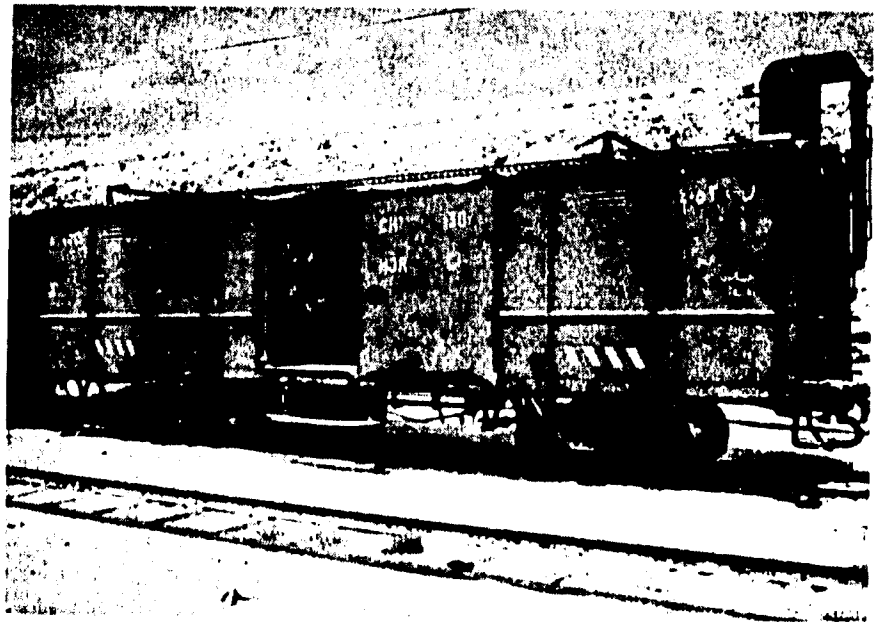
Development of the phosphate industry at Al Hasa and Ruseifa generated interest in the construction of rail access to Aqaba. The task was begun in 1971 and includes a single line from Aqaba to a junction with the Ma'an-Medina line at Hattiya. The project was difficult because of the rugged mountainous terrain surrounding Aqaba. The line became operational in late 1975. Further renovation will be required before the line between Amman and Ma'an can be fully utilized. North of Amman, however, the line is used by one or two trains daily. Full utilization of the Aqaba-Amman line cannot be achieved at present because of technical incompatibility between the two lines. A Rendel, Palmer & Tritton Report[1] states that a maximum of five loaded boxcars might be attached behind each empty train of empty phosphate hopper cars for movement from Aqaba to Ma'an, where they could be sidetracked and formed into separate trains for movement to Amman.

A more practical alternative would be to form 15-car unit trains at Ruseifa, comprised of the old Jordan Hedjaz Railway cars illustrated in Figure 4, to haul bulk phosphate from the Ruseifa mines to Aqaba. These trains could then haul bulk or sacked grain or other cargo on the return trip to Amman or Ruseifa. If the Ministry of Supply's planned bulk grain facility at Ruseifa is realized, bulk wheat and maize could be received

1 Rendel, Palmer & Tritton, Jordan Imports and Exports Transport Study, Draft Final Report, June 1975 p. 20.

from Aqaba and distributed in bulk to flour and feed, resulting in cheaper handling costs. This plan would eliminate disruption of the Al Hasa-Aqaba unit phosphate trains by stops at Ma'an for sidetracking, and could be employed until phosphate exports exceed 5 million tons per year. Due to limitations on axle loading caused by the roadbed capacity, train capacity would be limited to about 285 metric tons. Total annual grain hauling capacity from Aqaba to Ruseifa would be dependent on the quantity of phosphate hauled by rail from the Ruseifa mines to Aqaba. Grain shipments could be bulk or in bags, since the JHR boxcars are suitable for handling both.

FIGURE 4



Jordan Hedjaz Railway Car

c. Grain Distribution Patterns. The concentration of the populace in the northwestern quadrant of the country obviously implies that the greatest consumption of grains and foodstuffs occurs in that area. Since considerable portions of Jordan's total grain requirements must be imported, an analysis of where the greatest needs are located seems in order.

Using data generated elsewhere in this report, Table 12 provides a comparative analysis between consumption requirements and wheat production in each of the five districts.

TABLE 12

COMPARISON BETWEEN WHEAT PRODUCTION AND CONSUMPTION REQUIREMENTS BY DISTRICT FOR 1975

District	Average Annual Wheat Production (in tons)	Consumption[1] Requirements (in tons)	Import Needs (in tons)	Per Cent of Total
Amman	43,500	170,361	126,861	74
Balqa	8,900	19,479	10,579	6
Irbid	54,100	86,171	32,071	19
Karak	19,000	15,682	(3,318)	(3)
Ma'an	4,500	10,565	6,065	4

Source: BVI/MRI

1 Derived by multiplying population by 155 kg.

As shown in Table 12, 74 per cent of 1975 wheat imports were transported to the Amman District. The second largest need for imports is in the Irbid District, located in the extreme northwest corner of Jordan. Ostensibly, the City of Amman is the logical destination for most of the imported grain traffic.

2. GRAIN STORAGE. The government of Jordan maintains a system of horizontal grain storage facilities in strategic locations throughout the country, operated by the Ministry of Supply.

Existing storage capacity totals 14,000 MT. The planned expansion program mentioned earlier in this report will add 58,000 MT capacity, in accordance with the Government's desire to maintain a food grain supply adequate to meet consumption needs for a six month period.

The exact interpretation of this policy is unclear. In discussions with government officials it appeared by the policy more correctly indicates a three month supply of wheat, as approximately 75,000 MT in 1975. However, total government storage capacity is only expected to be 72,000 MT for all grains and sacked sugar under existing plans. For purposes of this study, it has been assumed that wheat storage will exist for 48,000 MT, or about 70 per cent of the total planned capacity.

Government storage is located or under construction at Ruseifa, Irbid, Ma'an, Salt, and Rabbah, as shown in Table 13. The following is a brief description of each installation.

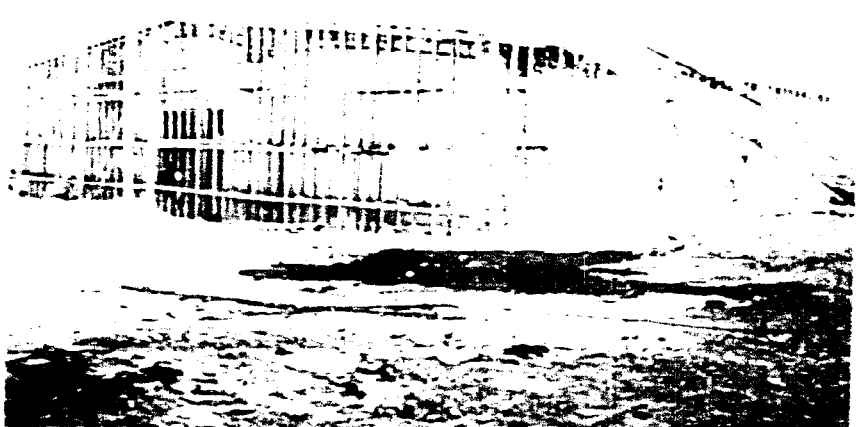
Ruseifa. The main government storage is located at Ruseifa, just northeast of Amman. Here there are two existing types of storage facilities in operation. There are five concrete warehouses standing in a parallel line, as shown in Figure 5. Three of these units measure 12.0 m in width by 49.4 m in length and 4.3 m in height. The remaining two units measure only 11.1 m in width with the other dimensions similar to the above. Each of these units is divided into seven bays down each

RUSEIFA

FIG. 5 – EXISTING CONCRETE WAREHOUSES, MAXIMUM 5,000 M.T. BAGGED STORAGE

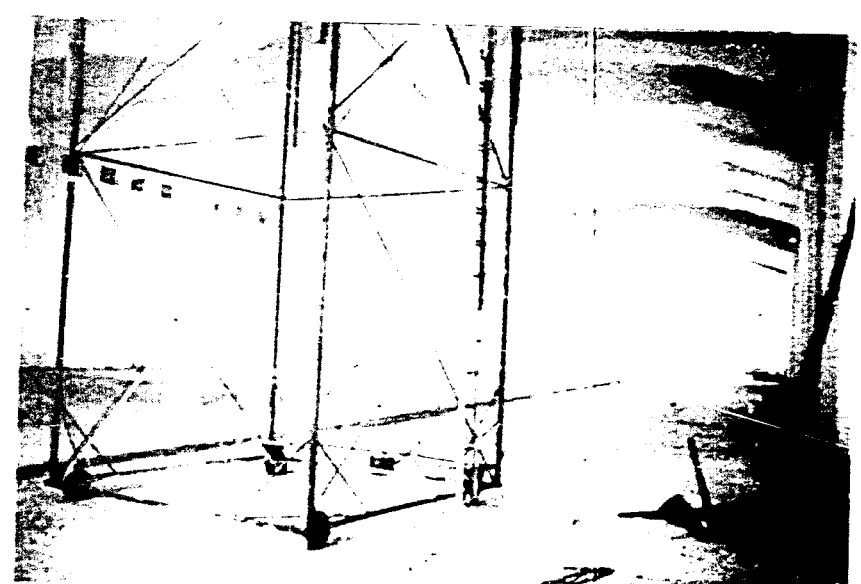
RUSEIFA

FIG. 6 – EXISTING 10,000 M.T. BULK GRAIN STORAGE FACILITY



RUSEIFA

FIG. 7 – ONE OF TWO CONCRETE WAREHOUSES UNDER CONSTRUCTION. ESTIMATED STORAGE CAPACITY 10,000 M.T. BAGGED GRAIN



RUSEIFA

FIG. 8 – INTERIOR OF NEW CONCRETE WAREHOUSE UNDER CONSTRUCTION

side, one of which is used for an office or storage compartment, leaving the rest for bagged grain or butter and cooking fats storage. These facilities are all of concrete construction with concrete floors and interior square columns to support the roofs. When the facility is full, the bags are stacked in such a way as to completely fill the bays from wall to wall and floor to ceiling. In some cases, the alleyways are also filled. Operation in this fashion will not permit proper air circulation and makes it extremely difficult to carry out a successful fumigation program. However, there was no evidence of insect infestation or rodent activity when the facilities were visited in September and November 1975. Phostoxin is applied as a fumigant at three month intervals, according to site personnel. Maximum storage time at the site is one year.

TABLE 13

GOVERNMENT CONTROLLED GRAIN STORAGE FACILITIES

Location	Existing Capacity	Planned or Under Construction	Total Capacity
	Metric Tons	Metric Tons	Metric Tons
Ruseifa			
Horizontal Warehouses	5,000	20,000	25,000
Vertical Storage	5,000	10,000	15,000
Irbid			
Horizontal Warehouses	1,000	10,000	11,000
Metal Silos (not in use)	1,000		1,000
Ma'an			
Horizontal		10,000	10,000
Salt			
Horizontal Warehouse		5,000	5,000
Rabbah			
Horizontal Warehouse	2,000	3,000	5,000
Total	14,000	58,000	72,000

Source: BVI

The openings between the five warehouses have been roofed over and gates installed for additional storage space. However, site personnel stated that no grain is stored in these areas and this space is utilized for the storage of jute bags. These warehouses could hold a maximum of 1,000 MT each if the alleyways were filled. Otherwise the capacity of each is approximately 800 MT.

An existing bulk storage facility at the Ruseifa site is shown in Figure 6. It is comprised of ten concrete bins with dome roofs, having a nominal capacity of 500 MT each, constructed in two rows, giving a

total nominal capacity of 5,000 MT. Two similar-type bins are utilized as a headhouse structure and house the bucket elevators, receiving scales, and cleaners. The bins are filled and emptied by a system of 9 inch diameter screw conveyors. In September 1975, the facility was filled with domestic wheat designated as seed. Apparently, all grain stored in this facility is eventually bagged by a portable bagger outside the headhouse. The facility is equipped to receive grain in bulk. It is possible to load trucks in bulk, but the facility is not presently utilized in this manner.

The site has a truck scale installation which is used to record all incoming and outgoing shipments. There is also a new 80 MT capacity truck scale under construction. There is a rail siding adjacent to the bulk facility, not used at the moment. The site is used primarily for storage of domestic wheat, while imported wheat is normally trucked directly from Aqaba to the flour mills. Imported rice, sugar, butter and cooking fats are also stored in this facility.

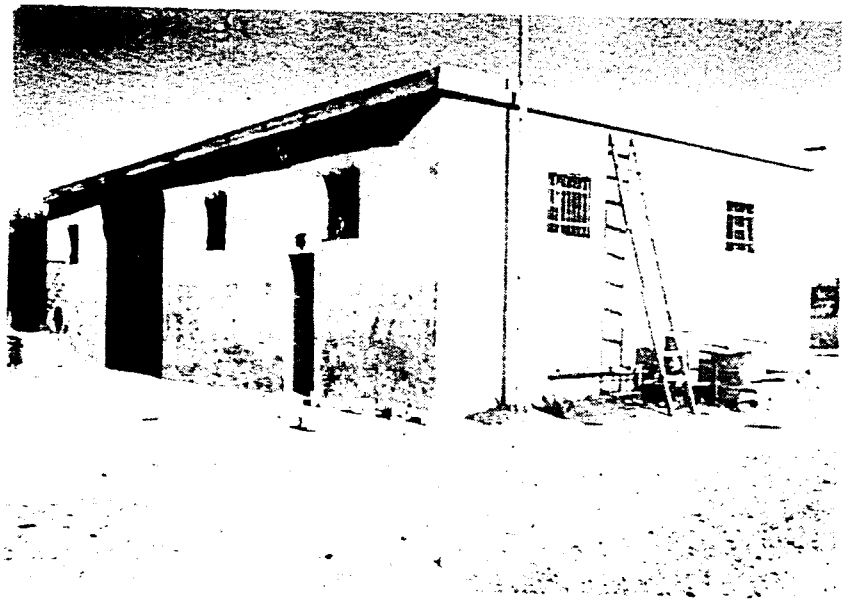
Two large concrete storage warehouses were under construction during the September 1975 site visit, and one was scheduled to begin operation in late 1975. The two new facilities are identical in size and construction, measuring 75 m in length by 37.5 m in width and 7 m in height. The walls have concrete columns with intermediate concrete panels poured in place. The roof is also concrete, poured in place with a slight batter and a raised roof ventilation system. These structures are shown in Figures 7 and 8. Each unit has a total storage capacity of 10,000 MT.

Plans are also under way to build a 10,000 MT vertical bulk storage facility on the same site, utilizing slipform construction. As with the other new facilities, this could be constructed by the Ministry of Public Works and turned over to the Ministry of Supply for operation. The consultant recommends that provisions be made to allow bulk rail shipments from Aqaba to be received at this new facility. This can easily be achieved by extending the existing rail siding into the site and constructing a bulk receiving pit with appropriate conveyor connections into the new headhouse.

Irbid. The storage at Irbid is housed in two concrete warehouses, one of which is similar to the older storage warehouses at Ruseifa. It measures 49.1 m in length by 12.0 m in width divided in 14 bays, and if the alleyway is filled, could store 1,000 MT. There is a smaller concrete structure measuring 10.1 m by 20.1 m. These are shown in Figures 9 and 10. There is also a row of ten aluminum silos without the roofs installed which have never been used. Apparently the roof support members were not considered adequate and this is the reason they have never been completed. A plan to renovate these units is included as Appendix I. As shown in Figure 12, there is open storage at the site during part of the year.

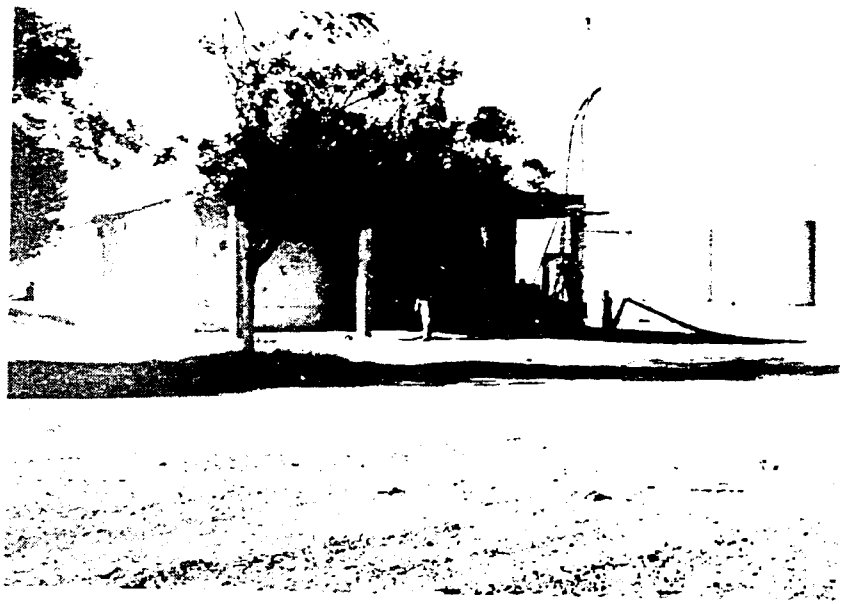
The Government is planning to construct an additional 10,000 MT of horizontal storage at the same site in the near future.

Rabbah. There are two horizontal warehouses similar to the older units at Ruseifa measuring 49.1 m in length by 12 m in width. These are shown in Figures 13 and 14. As can be seen in Figure 15, the grain is



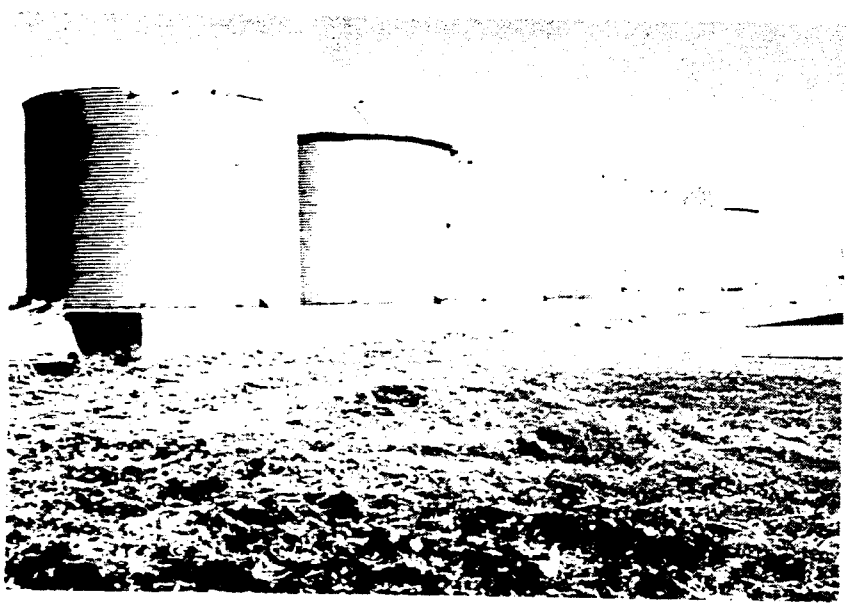
IRBID

FIG. 9 – EXISTING CONCRETE WAREHOUSE FOR BAGGED GRAIN



IRBID

FIG. 10 – EXISTING CONCRETE WAREHOUSE, MAXIMUM 1,000 M.T. BAGGED GRAIN



IRBID

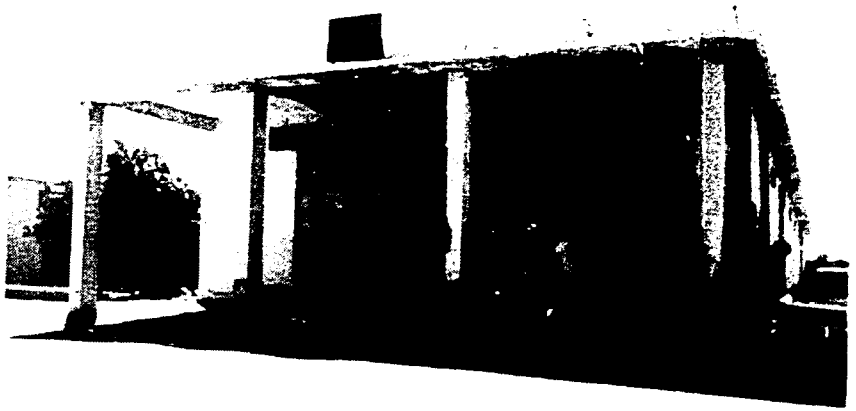
FIG. 11 – PARTIALLY ERECTED ALUMINUM GRAIN BINS WITH THEORETICAL STORAGE CAPACITY OF 1,000 M.T.

IRBID

FIG. 12 – BAGGED WHEAT STORED IN OPEN AT GOVERNMENT STORAGE SITE

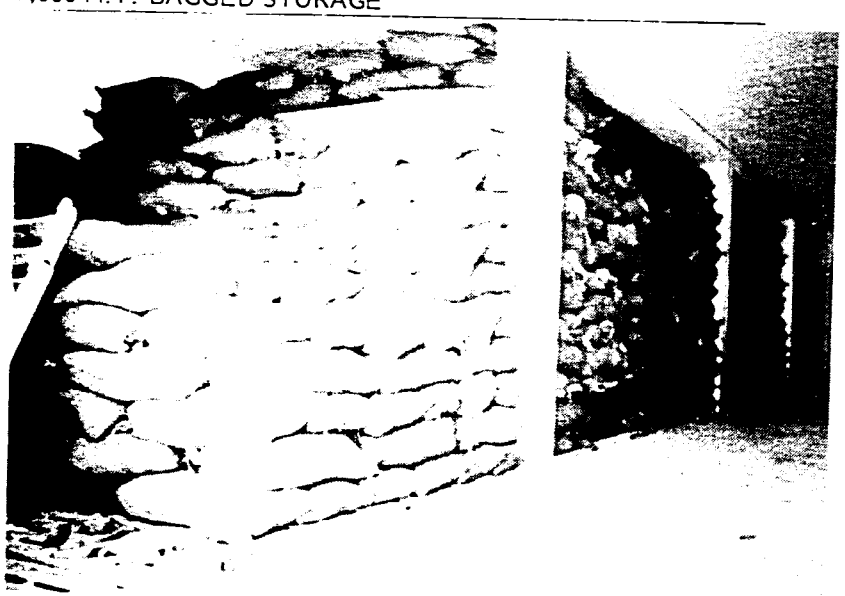
RABBAH

FIG. 13 – EXISTING CONCRETE WAREHOUSE, MAXIMUM 1,000 M.T. BAGGED STORAGE



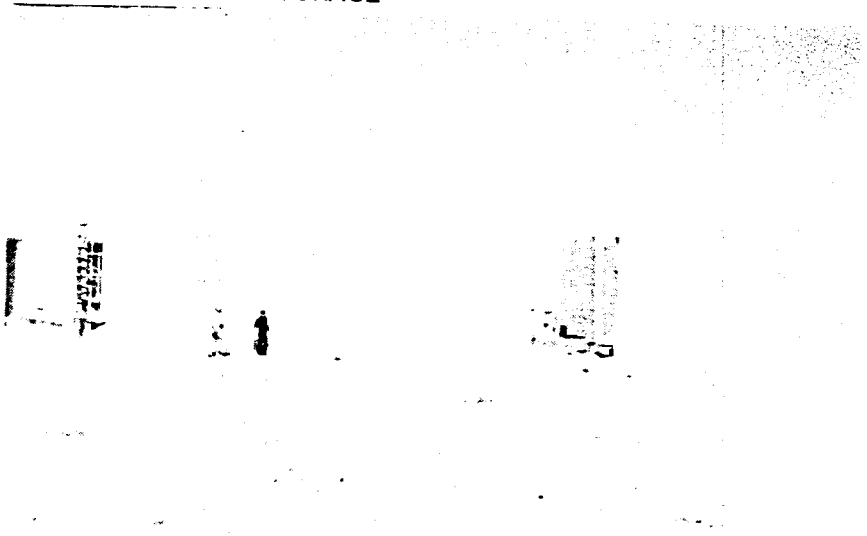
RABBAH

FIG. 14 – EXISTING CONCRETE WAREHOUSE, MAXIMUM 1,000 M.T. BAGGED STORAGE



RABBAH

FIG. 15 – BAGGED GRAIN IN EXISTING CONCRETE WAREHOUSE



MA'AN

FIG. 16 – CONCRETE WAREHOUSE UNDER CONSTRUCTION, ESTIMATES STORAGE CAPACITY 10,000 M.T. BAGGED GRAIN

neatly stacked and there was no evidence of infestation at the time that they were visited in September 1975. There was a strong odor of Phostoxin which indicated that the facilities had been fumigated recently.

The Government is planning to construct an additional 3,000 MT of horizontal storage at this site, increasing the total capacity of the facility to 5,000 MT. A truck scale will also be added.

Rabbah is located approximately 35 km north of Karak, and the commodities stored at the facilities supply both areas. There is a flour mill in Karak.

Ma'an. There is a large warehouse structure under construction outside of the twon adjacent to the old railway line leading to Ras En Naqb. This unit, shown in Figure 16, is of similar construction to the new units being constructed at Ruseifa and has a rated storage capacity of 10,000 MT. It is being constructed to store bagged wheat, sugar, rice, butter and cooking fats for consumption in the Ma'an area. With the adjacent railway line, it would be possible to haul bagged grain by rail from Aqaba for storage in this facility.

Salt. A facility similar to the unit at Ma'an is planned for Salt. It will contain a storage area for 5,000 MT of wheat, rice, sugar, butter, and cooking fats.

C. THE GRAIN PROCESSING INDUSTRY

At present, the Government is not engaged in the actual processing of grains. Grain processing firms are all owned and operated by private interests. This part of the study is primarily devoted to discussion of the flour milling industry, with some mention of the feed manufacturing industry. These two industries are germane to the study because they are industrial consumers of wheat and maize.

1. THE FEED INDUSTRY. There are presently three large feed mills in Amman, with two more under construction. One firm has 6,000 MT of bulk storage capacity, which is the only existing such facility. Two feed manufacturers were interviewed to ascertain current and projected demand for maize. Because of insufficient domestic production, nearly all maize must be imported. Unlike wheat, which is Government-imported, maize imports are all for private accounts of the feed manufacturers.

The ultimate consumption of maize is by the poultry industry in Jordan as a principal source of feed. The importance of maize to the East Bank did not occur until after the 1967 War. Prior to that time, the poultry industry was predominately located on the West Bank. After the 1967 War, skilled poultry tradesmen relocated to the East Bank and began rebuilding poultry production. Initially, the poultry was raised as a source of meat. The slump in meat prices during 1972 and 1973 shifted the emphasis to egg production. In 1974, Jordan produced about half its egg requirements.

The poultry industry, and consequently the demand for maize, is presently increasing at about 10 per cent annually. Government officials and

representatives of the feed industry agree that this trend is likely to continue. USAID officials in Amman state that the 10 per cent growth rate may be conservative. In either case, maize requirements in Jordan can be expected to assume increasing importance in the future.

Detailed statistics on the consumption of maize in feeds are not readily available because of its purchase by private accounts. However, since there seemed to be considerable agreement about available figures between private and Government officials on historic and projected demand for maize, further inquiry was deemed unnecessary. It is assumed that the feed industry will make the necessary additions to plant capacity as feed demand grows.

2. FLOUR MILLING. As with the feed industry, an analysis of the flour industry was deemed advisable because of its importance as a major consumer of wheat. More specifically, this analysis was conducted to determine if milling capacity, both existing and planned, is sufficient to allow current flour imports to be replaced by equivalent wheat imports. Increased industrial development, added employment opportunities, and the cost differential between the raw material versus the finished product provide strong economic incentives for the change. In addition, the increased wheat imports would obviously impact the throughput of grain for the proposed facility at Aqaba and affect its economic viability.

There were 110 active flour mills in Jordan in 1974.[1] Of the 110, however, only 6 use modern milling methods; the others are grist mills.[2] Table 14 provides data about the flour milling industry in Jordan.

1 Jordanian Ministry of Agriculture, Agriculture Statistics Yearbook, 1974
2 According to Tuma Yaghnam, Modern Flour Mill, Amman.

TABLE 14

ACTIVE FLOUR MILLS 1974
BY DISTRICT

District	No. Mills	No. Employees	(In Metric Tons) Kind and Quantity of Grain Milled: Local Wheat	Imported Wheat	Barley	Lentils	Other
Amman	26	150	14,316	47,000	1,869	50	9,670
Balqa	18	35	1,330	-	45	10	16
Irbid	32	70	13,610	9	200	120	192
Karak	24	50	2,000	-	50	30	60
Ma'an	10	20	407	-	30	-	5
Totals	110	325	31,663	47,009	2,194	210	9,943

Source: 1974 Agriculture Statistics Yearbook, p. 167.

The modern flour mills, their location, and estimated current capacities are shown in Table 15. This group of mills account for the majority of output.

TABLE 15

MODERN FLOUR MILLING CAPACITY - 1975 (in Metric Tons)

Location	Rated Capacity For 24 Hr Day	Potential Annual Capacity (365 Days & 24 Hr Day)	Practical Annual Capacity (14 Hr Day, 6 Day Wk & 50 Wk Year)
Amman	125 MT	45,625 MT	21,875 MT
Zerqa	100	36,500	17,500
Amman	100	36,500	17,500
Amman	80	29,200	14,000
Irbid	60	21,900	10,500
Zerqa	30	10,950	5,250
Totals	495	180,675	86,625

Source: BVI/MRI

The larger flour mills presently receive their grain in sacks delivered by truck directly from ships unloading at Aqaba. Wheat is purchased from the Ministry of Supply at the port. Millers also pay shipping

charges from Aqaba at a current rate of JD 3.5 per metric ton. Flour millers are partially subsidized by the Government, which uses the subsidies as an indirect method of controlling the price of flour and maintaining artificially low prices. The subsidies also provide an economic stimulus for improvement and expansion of milling capacity to a point which will eliminate the need to import flour.

In addition to existing capacity, the Government plans to construct and operate a 200 MT per day capacity mill, scheduled to be operational in 1978. Considering the modern mills only, potential annual milling capacity will reach 253,675 MT (7 mills operated 24 hours per day) when the new mill begins operation, a wheat equivalent of some 317,000 MT. Assuming operating schedules in the modern mills will remain at the existing level of 14 hours per day, six days per week, actual practical capacity will be a wheat equivalent of 152,000 MT. Adding the estimated 13,350 MT annual capacity of the older mills (wheat equivalent 17,360 MT) results in a total current practical capacity of about 125,000 MT and 168,700 MT with the new mill. If the mills were operated on a constant 24 hour basis, current capacity would approach 261,000 MT and reach 352,000 MT with the new mill. Table 16 shows a comparison of milling capacity to projected domestic household requirements, using both rated capacity data and estimated practical capacity.

TABLE 16

FLOUR MILLING CAPACITY AND DOMESTIC FLOUR REQUIREMENTS
1976 - 1985
(In 000 MT Wheat Equivalent)

Year	Net Domestic Requirements[1]	Rated Capacity (Shortage) or Excess [2]	Practical Capacity (Shortage) or Excess[3] (14 hour/day)
1976	174.8	86.2	(49.8)
1977	182.2	78.8	(57.2)
1978	189.7	162.3	(21.0)
1979	197.5	154.5	(28.8)
1980	205.6	146.4	(36.9)
1981	213.9	138.1	(45.2)
1982	222.5	129.5	(53.8)
1983	231.4	120.6	(62.7)
1984	240.6	111.4	(71.9)
1985	250.0	102.0	(81.3)

Source: BVI/MRI

1 Total household domestic wheat consumption (wheat equivalent) at 114 kg/person as determined by the Ministry of Supply less UNWRA and SMCDP annual imports of 54,600 MT (wheat equivalent).

2 Calculated as 261,000 MT for 1976-1977 and 352,000 thereafter with the addition of the proposed new mill at the beginning of 1978.

3 Calculated at 125,000 MT for 1976-1977 and 168,700 thereafter with the addition of the proposed new mill at the beginnning of 1978. Assume mill operation of 14 hours/day, 6 day/week and 50 weeks/year.

Rated milling capacity figures clearly reveal sufficient capacity to meet domestic milled wheat needs in every year. It should be recognized, however, that such figures are not realistically achievable and

are presented only to show maximum potential milling capacity. Discussions with flour millers and Government officials indicate the industry has been operating near full capacity and calculations tend to support practical capacities as a more realistic milling capability.

The practical capacity of the flour milling industry can be significantly influenced by changes in hours of operation. Indeed, increasing production time to 20 hours per day will result in surplus capacity each year after the proposed new mill begins operating up to 1985, when it can be reasonably assumed that additional capacity will be available.

In conclusion, it appears that Jordan need not rely on flour imports once the proposed new mill becomes operational, except for UNRWA donations. As a consequence, total domestic wheat import requirements (less UNRWA contributions) can be purchased in bulk form, beginning in 1978. This additional bulk grain contributes significantly to potential throughput and enhances the feasibility of a bulk grain handling and storage facility at Aqaba.

D. SHIP OFFLOADING OF GRAIN AT AQABA

All wheat and most of the maize shipments imported through the Port of Aqaba are received in bulk, while flour is delivered in sacks. Lack of any bulk grain or ample bagged storage facilities at the port requires immediate loading into trucks for transportation to inland storage or milling facilities. Ship offloading is performed by contract labor provided and supervised by the Maritime Establishment, a self-supporting corporation owned by the Government of Jordan.

1. HANDLING CHARGES. Labor is contracted on the basis of services to be performed, as follows:

(a) Stevedoring - movement of cargo from ships' holds to dockside (if the ship is berthed) or into barges (if the ship is anchored offshore).

(b) Lighterage - movement of cargo by barge from shipside at anchorage to dock.

(c) Bagging - filling and sewing of jute bags.

(d) Porterage - handling and movement of cargo from dock to a temporary holding or storage area, or direct loading onto transport vehicles.

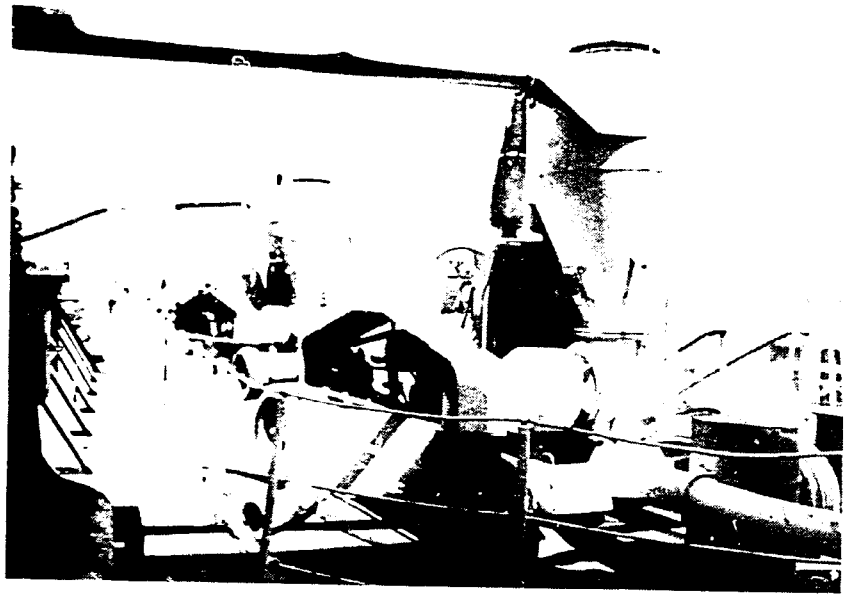
Labor charges are billed to the commodity receiver. Commercial rates are charged as shown below:

	Cost - JD/Metric Ton	
	Bulk Grain	Sacked Flour and Grain
Stevedoring	.500	.350
Lighterage	.220	.220
Bagging	.500	-
Porterage	.300	.300
Cost with Lighterage	1.520	.870
Cost without Lighterage	1.300	.650

The Jordanian Government currently pays a flat rate of JD 1.175/MT for unloading bulk grain and is granted a 25 per cent discount on sacked flour and grain. Unloading costs for an average 20,200 MT shipment of bulk grain costs the Government JD 23,805 (US $76,178).

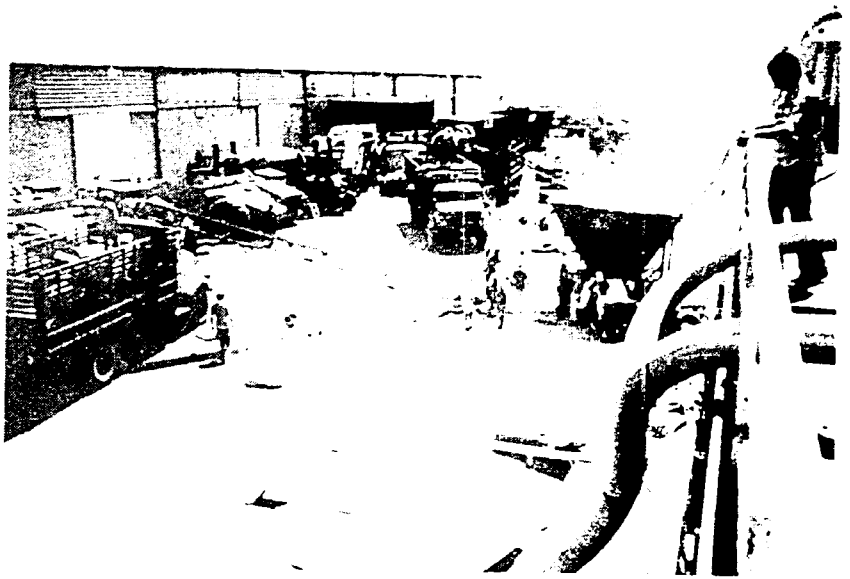
2. CURRENT OFFLOADING PRACTICES. Bulk grain is presently offloaded by placing portable pneumatic evacuators on the ship's deck, as illustrated in Figure 17, and discharging the grain through flexible spouts into small portable 4-spout hoppers located on the dock at shipside (Figure 18). Crews stationed at each hopper bag the grain in 100 kg sacks, manually sew the sacks, and place them on belt conveyors for loading onto trucks (Figure 19). In addition, a small amount of grain is sacked manually in the ship's holds by crews using 5 gallon cans for scoops, as shown in Figure 20. Filled sacks are manually sewn and placed in rope slings, then hoisted onto trucks by a mobile dockside crane (Figure 19). It was observed that this practice on the Aegis Link resulted in grain losses through holes and rips in sacks being hoisted.

There are 12 portable evacuators with 8 inch discharge lines rated at 15 MT/hour each. Offloading rates depend upon the number of evacuators in operation, configuration of the ship's holds, and depth of grain in the hold. Evacuator efficiency declines as the height of the lift increases. Offloading rates are therefore highest during early unloading when holds are full and lifts are nominal, declining as the level of grain is lowered, and are slowest during cleanup operations.



AQABA

FIG. 17 – PORTABLE PNEUMATIC EVACUATORS DISCHARGING GRAIN FROM SHIP



AQABA

FIG. 18 – BAGGING WHEAT FROM PORTABLE HOPPERS AT SHIPSIDE AND CONVEYING TO TRUCKS

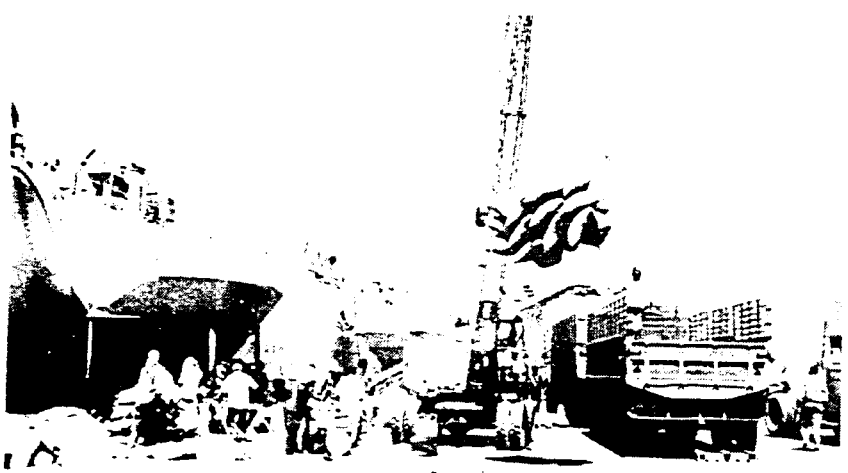


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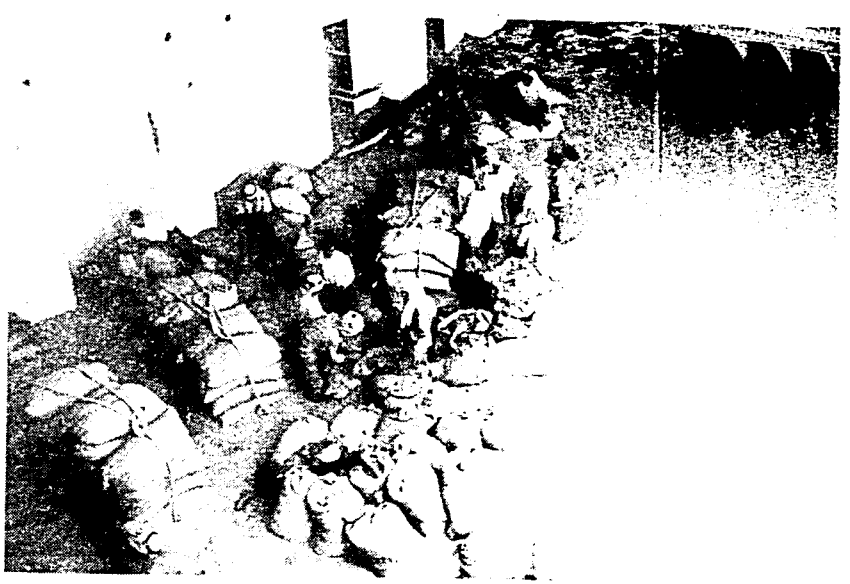
FIG. 19 – BAGGING WHEAT FROM PORTABLE HOPPERS AND LIFTING BAGGED GRAIN INTO TRUCK



AQABA

FIG. 20 – BAGGING WHEAT IN SHIP'S HOLD AND SEWING BAGS MANUALLY

The Aegis Link, a 35,000 MT vessel of Greek Registry, unloading 24,200 MT of bulk wheat in September, 1975 averaged 1,125 MT/day offloaded during the first nine days. Discussions with supervisory personnel indicate that an average of 1,100 MT/day offloaded is near maximum under present conditions. The Aegis Link operation utilized an average of 10 of the 12 evacuators and a crew of 144 laborers for each of two shifts, each shift working six days per week. Normally, each shift works eight hours per day. During Ramadan, working hours are reduced to six per day for each shift. Existing berth space and unloading facilities at Berths 1 and 2 restrict grain ship deliveries to one at a time at dockside. Ship arrivals are not necessarily scheduled to avoid the possibility of simultaneous or overlapping arrival and unloading times. While this situation appears to have occurred only once (in June, 1975), increased grain imports significantly increase the probability of recurrences under existing offloading periods of 20 to 30 days.

The frontage of Berths 1 and 2, approximately 310 meters, is adequate to berth only two 20-35 MT ships simultaneously. Thus, the arrival of a grain ship seriously impairs the port's ability to handle other cargo shipments. Additional arrivals must anchor in the harbor and lighter cargo to the quay at additional expense. According to a recent report by Rendel, Palmer and Tritton[1], present offloading demands for berthing space to offload grain will increase from 100 days in 1976 to around 180 days in 1985. However, the use of average linear projections does not recognize the wide annual fluctuations of grain

1 Rendel, Palmer & Tritton, Jordan Imports & Exports Transport Study, Draft Final Report, June 1975.

imports. Table 17 provides an estimate of variations in demand for berthing space which might occur, assuming an average unloading rate of 1,100 MT per day and no change in offloading methods. It should be emphasized that Table 17 is not a projection of actual berth space requirements for any given year, and is included solely to demonstrate the wide range of potential requirements over a 10 year period.

TABLE 17

ESTIMATED BERTHING SPACE DEMAND FOR BULK GRAIN DELIVERIES
1976 - 1985

Year	Approximate Projected Imports (Metric Tons)	Berthing Space Demand-Days Per Year
1976	157,000	143
1977	99,000	90
1978	165,000	150
1979	286,000	260
1980	174,000	159
1981	320,000	291
1982	147,000	134
1983	198,000	180
1984	185,000	169
1985	378,000	344

Source: BVI

3. COSTS FOR IDLE SHIP TIME DURING UNLOADING. In addition to the handling charges described in Section D-1-a, shipping costs include reimbursement to the shipowner for idle time incurred during unloading. A shipping contract negotiated between the contracting shipper and the shipowner generally specified an allowable period for unloading, based either on a given number of days between the ship's logged time of arrival at the port and the completion of unloading or upon a predetermined

minimum daily unloading rate. A per diem charge for demurrage if unloading extends beyond the specified period is also a part of the contract. If unloading is completed before the allowable time expires, the contract provides for a daily dispatch allowance or rebate to the contracting shipper. The dispatch rate is usually one-half of the demurrage rate.

Allowable unloading times vary considerably, depending upon ship size and hold configuration, type of cargo, unloading facilities and anticipated congestion at the port of destination. The Aegis Link had allowed JD 22,500 (US $72,000) in the shipping contract for unloading time, based on specifying a minimum unloading rate of 1,000 MT per day. The contract also calls for demurrage at JD 937.5 (US $3,000) per day if unloading requires more than 24 days. These changes reflect the currently depressed state of the shipping industry, and should not be regarded as typical or average for future projections. In late 1974, for example, the Aegis Link was charging JD 2,344 (US $7,500) per day for demurrage.

The wide cyclical variations in shipping and demurrage charges, depending upon supply and demand in the shipping industry, make it impractical to project future costs from current figures. The Aqaba Port Study completed in May, 1975 by Tippets-Abbott-McCarthy and Stratton (TAMS) develops a method for calculating unloading time and demurrage charges based on actual financial costs incurred by the shipowner.[1] These costs include ships' crew wages, capital costs, supplies and stores consumed, hull insurance, and administrative expenses; all allocated on a daily basis. The cost per day for a ship large enough to carry a

1 TAMS Aqaba Port Study, May 1975. Appendix B, p. 5.

20,260 MT cargo of bulk grain, which is the average size of shipments received during 1974 and 1975, would be about JD 1,650 (US $5,280) using this approach. Assuming an average unloading rate of 1,100 MT per day, the total charge would be JD 26,400 (US $84,500) for a 16 day unloading period. Thus, shipping charges could theoretically be reduced JD 1,650 (US $5,280) for every day's reduction in unloading time. For a larger ship, costs would be somewhat higher.

Conversations with shipping agents, U.S. grain exporters, and Kansas City Board of Trade officials indicate that an average daily rate of JD 1,562.5 (US $5,000) would be a reasonable and conservative figure for projecting future costs for idle ship time during unloading. Therefore, this amount has been used for purposes of this report.

E. ECONOMIC AND FINANCIAL ANALYSES

This section describes the techniques and results of analyses used to determine the economic feasibility of bulk grain handling facilities at the Port of Aqaba. The objectives of this section are to establish the economic and financial feasibility of constructing and operating any type of bulk grain handling facilities at Aqaba; to determine the proper size of various components within the total facility by evaluating cost trade-offs among various rated capacities of technical alternatives; and, based on economic and technical criteria and given the uncertainty inherent in forecasting the course of future events, to analyze the feasible alternative facility configurations and recommend a suitable bulk grain handling facility.

1. SUMMARY. The conceptual approach to evaluating and designing an economically feasible bulk grain handling facility consisted of specifying technical alternatives, costing the components of each alternative, determining the proper rated capacities for the various components, identifying total costs and benefits associated with the alternatives, and determining the facility type which provides the highest rate of return. This section summarizes the concepts and techniques used to perform this analysis.

Performance of economic feasibility and cost-effectiveness comparisons requires the development of engineering or technical alternatives. These alternatives are conceptual designs which would be capable of

handling future levels of grain shipments into the Port of Aqaba. Section I-E-2 reviews offloading, surge storage capacity, and bagging and shipping-out technical alternatives.

The cost-effectiveness analysis in Section I-E-3 describes the economic trade-offs among components within the grain handling facility. This analysis derives the optimum sizes and rated capacities for offloading equipment, surge storage facilities, and bagging and shipping facilities. The analysis shows that a minimum of 30,000 MT of surge storage will be required at Aqaba.

After the proper size of facilities has been determined, based on a given level of throughput, Section I-E-4 presents estimated capital and operating costs for facilities of given rated capacities. This section evaluates five different types of surge storage, each designed to hold 30,000 MT of grain.

Section I-E-5 presents the revenues or savings which are expected to accrue from the operation of the proposed facility. These savings are primarily costs (related to present methods) that will be avoided by using the proposed facility to receive and reship grain.

Section I-E-6 contains the economic, internal rate of return analysis. This analysis shows that an all-vertical, concrete facility with individual bins is the preferred facility for the Port.

2. TECHNICAL ALTERNATIVES. This section reviews the technical alternatives included in the cost-effectiveness analyses in Section I-E-3. These alternatives are described in detail in Section II-B.

a. Offloading Facilities. The two types of ship unloading facilities considered are marine bucket elevator and pneumatic (suction) devices. The range of rates considered for these devices is 200 to 1,500 MT/hour. Marine bucket elevator devices are more efficient and use less power than pneumatic devices, while pneumatic devices are more flexible than marine bucket elevator devices. Bucket elevator offloading devices cannot be used to unload tankers due to limited access to the ship's holds.

b. Surge Storage Facilities. Surge storage and no-surge storage alternatives are evaluated in the cost-effectiveness analysis. The no-surge storage alternative is developed by analyzing the costs of handling the anticipated average annual throughput of 210,000 MT, using the existing offloading, bagging and shipping procedures. The surge storage requirements and costs are evaluated by varying the size and type of surge storage facilities - for example horizontal versus vertical surge storage.

c. Bagging Facilities. Bagging facility alternatives and transportation out of the Port area are described in detail in Section II-B-5. It is necessary to remove grain from storage quickly in order to minimize surge storage requirements. The practical limit to these bagging facilities is determined by truck traffic density and the number of trucks available. Based on these considerations, the maximum rate of bagging consistent with the maximum practical truck loading and traffic rates was used in the cost-effectiveness analysis. The rate used

in the cost-effectiveness analysis is 1,728 MT/24 hours. This rate would be achieved by operating the bagging facilities for two 8 hour shifts, and the shipping on a 24 hour basis.

3. COST-EFFECTIVENESS ANALYSIS.

a. Economic Tradeoffs. The optimum size and configuration of bulk grain handling facilities is influenced by several factors, including the obvious consideration of total annual throughput. Due to the high daily cost of idle ship time (estimated at $5,000/day for purposes of this report), minimization of total ship days, berth unloading time plus waiting time, results in significant reductions in the total annual costs of receiving and reshipping grain. For a given system unloading rate, the minimum ship time results from scheduling arrival intervals so that no waiting time to berth is required. However, it has not been and is not expected to be possible to schedule arrivals in an optimum manner. For this reason it is necessary to consider both the size and frequency of ship arrivals at the proposed bulk grain facility. Surge storage requirements are then determined by the annual throughput, ship size and frequency (timing) of arrivals, rated capacity of the offloading facilities, and the rated capacity of bagging and reshipping facilities. The overall method of cost-effectiveness analysis used to determine facility size and configuration is summarized as follows:

(1) Specify the range of reasonable offloading rated capacities in metric tons per hour.

(2) For each offloading rate estimate ship turnaround time, including berthing and offloading time, for various ship cargo capacities;

(3) Based on historical experience and data for Port and expectations of future conditions, estimate the probability of receiving various cargo load sizes;

(4) Based on historical data concerning ship arrivals, estimate the distribution of probable future ship arrivals (intervals);

(5) Estimate future total annual shipments 210,000 MT in this analysis;

(6) Using a multi-period Monte Carlo simulation to develop a representative pattern of annual ship arrivals, estimate annual unloading and ship waiting times, based on the assumption that surge storage is not a limiting factor;

(7) Using the arrival patterns and total ship times from (b) above and the assumed rate of bagging and shipping out (1,728 MT/day), determine the amount of surge storage required for each offloading facility alternative.

A summary of the results of this analysis is shown in Table 18. This table contains the mean and standard deviation values for estimated waiting time, offloading time, and storage requirements.

TABLE 18

SUMMARY OF ANNUAL OFFLOADING & STORAGE CAPACITY REQUIREMENTS *

	Present	Pneumatic			Mechanical		
TIME, DAYS	180 MT/HR	200	400	800	750	1200	1500
Waiting:							
Mean	81.3	14.1	3.87	1.6	2.0	1.2	1.00
S. Dev.	58.1	15.4	5.40	2.3	2.6	1.9	1.65
Offloading:							
Mean	201.9	78.5	45.6	28.9	32.5	25.1	22.40
S. Dev.	6.9	2.9	1.8	1.3	1.5	1.3	1.33
SURGE STORAGE, MT							
Peak	-	35,327	62,284	69,023	68,505	69,369	67,237
Mean	-	23,860	36,346	42,945	41,282	43,982	44,441
S. Dev.	-	6,592	9,910	12,541	12,896	12,529	12,124

* Based on 210,000 MT annual throughput

The mean values of waiting time and offloading times will be used as measures of the future behavior of the system. The required storage is more difficult to characterize. The probability of requiring more or less surge storage than the mean value is approximately 0.5, which indicates that greater storage than the mean value will be required in about 50 per cent of the years over the project life, assuming constant throughput. If surge storage capacity is increased to the mean value plus one standard deviation, the storage would be adequate in about 85 per cent of the years. Since provision of inadequate surge storage

facilities would prevent full utilization of the rated capacity of off-loading facilities and would result in increased ship waiting times, surge storage capacity equal to the mean of peak annual surge storage requirements plus one standard deviation is used for the determination of the least-cost (cost-effective) facility size.

Once the operational parameters of the system have been determined the total annual cost for each alternative can be calculated. Capital costs are amortized at 10 per cent over a 30 year period and Table 19 shows a summary of annual system costs.

The 750 MT/hr mechanical system would be the least cost choice but this system is subject to two major types of cost penalties. The first is incurred when a tanker is assumed to arrive since this system is unable to unload a tanker and would require manual unloading. The second problem arises with a system failure. In the case of a single unit failure, such as with the single 750 MT/hr unit, the total off-loading capability is lost and cost penalties are incurred in the form of ship waiting time. It is assumed for the analysis summarized in Table 19 that at least one ship arrival per year is a tanker. It is also assumed that this is a 30,000 MT ship which would cause additional annual costs of JD 61,625 for the 750 MT/hr system, JD 63,344 for the 1200 MT/hr system, and JD 63,969 for the 1500 MT/hr system. These costs are based on the assumption that the tanker does not cause any other ships to wait. If ships must wait while a tanker is being unloaded, additional costs are incurred. Even without allowing for increased

TABLE 19

COST-EFFECTIVENESS ANALYSIS

ANNUALIZED TOTAL SYSTEM COSTS
(1978 JD)

System Type		Present	Pneumatic	Pneumatic	Pneumatic	Mechanical	Mechanical	Mechanical
RATED OUTPUT, MT/hr			200	400	800	750	1,200	1,500
OFFLOAD POINTS			4	4	4	1	1	2
STORAGE REQUIREMENT, MT		--	30,432	46,256	55,486	54,178	56,511	26,565
TOTAL CAPITAL INVESTMENT								
Offload System	JD	--	625,000	750,000	1,021,875	593,750	781,250	1,187,500
*Storage	JD	--	647,105	982,940	1,179,078	1,151,283	1,200,859	1,202,006
TOTAL	JD	--	1,272,105	1,732,940	2,200,953	1,745,033	1,982,109	2,389,506
SHIP TIME								
Waiting, days		81.3	14.1	3.9	1.6	2.0	1.2	1.0
Offload, days		201.9	78.5	45.6	28.9	32.5	25.1	22.4
TOTAL		283.2	92.6	49.5	30.5	34.5	26.3	23.4
ANNUAL COSTS								
**Investment Cost	JD	--	134,944	183,828	233,475	185,111	210,260	253,477
Ship Cost @ $5000/day	JD	442,500	144,688	77,344	47,656	53,906	41,094	36,563
Operating Cost	JD	252,000	99,094	99,094	99,094	95,156	95,156	95,156
SUB TOTAL		694,500	378,726	360,266	380,225	334,173	346,510	385,196
Allowance for 1 tanker/yr	JD	--	--	--	--	61,625	63,344	63,969
TOTAL ANNUAL COST	JD	694,500	378,726	360,266	380,225	395,798	409,854	449,165

*Storage Costs Based on JD 21.3/MT

**Total Capital Investment Cost Amortized At 10% For 30 Years

waiting time, the increased cost to service one tanker per year raises the annual costs of every mechanical system so that they are greater than the pneumatic systems.

The least cost system shown in Table 19 is the 400 MT/hr, four spout pneumatic offloading system with 46,256 MT of surge storage. The level of annual throughput used to determine offloading and surge storage required capacities is 210,000 MT. However, since this level of throughput will probably not be reached for some time into the future and since ship arrivals (and therefore intervals between ship arrivals) are subject to some degree of control, it is not necessary to immediately construct the full amount of required long-term surge storage capacity. Initial surge storage capacity equal to the mean value--approximately 30,000 MT--should be constructed initially and additional amounts of storage constructed as annual throughput increases over time. This concept is feasible because grain storage is modular in nature and capacity can be added in relatively small increments without incurring a significant cost penalty. Once the headhouse and other major facility components are constructed, the marginal cost of additional silos and conveyor equipment does not substantially increase. The effects of escalation on capital costs for incremental capacity over time are offset by the fact that excess surge storage capacity--surge storage capacity built now, but unused during the first five to ten years--generates no savings of the kind discussed in Section I-E-5. Storage cost is estimated at JD 21.3 per MT (installed) for the purposes of cost-effectiveness analysis. Since the same cost per ton is applied to all systems any variation in

storage costs affects only the magnitude of total costs and not the realtive ranking of the system.

b. Offloading Facilities. Table 19 shows that the 200 MT/hr and 750 MT/hr offloaders, pneumatic and mechanical, are the least cost alternatives when evaluated on a stand-alone basis. However, as discussed in Section I-E-3-a, Economic Tradeoffs, the offloading system is directly associated with other system costs. The 400 MT/hr offloading facility is the proper capacity rating for bulk grain handling in the time frame of this study and pneumatic devices are preferable to mechanical devices because of flexibility and redundancy. Within the limits of the cost-effectiveness analysis the 400 MT/hr, pneumatic device requires the least cost combination of capital, ship time, and surge storage costs.

c. Surge Storage Facilities.

(1) Facility Size. Table 18 indicates that 36,000 MT would be adequate surge storage capacity for average annual requirements. As discussed in Section I-E-3-a however, 46,000 MT (mean plus one standard deviation) would be required to meet peak requirements during 85 per cent of the years in the study period. Section I-E-3-a recommends that 30,000 MT is adequate for the near term since throughput will not reach the assumed annual level of 210,000 MT for some time and since the incremental costs of waiting to add to surge storage are insignificant.

(2) Facility Type. Once the proper annual surge storage size (capacity) has been determined, it is possible to evaluate a number of alternative design types. These alternatives are discussed in detail in Section II, Engineering Study. The owning and operating costs of these alternatives are the basis for choosing the technically feasible plans to be analyzed in Section I-E-6, Internal Rate of Return. The alternative plans are discussed here so that the minimum number of reasonable alternatives are evaluated in Section I-E-6.

Table 20 shows cost estimates for the range of 30,000 MT surge storage alternatives discussed in detail in Section II-B-5. The purpose of Table 20 is to demonstrate why flat storage without gravity reclaim and vertical storage without hoppers have been eliminated from further consideration. Table 20 shows that the annual cost of flat storage without gravity reclaim is greater than Plan C which is flat storage with gravity reclaim. The technical difference between these alternatives is gravity reclaim versus reclaim with labor. The difference in annual costs, JD 683,524 and JD 672,035, is explained by the fact that incremental annual labor required to reclaim grain is more expensive than the additional annualized costs of gravity reclaim equipment.

Surge storage by vertical silo without hoppers costs are greater than estimated costs for Plan E, vertical individual concrete silos with hopper bottoms. As above, increased annual operating costs for the without-hoppers alternative more than offsets lower annual capital

costs. Section I-E-6 evaluates Plans A, B, C, D, and E. The technical descriptions of these alternatives are presented in detail in Section II-B.

TABLE 20

30,000 MT, ANNUALIZED SYSTEM COSTS ALTERNATIVE CONFIGURATIONS

System	Total* Capital Cost JD	Annual Operating Cost JD	Total Annual Cost** JD
Flat storage, No Without Gravity Reclaim	3,626,217	298,859	683,524
Vertical Storage, No Hopper Bottoms	3,965,086	225,113	645,725
Plan A Vertical Concrete Storage	4,108,764	216,477	652,327
Plan B Combination Horizontal Vertical Storage	4,047,077	231,417	660,727
Plan C Horizontal Storage	4,012,814	246,360	672,035
Plan D Vertical Storage	4,141,998	216,477	655,852
Plan E Vertical Concrete Individual Bin Storage	4,036,490	216,477	644,660

*Includes offload system, Head House, and support facilites
**Includes Capital amortization over 30 years at 10% interest.

4. COSTS OF PROPOSED FACILITY. This portion of the report includes operating and capital cost estimates for each of the five alternative facility configurations developed in Section II.

a. Proposed Facility Operating Costs. The derivation of operating cost data is dependent upon a large number of assumptions which represent the collective knowledge and experience of the entire

consulting team. A summary of average operating costs based upon the 210,000 MT average annual throughput is shown in Table 21. Similarly derived operating cost totals for minimum and maximum throughput volumes are also shown for comparative purposes.

TABLE 21

SUMMARY OF ANNUAL OPERATING COSTS
FOR 30,000 MT GRAIN STORAGE FACILITY
PORT OF AQABA

Cost Category	All Vertical JD/Year	Combination Vertical and Horizontal JD/Year	All Horizontal JD/Year
Labor	70,560	77,616	84,672
Electricity	49,980	54,978	59,976
Stevedoring	6,300	6,300	6,300
Repairs and Replacements	28,900	31,786	34,675
Fumigation	1,155	1,155	1,155
Administrative	32,487	32,487	32,487
Insurance	2,000	2,000	2,000
All Other	25,095	25,095	25,095
210,000 MT Annual Throughput	JD216,477	JD231,417	JD246,360
146,600 MT Annual Throughput	151,723	162,155	172,586
378,200 MT Annual Throughput	388,257	415,170	442,082

(1) Labor. The development of labor costs, both direct and administrative, are based upon the manning schedule presented in Table 22.

TABLE 22

KEY PERSONNEL REQUIREMENTS FOR PROPOSED VERTICAL BULK GRAIN FACILITY PORT OF AQABA

	Position	Monthly Compensation
1	Superintendent	JD 400
2	Assistant Superintendents at JD 350	700
1	Maintenance Foreman	300
2	Millwrights at JD 150	300
1	Electrician	200
2	Clerks at JD 150	300
1	Maintenance Shopman	150
1	Weighmaster	150
2	Laboratory Technicians at JD 150	300
4	Tower Operators at JD 200	800
3	Spouters at JD 100	300
1	Bagging Supervisor	200
1	Bagging Maintenance Man	150
1	Warehouseman	150
12	Bagging Machine Operators at JD 150	1,800
12	Loadout Men at JD 90	1,080
		JD 7,280

Compensation rates used in the table are based upon discussions with the director of the Maritime Establishment at the Port of Aqaba. Current costs have been adjusted upward to reflect anticipated wage rates for 1978. All personnel except the superintendent, the assistant superintendents, and the maintenance foreman are considered direct labor. Annual direct labor costs are calculated at JD 70,560. The administrative personnel salaries mentioned above are included in the Administrative Burden expense category.

(2) Electricity. Electrical power requirements are based upon the electrical machinery required to operate the facility. Power is considered to be a variable expense item. The electric rate of JD 0.014/KW used was obtained from the electric power generating plant at Aqaba. Projected electricity expenses are based upon a cost of approximately JD 0.238 per ton of grain volume.

(3) Stevedoring Expense. Expenses for labor required to work on the ship during offloading are based upon crew requirements of two ship deck supervisors at JD 4.000 per day and 16 evacuator hose handlers at JD 2.000 per day. An unloading rate of 6,000 MT per day is assumed, requiring three shifts during a 24-hour period. The stevedore crews are assumed to be hired from the Maritime Establishment and, for cost purposes, a 10 per cent surcharge is added to the actual labor cost for administrative overhead. The cost per ton of grain handled is thereby calculated to be JD 0.030.

(4) Repairs and Maintenance. Repairs and maintenance expenses associated with the building, equipment, and all appurtenant structures are considered to be variable costs. These costs include expenses of painting, equipment replacement and other anticipated repairs. Since nearly all of the equipment can be expected to be replaced during the 50 year life of the facility (some as frequently as every two years), depreciation for equipment is not considered separately.

(5) Fumigation. Fumigation expenses are considered to be variable and are calculated at 5.5 fils per MT of grain handled. This assumes periodic fumigation practices similar to those used in the United States.

(6) Administrative Burden. This expense category includes the salaries of the superintendent, the assistant superintendents, and the maintenance foreman. In addition, allowance is made for Government administration costs of 75 fils per MT of grain handled. The total annual administrative cost is assumed to be 154.7 fils per MT.

(7) All Other Variable Costs. This item is intended to capture all other variable expenses which are too small to itemize individually. Included are legal, auditing, travel, telephone and telegraph, supplies, interest on working capital at 7 per cent per annum, and protective services. In total, this amounts to 119.5 fils per MT.

(8) Insurance. Insurance coverage for the proposed facility is estimated to cost approximately JD 2,000 per year. This coverage includes the alternative facilities and their contents, providing coverage against destruction by fire or other sources excluding armed conflict.

b. Facility Capital Investment. Estimated capital investment costs including engineering, civil construction, equipment purchase, and erection, are shown in Table 23. The bases for these estimates are presented in detail in Section II-G. The basis for arriving at the [illegible] layouts is presented in Section I-E-3-c.

TABLE 23

ESTIMATED CAPITAL INVESTMENT FOR FACILITIES

TYPE OF STORAGE	CAPACITY MT	ESTIMATED INVESTMENT Local Costs Jordanian Dinars	Foreign Exchange U.S. Dollars	Total Costs Jordanian Dinars
Plan A - Vertical Concrete	30,000	1,706,616	7,686,873	4,108,764
Plan B - Horizontal Warehouses	20,000			
Vertical Concrete	10,000	1,609,161	7,801,330	4,047,077
Plan C - Horizontal Warehouses	30,000	1,582,545	7,776,861	4,012,814
Plan D - Vertical Steel	30,000	1,394,650	8,791,512	4,141,998
Plan E - Vertical Concrete (Individual Bins)	30,000	1,632,710	7,692,097	4,036,490

5. SAVINGS FROM OPERATION OF PROPOSED BULK GRAIN FACILITY. The economic feasibility of the grain handling and storage facilities proposed in Section II of this report is based upon potential savings that will accrue from three factors:

- The potential annual savings of freight costs resulting from ship idle time required for unloading.
- Relative costs of unloading cargo at dockside which must presently be lightered from ships anchored offshore.
- Reduction in grain losses during unloading and storage.

These items are examined and discussed separately in the following text. Calculation procedures demonstrated in the text are based upon the average annual grain throughput of 210,000 MT, as shown in Table 24 below. The minimum and maximum annual throughput figures are 146,600 MT (1982) and 378,200 MT (1985), respectively, assuming the proposed facility is operational in 1978.

TABLE 24

PROJECTED BULK GRAIN IMPORTS
PORT OF AQABA, 1976-1985
(000 MT)

Year	Wheat Imports(1)	Maize Imports(2)	Total
1976	113.8	43.0	156.8
1977	51.0	47.8	98.8
1978	112.0	52.6	164.6
1979	228.7	57.4	286.1
1980	111.3	62.2	174.5
1981	252.8	66.9	319.7
1982	74.9	71.7	146.6
1983	121.0	76.5	197.5
1984	103.3	81.3	184.3
1985	292.2	86.0	378.2
10 year average	146.1	64.4	210.7
Per cent of total	69.3	30.7	100.0
Per cent Projected	70.0	30.0	100.0

Source: (1) Table 7
(2) Table 10

a. Ship Idle Time Cost Savings. Based on existing unloading rates of 1,100 MT/day, estimated unloading time required would average 202 days per year during the next decade. The unloading facilities proposed in Section II-H of this report provide for an average daily

unloading rate of 400 MT per hour, thus saving 156 days of unloading time per year. Assuming an average cost of JD 1562.5/day (US $5,000) for idle ship time while unloading, as previously discussed in Section I-D-3 of this report, an average annual savings of JD 243,750 (US $780,000) would result, based on 210,000 MT throughput. For the minimum (146,600 MT) and maximum (378,200 MT) annual throughput, the annual savings would be JD 124,437 (US $398,198) and JD 320,828 (US $1,026,650), respectively.

b. Unloading Costs. The recent TAMS/DAH Port Study projects annual general cargo imports through the existing Aqaba port facility, assuming the Suez Canal remains open, as shows in Table 25:

TABLE 25

ANNUAL GENERAL CARGO PROJECTIONS
EXISTING AQABA PORT FACILITY
1979-1985[1]

Year	MT/Cargo	Year	MT/Cargo
1979	605,000	1983	740,000
1980	639,000	1984	774,000
1981	673,000	1985	808,000
1982	706,000		

Average for Period - 706,400 MT/Year

Since the proposed bulk grain facility would not be completed until 1978, tonnages for previous years are not considered pertinent and the average tonnage developed in Table 25 is considered reasonable and was used for purposes of this report. If the present unrest in Lebanon and congestion in other Mediterranean ports continues, the projected 706,400 MT

1 TAMS/DAH Aqaba Port Study, May 1975. Table B-1. p. B-1.

average for Aqaba may, in fact, be highly conservative. If the West Bank should be reintegrated into Jordan, the TAMS/DAH report estimates that imports would increase 15 per cent.

The TAMS/DAH report assumes the port will operate 350 days per year.[1] Based on conversations with port officials, this assumption appears reasonable and was adopted for purposes of this report. Multiplying 350 days/year by the two existing cargo berths equals 700 berth days/year. Dividing the 706,400 MT average annual cargo offloaded by 700 yields a figure of 1,009 MT/day per berth. To remain on the conservative side, this figure was rounded to 1,000 MT/day per berth. Multiplying 1,000 MT/day by the 156 days/year anticipated reduction in bulk grain unloading time (based on 210,000 MT of grain) when the new grain facility becomes operative yields an annual total of 156,000 MT of general cargo that can unload at dockside instead of anchoring offshore and lightering their cargo. Prior to the Suez Canal reopening, the cargo berths were occupied over 95 per cent of the time.[2] With the projected increase in total import cargo, it appears reasonable to assume that the 156 berth/days saved will all be utilized by ships that would otherwise be required to unload offshore. This means that lighterage and porterage charges for transferring 156,000 MT of cargo from ships anchored offshore to dockside could be saved each year.

Existing costs for transferring goods from ship to dock via lighterage are shown in Table 26, following:

1 TAMS/DAH Aqaba Port Study, May 1975, p. IV-8.
2 Rendel, Palmer & Tritton, Jordan Imports and Exports Transport Study, June 1975, p. 10, Table 2.2.4.

TABLE 26

1975 COST/MT FOR TRANSFERRING CARGO FROM

SHIPS ANCHORED OFFSHORE TO DOCK[1]

Type of Material	Lighterage JD	Porterage JD	Total JD
Bagged Goods	.220	.300	.520
Iron and Steel	.300	.450	.750
Boxed Goods	.340	.450	.790
Machinery, etc.	.750	.450	1.200
Average			.815

As knowledge of future cargo ratios is speculative, the "average" of JD .815 was adopted as the excess cost per ton for unloading cargo offshore and lightering it to the dock, as opposed to unloading from a ship berthed dockside. Multiplying JD .815/MT by 156,000 MT per year yields an annual saving of JD 127,140 (US $406,848) by eliminating the need for unloading 156,000 MT of cargo offshore. In addition to this savings, costs shown in Table 21 do not include rental of lighters. Unloading 1,000 MT/day would require rental of two 500 MT lighters at JD 20 per day each, or a total of JD 40 per day for 156 days per year. Annual savings from this source would be JD 6240 (US $19,968). Similar figures for the minimum and maximum estimated annual throughput are JD 68,903 (US $220,490) and JD 175,557 (US $561,782), respectively.

c. Reduction in Grain Losses. No detailed study was made of grain losses during unloading and transfer to storage. However, based on experience and informed judgment, it appears reasonable to assume that modern unloading methods and handling devices will reduce losses by at

1 Government Official Gazette No. 2418 dated 2-5-1973.

least one per cent of the total volume, or 2,100 MT/year. As shown in Table 24, 70 per cent of the total volume will be wheat and 30 per cent will be corn.

Current delivered wheat prices are above JD 1.25 (US $4.00) per bushel and are not considered likely to fall below JD 1.25 in the foreseeable future. At 36.73 bushels per ton, the estimated cost per ton would be JD 45.9 (US $146.88). Multiplying the cost per ton by 1,470 tons per year (2100 x 0.7) equals JD 67,473 (US $215,914) annual savings on wheat. Corn prices currently exceed JD .78 per bushel (US $2.50) and are not likely to fall below this figure. At 36.73 bushels per ton, the estimated cost per ton would be JD 28.6 (US $91.52). Multiplying the cost per ton by 630 (2100 x 0.3) equals JD 18,018 (US $57,658). Total savings from reduction in grain losses would then total JD 85,491 (US $273,571). Similar savings for minimum and maximum annual throughput are calculated at JD 59,681 (US $190,979) and JD 153,966 (US $492,691), respectively.

d. Avoidance of Stevedoring and Portering Costs. As previously mentioned, the Government pays a flat rate of JD 1.175 MT for labor involved in unloading bulk wheat. A similar flat rate of JD 1.300 MT is in effect for private importers of maize. Table 19 (Subsection E-1-a) shows projected annual average bulk grain imports of approximately 210,000 MT, of which 70 per cent is wheat and 30 per cent is maize. Multiplying 210,000 x .7 x 1.175 yields an average annual cost of JD 172,725 for unloading wheat. The same calculation for maize (210,000 x .3 x 1.3) yields an annual cost of JD 81,900. The total annual cost

would then be JD 254,625 (US $814,800). This cost will be eliminated when the proposed facility becomes operative, although it will be offset by operating costs of the new facility which are discussed in Subsection F-2. For the minimum and maximum annual throughput, savings will be JD 177,752 (US $568,806) and JD 458,568 (US $1,467,418), respectively.

c. Total Savings. A summary of potential estimated savings described in the foregoing sections is shown in Table 27, based upon the average annual throughput of 210,000 MT. The total of JD 717,246 (US $2,295,187) compares with JD 430,773 (US $1,378,474) at the minimum level of throughput and JD 1,108,919 (US $3,548,541) at the maximum annual throughput volure.

TABLE 27

SUMMARY OF ANNUAL SAVINGS IN SHIP UNLOADING COSTS WITH PROPOSED FACILITY

	Government JD	Private JD	Total JD	Total $US
Reduction in ship idle time while unloading[1]	170,625	73,125	243,750	780,000
Savings in unloading cargo other than grain[2]	50,856	76,284	127,140	406,848
Lighter Rental[2]	2,496	3,744	6,240	19,968
Reduction in grain loss[1]	67,473	18,018	85,491	273,571
Stevedoring/portering costs avoided	172,725	81,900	254,625	814,800
Total Gross Annual Savings	464,175	253,071	717,246	2,295,187

Source: BVI/MRI

1 Assumes 70 per cent Government, 30 per cent private
2 Assumes 40 per cent Government, 60 per cent private

6. INTERNAL RATE OF RETURN - COMPARATIVE ANALYSIS.

a. Economic Criteria. The savings and costs associated with the construction and operation of alternative types of facilities are combined in this section and the alternatives are compared on a consistent basis. Internal rate of return is one criterion used to evaluate a proposed capital project. This technique, discussed in detail in Section I-E-6-c, solves for a discount rate which equates the present value of project benefits (savings in this study) and costs. (This derived discount rate represents a maximum cost of capital which should be paid when the project is financed - if the project is financed at all.) The internal rate of return also provides a commensurate value useful for comparing the feasibility of a wide range of potential capital projects. Therefore, the criterion used to select the preferred facility is the internal rate of return.

b. Economic and Design Assumptions. The construction and operation costs have been presented in Section I-E-4. Section I-E-5 discussed the savings (or benefits) associated with the proposed facilities. All subsequent calculations in this section are based on these values and the following assumptions.

- Year of commercial operation is late 1978.
- Cost estimates and present worth calculations are as of 1978.
- The economic life of the facility is expected to be 50 years.
- Internal rate of return calculations are performed for 30 and 50 year periods.

c. Internal Rate of Return - Financial Feasibility. Among the various combinations of facility configurations and their respective inverstment and operating costs, the economic or internal rates of return (IRR) vary accordingly. The purpose of this section is to provide a comparative assessment of the proposed investment options. The analytical procedure is straightforward, using the standard IRR formula:

$$C = \frac{Y_1}{1 + r} + \frac{Y_2}{(1 + r)^2} + \ldots \frac{Y_n}{(1 + r)^n}$$

Where: r = the internal or economic rate of return
C = the initial investment cost
$Y_1 \ldots Y_n$ = the expected net benefit at present period 1...n,

that is, total annual savings, less total operating expenses since C is given for each of the alternative structures A through E, and $Y_1 \ldots Y_n$ is given for each of the alternative structures A through E, the formula is modified to compute r. Data for C are obtained from Section I-E-4, Table 23, Data for $Y_1 \ldots Y_n$ are presented in Sections I-E-4 and I-E-5 as summarized in Table 23 and Table 27, respectively. For purposes of comparison, the internal rates of return are calculated at n = 30 years in Table 28, and N = 50 years in Table 29, as follows:

TABLE 28

COMPARATIVE INTERNAL RATES OF RETURN
(n = 30 years)

IRR BY FACILITY TYPE	IRR BY ANNUAL GRAIN THROUGHPUT 210,000 MT	146,600 MT	378,200 MT
Vertical A	11.75 %	5.38 %	17.40 %
D	11.65 %	5.31 %	17.25 %
E	11.99 %	5.54 %	17.72 %
Combination B	11.55 %	5.18 %	16.99 %
Horizontal C	11.26 %	4.90 %	16.45 %

Source: BVI/MRI

TABLE 29

COMPARATIVE INTERNAL RATES OF RETURN
(n = 50 years)

IRR BY FACILITY TYPE	IRR BY ANNUAL GRAIN THROUGHPUT 210,000 MT	146,600 MT	378,200 MT
Vertical A	12.15 %	6.50 %	17.53 %
D	12.05 %	6.44 %	17.39 %
E	12.37 %	6.63 %	17.85 %
Combination B	11.96 %	6.33 %	17.14 %
Horizontal C	11.69 %	6.10 %	16.61 %

Source: BVI/MRI

Clearly, the IRR is significantly more sensitive to the annual throughput volume than the type of structure. Variations of the IRR between the alternative facilities A through E are marginal, nevertheless, the vertical facility Plan E yields the highest return. The results of the analysis indicate that if the rate of interest for funds used to construct the facilities are less than the IRR, the project is economically feasible, assuming no other factors other than those included in this analysis. Hence, the all-vertical structure Plan E is the preferred option.

d. Sensitivity Analysis. Recognizing the potential variability of the cost and savings factors involved, a sensitivity analysis has been performed. To simplify the discussion, calculations are restricted to the annual average throughput of 210,000 MT, and proposed facility Plan E.

Increasing the investment by 10 per cent and holding annual operating costs and gross annual savings constant, results in an IRR of

10.75 per cent, or a decrease of 1.24 per cent below the original IRR of 11.99 per cent.

Increasing the total operating cost 10 per cent, and simultaneously holding investment cost and gross annual savings constant, decreases IRR by 0.58 per cent to 11.41 per cent.

Decreasing the gross annual savings 10 per cent while holding both annual operating costs and investment cost constant, results in the original IRR being reduced by 1.97 per cent to 10.02 per cent. Clearly, a percentage change of 10 per cent for each of the three variables is most significant to IRR calculations if gross annual savings fluctuates. Hence, if the estimates of factors used in deriving this figure (off-loading time savings, reduction in grain losses, etc.) vary the IRR will be significantly affected.

Using a different approach, that is, increasing or decreasing the three variables by an equivalent amount yields similar results. For example, increasing investment by JD 50,000 and holding the other two factors constant decreases the IRR by 0.16 per cent from 11.99 per cent to 11.83 per cent. Likewise, decreasing gross annual savings by JD 50,000 results in a decrease of the IRR by 1.36 per cent to 10.63 per cent (the same effect is obtained by increasing operating costs JD 50,000).

The amount of fluctuation (margin of error) permissible in the estimated savings and cost figures cannot be determined without knowing the interest rate (or cost of funds) used to finance the project. The above calculations however, provide an indication.

F. ENVIRONMENTAL IMPACT OF PROPOSED FACILITY

1. GENERAL. The environmental factors considered in the placement of a grain storage and handling facility at the Port of Aqaba include air, water, flora and fauna. Of these factors, air quality maintenance is the most significant because atmospheric emissions are the greatest source of potential environmental damage. Consequently, most of the following discussion will be devoted to this factor.

2. ATMOSPHERIC. Atmospheric emissions from a grain storage and handling facility result from the handling or movement of grains. Most of the sources are of a "fugitive" nature, that is, emissions which become airborne because of ineffectual or nonexistent pollutant containment systems, rather than those which penetrate an air pollution control device. Emissions vary considerably according to specific operations being performed and, consequently, are subject to day-to-day variations.

The main particulate emission sources of a grain handling and storage facility are:

a. Grain unloading

b. Grain loading

c. Grain drying

d. Grain cleaning

e. Garner and scale bins

f. Elevator legs

g. Belt conveyors

h. Transfer points

i. Bin vents

Table 30 presents data on rates of dust emission from grain handling operations at terminal port facilities. These data are based upon limited observations and should be considered as indications rather than absolute values.

TABLE 30

PARTICULATE EMISSIONS FROM GRAIN HANDLING AT A TERMINAL PORT GRAIN FACILITY[1]

Emission Source	Range of Emissions (kg/MT)
Shipping and Receiving	
Rail	0.50 - 1.50
Truck	0.40 - 1.74
Ship	0.50 - 1.74
Transferring, Conveying, etc.	1.00 - 1.24
Screening and Cleaning	2.50 - 3.47
Drying	2.00 - 4.00

The amount of dust emitted during various operations depends on the type of grain being handled, quality of the grain, moisture content of the grain, and the speed of the conveying equipment. Grain dust emitted from these sources is composed of approximately 70 per cent organic material, about 17 per cent free silicon dioxide, and specific materials in the dust including particles of grain kernels, spores of smuts and molds, insect debris, pollens, herbicides, and dirt. Grain dust suspended in the air inside the grain facility consists mainly of highly dispersed particles measuring less than 5 μm in diameter[2].

1 $\mu = \frac{1}{1,000,000}$

2 Midwest Research Institute, Emissions Control in the Grain and Feed Industry; Volume I, Engineering and Cost Study; Environmental Protection Agency, U.S.A., December 1973

Dust emitted from grain handling operations may cause irritation of skin or eyes and respiratory ailments. At normal low ambient particulate concentrations ($<100\ \mu g/m^3$)[1] no evidence exists for adverse effects to healthy people. However, people with preexisting respiratory disorders may be affected by continued exposure to concentrated levels of particulate grain dust.

Inside the confined areas of the facility, dust emissions create more housekeeping, working environment, and safety problems than atmospheric pollution problems. Of particular significance is the safety problem. Grain dust is potentially explosive if exposed to open flame or electrical spark and safeguards to prevent this possibility are mandatory. Spontaneous combustion is another potential hazard which must be guarded against.

Outside the facility, dust emissions create more of an appearance problem than an actual threat to surrounding flora and fauna because of the high proportion of organic materials involved. With proper dust control systems installed, nearly 90 per cent of the dust emissions from a grain facility can be effectively captured, using fabric filter devices or cyclones at points where major emissions are generated. The approximate 10 per cent which cannot be captured is nominal (about 1.819 kg/MT of grain handled) and much of this precipitates inside the storage facility. Consequently, the resultant environmental atmospheric pollution is generally considered not problematic, provided dust control devices are regularly maintained.

For the proposed facility, it is recommended that dust control devices be installed at certain critical points, particularly where grain is dumped from one conveyor to another as it is moved from dockside to the storage

[1] $\mu = \frac{1}{1,000,000}$

facility. The collected dust may be added back to the grain stream or sold as animal feed. The more common practice is to add the dust back into the grain stream, since much of the material is not considered a contaminant.

3. AQATIC. The negligible amounts of dust and solid wastes which can be anticipated at the proposed facility are not sufficient to pose an environmental hazard to underground water sources or seawater. This statement presupposes ordinary precautionary measures being undertaken and the rare occurrence of extraordinary accidents. Even in the event of an extraordinary accident, the risks are negligible if prompt corrective actions, including clean-up, are undertaken.

4. FLORA. The environmental impact on flora in the port area can be disregarded if the recommended dust control devices are installed and properly maintained. Existing tree and plant life in the area is scarce and is far more susceptible to damage from the phosphate operations. The displacement of vegetation on the proposed construction site of the facility will be virtually nonexistent. Consequently, the environmental hazard to existing flora will be nominal. Indeed, flora surrounding a grain facility is generally considered to be more of a threat to the facility than vice versa, since it often provides a haven for pests and makes clean-up more difficult.

5. FAUNA. The operations of a grain facility are not generally considered to pose an environmental hazard to fauna. Like flora, however, certain fauna pose a problem to a grain storage facility, vermin being the most common. In such instances prompt clean-up of spillages, good housekeeping procedures, periodic fumigation, and the removal of flora in the immediate surrounding area provide adequate inhibiting controls. Uncontrolled

infestations can pose a threat to other forms of life, particularly humans and domesticated animals, since vermin can be carriers of certain diseases. While complete extermination cannot be accomplished, the problem can be mitigated by systematic preventative measures such as those suggested above.

6. OTHER ENVIRONMENTAL CONSIDERATIONS. One of the more serious environmental concerns of a grain handling and storage facility is related to the grain itself. Since the grain is often processed into products for consumption by humans and animals, it is essential that measures be undertaken to avoid potential spoilage from contamination. Excessive moisture is the principal source of contamination, and preventive measures should be undertaken where exposure can be anticipated. Storage spaces and grain conveyors should be watertight. Temperature detection equipment should be installed in the storage bins for readily accessible observation. In the event of spoilage, contaminated grain should be promptly removed from the immediate area of the facility.

7. FINANCIAL ASPECTS OF POLLUTION CONTROL. The installation of pollution control devices on the proposed facility will require an approximate investment of JD40,000. In terms of operating costs, the most significant additional costs will be fixed expenses (interest on the investment and depreciation). Additional variable costs will depend on grain throughput volumes, and will fall primarily in the expense categories of electricity and maintenance.

Aside from environmental considerations, the financial aspects of pollution control devices largely depend on the manner in which the collected dust is disposed. The amount of shrinkage from the grain stream may vary

from 0.5 kg/ton to as high as 3.5 kg/ton depending on the type of devices installed, their operating efficiency and the cleanliness of the grain stream.

If collected dust is returned to the grain stream, shrinkage can be minimized. Furthermore, this dust is valued at the same price as the grain thereby minimizing the financial loss. If the dust is sold separately as animal feed, its value is substantially less than grain because of the high amount of impurities, and the financial loss is greater. Theoretically, the cleaner grain would command a higher market value, partially offsetting the financial loss. However, Jordan does not presently have grain price differentials based upon graded impurity levels.[1] Furthermore, since the majority of the import grain is wheat which is subsidized by the Government of Jordan, the matter of financial loss is important only to maize imports. It is advisable that the collected dust be returned to the grain stream to avoid the complication of dust disposal.

[1]This matter is discussed at length in: D.D. Hill, The Utilization, Quality, and Storage of Wheat in Jordan, U.S.A. - Agency for International Development, February, 1970

SECTION II - ENGINEERING STUDY

A. DESIGN PARAMETERS

The economic section of this study and the consultant's review of existing conditions have emphasized the need for a facility to improve grain handling in the Port of Aqaba. The major objectives together with the principal parameters affecting the design of a new facility are developed in this section of the study.

1. THROUGHPUT. The facility should be designed to handle, on a nominal basis, the type and quantity of grain projected in the economic section over its economic life with relatively nominal maintenance cost. The basic throughput may be summarized as follows:

a) The maximum throughput, based on projections of imports in 1985, is 292,200 MT of wheat and 86,000 MT of maize, per year, for a total annual throughput of 378,200 MT.

b) The average annual throughput, based on economic projections, is 146,100 MT of wheat and 64,600 MT of maize, totaling 210,700 MT of grain per year. The average has been rounded off at 210,000 MT for purposes of this report.

2. SHIP SIZE. The maximum ship size which the Port can accommodate is restricted by draft limitations. While shipments of up to 30,000 MT have been received in the past, it is assumed that normal grain shipments received will continue to be approximately 20,000 MT, with some shipments of less than 5,000 MT and no shipments in excess of 32,000 MT in the foreseeable future.

3. SHIP UNLOADING. Although there are many advantages to improving ship unloading, the principal savings accrue from developing the capability to offload ships quickly, thus reducing grain ship berthing time, eliminating grain ship lightering operations, and reducing ship offloading and stevedoring costs. In addition, the design of a grain facility at Aqaba should reduce interference with general cargo operations to a minimum.

4. GRAIN LOSSES. The consultant has observed the offloading of one ship, reviewed reports prepared by previous consultants, and concluded that serious losses in grain occur in offloading operations under present conditions. A major objective of any facility at Aqaba should be to reduce grain losses and provide an accurate means of measuring the quantity and quality of grain received and shipped.

5. BULK HANDLING. At present, all wheat and nearly all of the maize which is imported through Aqaba is bagged and delivered by truck to its final destination. Only two facilities in Jordan are equipped to receive bulk grain from trucks, and there are no existing facilities equipped to receive bulk grain by rail. The two facilities equipped to receive grain in bulk from trucks are a private Feed Mill at Ruseifa, which imports maize through Aqaba, and the Government Grain Storage Bond at Ruseifa. The consultant feels that the new facility at Aqaba should be designed to bag all grain received, but that conversion to bulk handling at inland facilities should be encouraged by the installation of adequate bulk loading equipment at Aqaba.

6. INLAND TRANSPORT. Under present ship offloading conditions, there is a large demand for trucks and labor throughout the period in which the grain ships are being discharged. The consultant considers that a major objective of any facility constructed in Aqaba should be the reduction or leveling-out of these peak demands for trucks and labor. In addition, the facility should be designed so as to encourage use of the newly constructed rail connection to Aqaba.

7. BUDGET LIMITATIONS. Due to the limited throughput of grain and limited budget, it is obvious that a new berth to be used exclusively for grain ships would not be practical. Therefore, the consultant considers the use of existing berthing facilities as vital to the economic feasibility of a new grain facility.

8. LAND USE. A major limitation is the small amount of space which can be made available for the exclusive use of the grain facility. Land area, particularly the area adjacent to the water front, is in great demand for expansion of the general Port area, the phosphate exporting operations, and the Free Trade Zone development. Therefore, the consultant has recognized the need to design a grain facility which requires a minimum amount of land area.

9. GRAIN TECHNOLOGY. At present, there are no formal grades or standards of grain in use in Jordan. Furthermore, the consultant has not been able to determine if the importers of grain make an effort to verify the quality of grain received according to any formal grading system. There appears to be no need, at this time, to equip the facility to clean and blend grain. However, the facility should include the equipment

necessary to sample the grain received, provide accurate weights of all grain received and shipped, and be designed so that cleaning and blending capabilities may be added in the future.

B. DESIGN LOGIC

There are numerous possible solutions to the design requirements. This section discusses several possible solutions and reduces the alternatives to be developed and considered in detail to a manageable number.

1. SHIP UNLOADING. An efficient mechanical system of ship unloading is basic to the development. Ship unloading may be accomplished mechanically by two basic means: Marine bucket elevator or pneumatic (suction) devices. Marine bucket elevators are the most efficient means of discharging grain in terms of operating cost but are limited in their usage to bulk carrier-type vessels. The consultant believes that if Jordan is to be capable of purchasing grain on the most economical and efficient basis, then the type of vessels which will carry grain to Aqaba cannot be anticipated nor controlled. The design of the facility must anticipate receipt of general cargo vessels, bulk carriers or tanker-type vessels in various sizes. To achieve flexibility in operation, and avoid movement of the ship during unloading, which would tie up valuable berthing space, unloading machines should be mounted on gantries which are capable of movement along the breasting line of the ship.

Based on the detailed analysis shown in Section I-E, the consultant recommends installation of two independent self-propelled unloading gantries, each equipped with two independent 100 MT/hour (peak rate) pneumatic systems.

2. TRANSPORT AWAY FROM BERTH AREA. The berths which are presently available for installation of the pneumatic unloading gantries are limited in dock area and access. If a 30,000 MT ship is offloaded in five days,

the grain must be transported away from the berth at a rate equal to the rate at which it is offloaded. This is most easily accomplished by a conveyor system elevated sufficiently above the wharf level and located in a manner which will not interfere with other uses of the berth. The grain must be conveyed to some area suitable for handling a high volume of truck traffic in an efficient manner.

3. STORAGE AT AQABA.

a. Direct on-stream Transport to Destination -- No Storage. It is difficult, if not impossible, to transport the average shipment of grain to its final destination in the northwestern area of Jordan within the five day offloading time. The average rate of offloading is 6,000 MT per day, which is equivalent to four hundred 15 MT loads per day. This would require the following for each day of the five days during offloading:

-	15 car train	=	15	15 ton loads
201	15 ton trucks	=	201	15 ton loads
50	Trucks with trailers	=	100	15 ton loads
42	Semi-Trailer Trucks	=	84	15 ton loads
293	Total trucks per day	=	400	Total 15 ton loads

Assuming trucks require two days for a round trip, 879 trucks would be required. This is two-thirds of all bulk trucks available in Jordan. Continuous 24 hour per day truck loading, fed directly by a receiving conveyor, would require in excess of 12 trucks per hour to be loaded. If bulk loading was utilized, this would require three loading stations, each handling four trucks per hour. In order to achieve bulk truck handling in 15 minutes, it might be proposed that each loading station be equipped with a truck scale located beneath two bulk loading bins (two would be

required to efficiently load semi-trailers and rigid trucks with trailers).

Bagging and bag loading of 12 trucks per hour would require more than 12 bagging machines and a minimum of 24 truck-loading positions.

Either of the above systems would require a certain amount of surge storage capacity to balance out the peak offloading capability of 400 MT per hour with the average loading capability of 250 MT per hour.

Based on a review of the major destination facilities, it is obvious that extensive improvements would be required, to both private sector and government facilities, in order to accomplish the truck and rail "turn-around" time necessary to accommodate this plan. Based on the above analysis, the consultant has discarded the possibility of direct "on-stream" transport from Aqaba to final destination.

b. Direct On-stream Transport to Satellite Storage Located Outside of Aqaba -- No Storage in Aqaba. This concept would require the same type of truck loading facilities within the port area as those described in 3a above. In addition, the storage site would require extensive receiving facilities as well as truck and rail loading facilities. However, the truck "turn-around" time would be reduced from that required in 3a with a result that fewer trucks would be required. The use of rail for transfer from the port to the storage site would probably not be practical. This system would necessitate duplication of truck and rail loading facilities, since it would require loading at the port and reloading at the satellite storage for shipment to final destination. In

addition, receiving facilities of a fairly extensive nature would be required at the satellite storage point and additional operating personnel would be required.

Based on this analysis, the consultant has discarded the possibility of on-stream loading at the port and transfer to a satellite storage at a point remote from Aqaba.

c. Minimum Surge Storage. The brief analyses in Paragraphs a and b above emphasize the need for construction of some minimum amount of surge storage at Aqaba to level out the transportation from Aqaba to the final destination. Storage in this case is merely a surge capacity to assure that a ship can be offloaded efficiently and thus achieve the financial benefits.

Based on the analysis shown in Section I-E, the consultant recommends that the minimum surge storage capacity, to assure efficient ship off-loading, should be approximately 30,000 MT. The storage must be separated so that receiving grains of different types and grades could commence prior to complete discharge of wheat from the storage facility or vice versa.

4. TYPES OF STORAGE. There are many types of grain storage available for consideration in terms of both configuration and construction. A brief discussion of the various types is presented in order to reduce the number of alternatives.

a. Configuration.

i Open, unconfined, uncovered storage with or without gravity reclaim: Because of the rather nominal rainfall (and wind velocity) in the Port of Aqaba, it may

seem logical to consider construction of an open concrete slab for surge grain storage. The grain stored on this concrete slab could be reclaimed by means of either front end loader vehicles, pneumatic machines or tunnels equipped with conveyors for gravity reclaiming. Although the system thus described would be economical in terms of initial investment, it would require a considerable amount of land area and would not produce maximum benefits in terms of reducing grain losses. If 20,000 MT of grain were piled on the ground, the pile would be 30 meters wide, 8 meters high, and 213 meters long; or a conical pile over 70 meters in diameter and 19 meters high. The grain stored in this manner represents an investment of over JD 1,000,000. The consultant feels that the risk of loss due to wind, rain, insect infestation and rodent damage is not acceptable.

ii Flat bottom, covered and contained storage without gravity reclaim: It is possible and considered normal to store grain for long periods of time in facilities which simply contain and protect it from the elements. Among the possibilities available are large diameter steel tanks resembling oil tanks or large rectangular buildings with walls suitably designed and constructed for the surcharge of the grain contained. These structures are relatively economical, particularly if they are not equipped with a means of gravity reclaim. Grain can be reclaimed by using front end loaders, pneumatic machines or portable conveying systems. In all cases, the cost and time involved in reclaiming the grain is substantial. The consultant has discarded this alternative on the basis of the cost of operation if the facility is to have the number of turnovers projected by the economic study. An analysis of operating versus capital cost is included in Section I-E.

iii Flat bottom, covered and contained storage with gravity reclaim of approximately two-thirds of the material: Storage facilities of the type described in ii above may be equipped with tunnels and conveying systems which would allow reclamation of up to two-thirds of the grain stored by gravity. The balance of the grain in such a structure is reclaimed by means of front end loaders, pneumatic systems or portable conveying systems. The facilities described in this paragraph are similar in nature to those currently used for phosphate handling in the Port of Aqaba. The

consultant feels that this is the minimum type of storage that should be considered for application to the proposed facility. This storage type is employed as flat storage in plans "B" and "C" in this report.

iv Flat bottom vertical silos with gravity reclaim of 90% of the stored material: This type of storage is efficient in terms of land space and reclaiming but has the disadvantage that the reclaiming of the final 10% of grain in the bin is difficult. These facilities would normally be silos of small diameter and substantial height. It is relatively economical to equip these silos with hopper bottoms to avoid clean-out of the bottoms. The economic analysis has shown that the total annual cost for this system is nearly equal to a plan with hopper bottoms. Since labor cost is more subject to increase, and as a result annual costs are less accurate, the consultant has thus arbitrarily eliminated flat bottom silos from consideration.

v Hopper bottom vertical silos with gravity reclaim of 100% of material: This is the most efficient type of storage in terms of operations and is the type which is normally found in port facilities where the handling of grain is rapid and the annual throughput is relatively high. The consultant recommends that this type of storage be considered for all or part of the storage required at Aqaba. This storage type is employed as vertical storage in Plans "A", "B", "D", and "E".

b. Construction Materials and Methods for Grain Storage. The basic objectives and economic justification dictate that any grain storage facility in Aqaba be of a permanent type. Materials other than steel or reinforced concrete are considered not permanent or relatively expensive. Recognizing that all structural steel and steel plate must be imported, whereas cement is manufactured in Jordan and concrete construction is common, the consultant has eliminated consideration of flat storage composed of large diameter steel tanks. The flat storage buildings which were described above could be constructed of reinforced concrete walls

with relatively light structural steel roofs. The hopper bottom silos described above could be constructed of either reinforced concrete or steel plate.

c. Systems Selected for Development. Based on the analysis discussed above, the consultant reduced the number of alternative types of grain storage to the five which would provide the most appropriate and economical systems. These five systems were developed in terms of preliminary layout and costs were estimated in order to compare costs as a means of selecting the system to be recommended.

i Vertical Concrete Silos in Contact - Plan "A": This system is composed of 27 slipform concrete silos in contact such that the spaces between the silos are used for grain storage. All storage spaces are equipped with hopper bottoms so that no pneumatic or mobile mechanical equipment would be required for reclaim of the grain from storage.

ii Horizontal-vertical combination - Plan "B": This system consists of one storage unit of 10,000 MT capacity in hopper bottomed concrete silos plus two 10,000 MT capacity horizontal storage buildings of the same design described in Paragraph iii below. This facility would permit gravity loading of all grain out of the vertical facility by providing the capability of transferring grain from the horizontal storage unit to the vertical storage unit prior to loadout. All grain could be loaded out from the facility by gravity, thus assuring efficiency in the loadout operations.

iii All horizontal - Plan "C": This system is composed of three separate rectangular flat bottom bulk storage buildings constructed of reinforced concrete walls with structural steel frame roofs and equipped with tunnels for gravity discharge of the grain to belt conveyors for reclaim.

iv Vertical Steel - Plan "D": This system is composed of hopper bottomed bolted steel tanks and has the same basic operating characteristics as the vertical

concrete. However, since the bolted steel tanks cannot generally be built to the height of concrete tanks, the facility would consume slightly more site area than the vertical concrete system.

v Vertical Concrete-Individual Silos - Plan "E": This system is composed of 16 individual slipform concrete silos with hopper bottoms such that no pneumatic or mobile mechanical equipment would be required for reclaim of the grain from storage.

5. LOAD OUT. There are two means of transport available to move grain away from Aqaba in two forms. They are as follows:

a) Bagged grain by trucks.

b) Bulk grain by trucks.

c) Bagged grain by rail.

d) Bulk grain by rail.

Since the rail system is now designed primarily to serve the phosphate industry; and cannot be used for grain without operational and physical modifications, it should not be depended upon for grain service in the near future. Therefore, the capacity of truck transport becomes the limiting factor in determining the total outloading capacity of the facility. The current outloading rate at Aqaba is 1,100 MT/day. If this outloading rate was increased by 60% to 1,760 MT/day and it is assumed that 75% of the trucks are 15 MT loads and 25% of the trucks are 30 MT loads, 100 trucks per day would be required. On a 16 hour day basis, the truck interval would be 9.6 minutes. The consultant feels, therefore, that 1,760 MT/day is a reasonable maximum outloading rate until the road between Aqaba and Amman is improved or until the railroad can take a large share of the load.

a. Bagging. The design of a bagging system must be consistent with two basic objectives. First, the facility must be capable of bagging all grain received for at least a few years following completion of construction. Second, the cost of the bagging system should be held to a minimum, because it will become obsolete as bulk handling is introduced into the system.

Grain in Jordan is normally bagged in 100 kg jute bags. Bagging machines with a maximum rated capacity of five bags per minute, per machine, are available to handle this size of bag. The normal average operating capacity of these machines should be considered at three bags per minute, per machine. Each bagging machine of this class is capable, on the average, of producing 180 bags per hour of 18 MT. If six bagging machines are installed, the average capacity of the system would be 1,080 bags or 108 tons per hour. With six machines, the facility would be capable of producing 864 MT in an eight-hour working shift. On the basis of two shifts/day, the facility could bag 1,728 MT per day.

b. Bag Truck Loading. The bag truck loading arrangement should convey the bags directly from the bagger to a truck dock area and deliver them by chute into the truck beds. In order to ensure efficient truck loading, there should be sufficient truck spaces, so that truck movement time need not be deducted from the average production time, i.e., one truck can be positioned while an adjacent truck is being loaded so that, when loading of one truck is complete, the bags can be immediately directed into the empty truck. Furthermore, there are a high number of standard single unit trucks operating with four-wheel trailers. If these

trucks are to be loaded from a conventional loading dock, the trailers will have to be disconnected from the trucks. This operation would be relatively inefficient. It is recommended that this type of truck be loaded from retractable spouts in a drive-through type of loading position. This would permit both the trailer and the truck to be loaded without disconnecting the units.

c. Bulk Truck Loading. Following conversion from bagged grain handling to bulk grain handling, bulk truck loading will be the principal means of transport from Aqaba to destination. Therefore, a primary consideration for design of the facility is for bulk truck loading. Bulk truck loading is most efficiently carried out by means of a gravity spout from a surge bin which allows the main elevator equipment to operate continuously, although the loading spot is operated intermittently. Intermittent operation of the loading spout is required to trim the load of the bulk trucks and to allow time for truck movement. The surge bin can be either a separate bin designated for truck loading with a discharge sufficiently above grade to permit gravity spouting to the truck or simply the upper section of a main storage bin equipped with a spout to load the trucks. In the latter instance, it is assumed that the grain is not blended or pre-weighed into the surge bin. One gravity discharge spout would be capable of loading approximately seven 15 ton trucks per hour. Under present conditions, one bulk loading spout equivalent to 100 MT per hour of discharge would be more than adequate to handle the amount of bulk grain to be shipped by truck in the near future. The facility should provide for an additional spout to be added in the future

as conversion from bag handling to bulk handling takes place. In addition, auxiliary spouts could be provided from the top sections of storage bins.

d. Bag Rail Loading. Loading of bagged grain into rail cars is considered a secondary means of shipping from Aqaba to destination, or from Aqaba to an intermediate storage point. This means of loading is provided only to assure flexibility in operation and to meet future demands for shipping wheat and maize to government bagged grain storage facilities. The consultant recommends that one siding be made available for relatively slow loading by means of forklift trucks to 15 boxcars in a unit train configuration.

e. Bulk Rail Loading. Bulk rail loading is considered a primary future means of grain transport. The consultant understands that only boxcar type rail wagons will be available for grain service from Aqaba to the Amman vicinity, due to limitation in the load carrying capability of the track from Al Hasa to Amman. The consultant further understands that, due to the grade of the rail from Aqaba to Ma'an, loaded trains will be limited to approximately 15 cars. Therefore, a facility for loading the small boxcar type bulk cars will be provided on the basis that cars will be in a unit train configuration loading through ports in the boxcar roofs. Since the frequency of bulk rail loading will be low for the immediate future, and since the loading time will be less than 2 hours per unit train; the consultant recommends that specialized car moving equipment for the grain facility not be considered. Car movement during loading can be carried out by a locomotive provided by the railroad. Off-line trackage should be available, separate from the bag loading

track, which would permit 15-car storage spaces on each side of a bulk loading spout. Clearances and loadings on the grain terminal trackage should be adequate for operation of a line locomotive.

f. Outloading Summary. The maximum truck movement rate is 1,760 MT/day and the maximum average bagging rate is sized at 1,728 MT/day to approximately equal the transportation limitation.

6. AUXILIARY FEATURES.

a. In-bound Weights. All grain received by the facility from ships should be accurately weighed. This is most easily accomplished by requiring all grain to pass through a bulk weighing system composed of an upper garner (surge bin), a weigh hopper and lower garner (surge bin). The weighing can be carried out automatically be this means, continuously "on-stream" as the grain is conveyed into the facility.

b. Out-bound Weights. All grain shipped from the facility should be accurately weighed. Weights can be taken by several different means. In the case of bagged grain, each bag will be weighed at the time of bagging thus producing the capability of counting bags of known weights. A truck scale may be used for both bagged and bulk grain shipments by truck. Weights shipped by bulk rail can be measured with the bulk weigher system described in Paragraph a above. This bulk weigher system can also be used as an alternate method of loading bulk trucks. The combination of bagging scales, a truck scale and the bulk weigher will provide adequate flexibility and versatility for out-bound weights.

c. Sampling. Although grades and standards are not used within the country of Jordan, it is probable that grain purchased from foreign

countries will be purchased on the basis of some establishing grading system. The consultant recommends, therefore, that a sampling system be installed to allow samples to be taken of all grain received. When grain is not being received, this sampling system could be used for obtaining shipping samples.

d. Drying and Aeration. Since most of the grain to be handled in the Aqaba facility is wheat; the probable duration of storage of either wheat or corn is approximately six weeks; the majority of the grain received is assumed to be in satisfactory condition; and since it will be well protected during receiving and storage, the consultant sees no justification at this time for the installation of drying or aeration systems. Any of the recommended storage facilities which the consultant is considering could be equipped with aeration at some future date if the need should arise.

e. Temperature Detection. Temperature detection is considered a primary safety device in the handling and storage of grain, therefore, it is recommended that a complete temperature detection system be installed in all storage units.

f. Bagged Grain Storage. Some amount of surge capacity for the bagged grain production is necessary to assure that bagging can operate continuously and efficiently in case the transport of bagged grain is interrupted for short periods of time. The consultant recommends a minimum amount of bagged grain storage to accommodate surges.

g. Maintenance Shop. There are currently no maintenance contractors in Aqaba equipped to carry out routine maintenance work on the type

of equipment which will be installed for handling grain. Also, the maintenance facilities for the general port and phosphate operations are considered to be adequate only for their presently assigned duties. It is recommended that a fairly complete maintenance facility and spare parts warehouse be provided to assure that proper tools, equipment and spare parts are available for routine maintenance.

h. Automation. Because of the relatively low cost of labor as opposed to the relatively high capital and maintenance cost of sophisticated automation systems, the consultant recommends that the grain facility at Aqaba be equipped only with the minimum amount of automation and remote control consistent with safety and accessability of the equipment. In general, automation or remote control should be limited to the upper sections of the headhouse and the starting and stopping of major equipment. The facility should be equipped with a complete interlocking system consistent with the safety of the operating personnel and equipment.

C. SITE CONSIDERATIONS

During the process of this study, several alternative sites were considered relative to their effect on existing and future developments in the port as well as their effect on the economic feasibility of the facility. This section of the report discusses the principal reasons for the selection of the site shown on Drawing 2, Site Plan "E".

1. GRAIN SHIP BERTH. There are four existing berths which could be considered for use in discharging of grain ships. They include two phosphate loading berths and two general cargo berths. The phosphate berths were discarded from consideration due to the high volume of phosphate presently being exported and the projections for increased phosphate exporting. There would be little or no time available at the phosphate berths without disrupting export operations. General cargo Berths 1 and 2 are well suited to installation of the grain receiving facilities. Both of these berths are equipped with a complete concrete wharf and are designed to accommodate rail-mounted cranes for offloading of general cargo. Berth 1 was selected for use as the grain unloading berth because of its closer proximity to the proposed site of the grain storage and load-out facility.

2. STORAGE AND LOADING SITE. Selection of the site for the main silo facility was based on several factors. Requirements included proper connection to the railway line, easy access to roads for truck transportation, economical conveying distance from the ship berth and minimum disruption of present activities and future developments. The consultant was informed that the railway to the north and east of the

Mosque was on a grade too steep to allow safe turnouts. Therefore, consideration of railway access limited the site location to an area between the existing Mosque and the drainage ditch immediately north of the phosphate area. Existing developments dictated that the grain facility be located on the east side of the railway. Several sites in this general area were proposed, and the final site selected on the basis that it caused minimum interference with the Free Trade Zone development. The north-south length of the site is dictated by the space required for back track loading of 15-car unit trains. The bulk loading point must have a minimum of 165 meters of siding to the south of this point. The end-of-track location is dictated by the future location of a main drainage ditch. The consultant has carried out a preliminary soil boring program that confirmed that this area has suitable soil bearing conditions for construction of the grain facility.

D. CAPABILITY OF JORDANIAN CONTRACTORS

During a field visit to Jordan in September, 1975, the consultant held discussions with three of Jordan's leading general construction contractors. All expressed interest in becoming involved in the construction of a recommended grain storage facility in Aqaba. All agreed that they would require assistance should they be selected for the project and if slipform-type construction was involved. All expressed concern over difficulties in obtainin skilled and unskilled labor in the Aqaba area at the present time. Presently there is a shortage of skilled labor in Jordan as the workers are being lured by higher wages into the oil-producing counties to the east of Jordan. Hopefully, the expansion program in the port area will attract a larger number of workers to Aqaba and, by the time that the construction on the recommended grain facility is commenced, the shortage will be resolved. There should not be any difficulty in one of the Class 1 Jordanian general contractors carrying out the construction phase of the proposed project with assistance from a foreign contractor on the slip form phase, should this method be undertaken. This assistance could be provided either by a joint venture with a foreign contractor or through a subcontract agreement. Slipform silos have been constructed in Jordan at the Al Hasa phosphate mines and at the Jordan Cement Company in the Amman area. The cement company is planning an expansion of their existing facilities and are scheduling additional slipformed silos in late 1976.

It is recommended that the detailed design of the recommended facility be carried out by a competent consulting engineer familiar with the type of equipment to be incorporated. The consultant would develop detailed equipment and materials specifications, tender documents and assist in the purchasing of materials which are not readily available in Jordan. The design and specification development phases could be carried out in the early stage of the project and the equipment could be placed on order with the manufacturers simultaneously with the prequalification of the general contractors. This would relieve the general contractor of the responsibility for selecting the equipment manufacturers and assist the project in getting an early start on long-delivery items. It is also recommended that the contractor be provided with technical assistance on the installation of specific items of equipment, such as bagging machines, temperature detection equipment, scales and passenger elevators either by having these items installed by the manufacturer or by the general contractor being provided the technical assistance of a competent manufacturer's respresentative familiar with the specific item.

In the case of the pneumatic ship unloaders, which are the largest single item of equipment, it is recommended that a design-build, performance type specification be developed by the consultant. Tenders from prequalified manufacturers for supply of the units and erection supervision can be called in the early stages of the design before the general contractor is selected. The erection can be included as part of the scope of the

general contractor incorporating assistance of the manufacturer's erection supervisor. This procedure will speed up the overall completion of the facility.

It is recommended that the remainder of the installation of mechanical and electrical equipment would be the responsibility of the general contractor. If necessary, the general contractor could subcontract the installation work to qualified Jordanian mechanical and electrical subcontractors. It is felt that the general contractor is in the best position to schedule the civil and mechanical electrical phases and thus avoid possible delay claims if separate contractors were selected for the respective phases of construction.

It is further recommended that the selected consultant for the design phase of the project should also maintain a resident staff at the site during the construction phase for the guidance of the contractor, quality control certification of contractor's invoices and general construction supervision.

If the above procedure is adopted, there should not be any difficulty for a prequalified Class 1 Jordanian general contractor carrying out the construction phase.

E. CONSTRUCTION MATERIALS AND METHODS

One of the major considerations in determining the construction mthods to be utilized is the soil bearing capacity of the selected site. A soils and foundation investigation was carried out under this study and it has been determined that a mat slab foundation can be utilized with tolerable limits of settlement provided that the soil bearing pressure shall be less than 2.9 kg/cm^2. This has eliminated the necessity of piling under the storage and headhouse structures.

In the early discussions in Section II, five types of facilities or combinations of these have been discussed and considered. Three of these facilities utilize vertical concrete storage bins. The universal approach to this type of structure is to utilize "slipform" type construction. This is a procedure where a single or group of bins can be cast continuously by vertically jacking a pre-constructed form. While construction of the form may require a number of days for a single bin or a number of weeks for a group of bins in contact, the "slip" can be jacked at rates from 15 cm to 30 cm per hour, allowing single line or an average group of bins to be cast in seven days or less. For a 27-bin unit together with intermediary storage areas commonly referred to as interstice bins, it is recommended that the storage be slipped in three separate segments so as to keep the crews to a manageable size and for better overall construction control. The slipform can then be left in place, at the discretion of the contractor, to use as a form in pouring the silo roof. Otherwise, it can be jacked free immediately and re-assembled for use in the next slip pour.

The best results in vertical concrete silo construction are usually achieved with the use of deformed reinforcing bar. If this is not available at the time of construction, it is recommended that it be imported for the slipform portions of the construction. The reinforcing steel utilized in many other areas of the concrete work may be non-deformed bars which are rolled in Jordan.

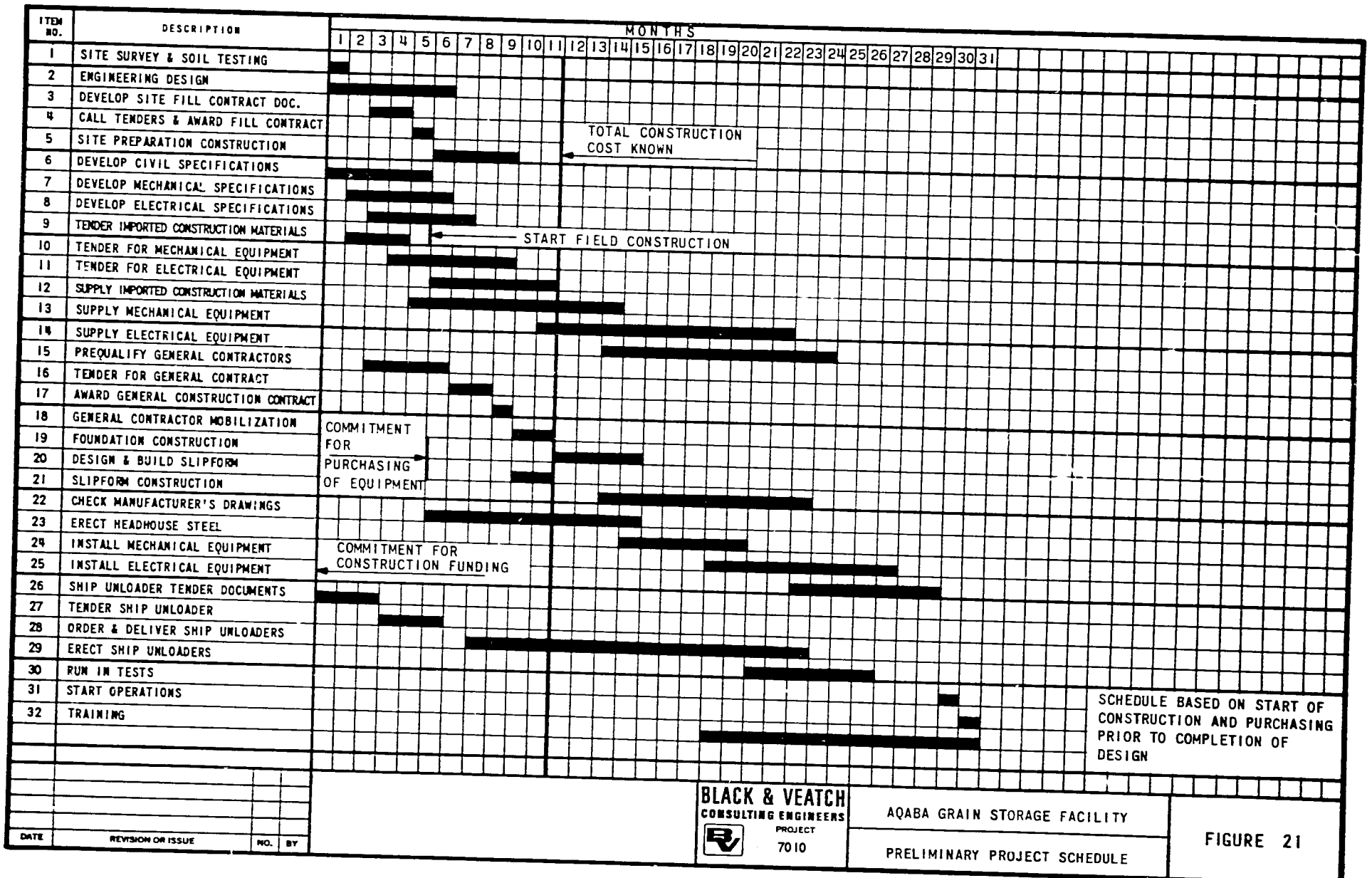
The headhouse, as well as the conveyor bridge leading from the berth would be constructed with shop-fabricated structural steel. The maintenance shop and bagging house structures could be economically provided by using prefabricated, metal buildings. All foundation concrete, retaining walls, railway platforms, etc., would be of standard concrete construction utilizing materials available in Jordan. It is recommended that granitic aggregate be used in the concrete work. The aggregate will be required to be crushed, as it will not be found in the required gradation for the concrete work. Fine aggregate is readily available by combining wadi and dune sands from sources a short distance from Aqaba.

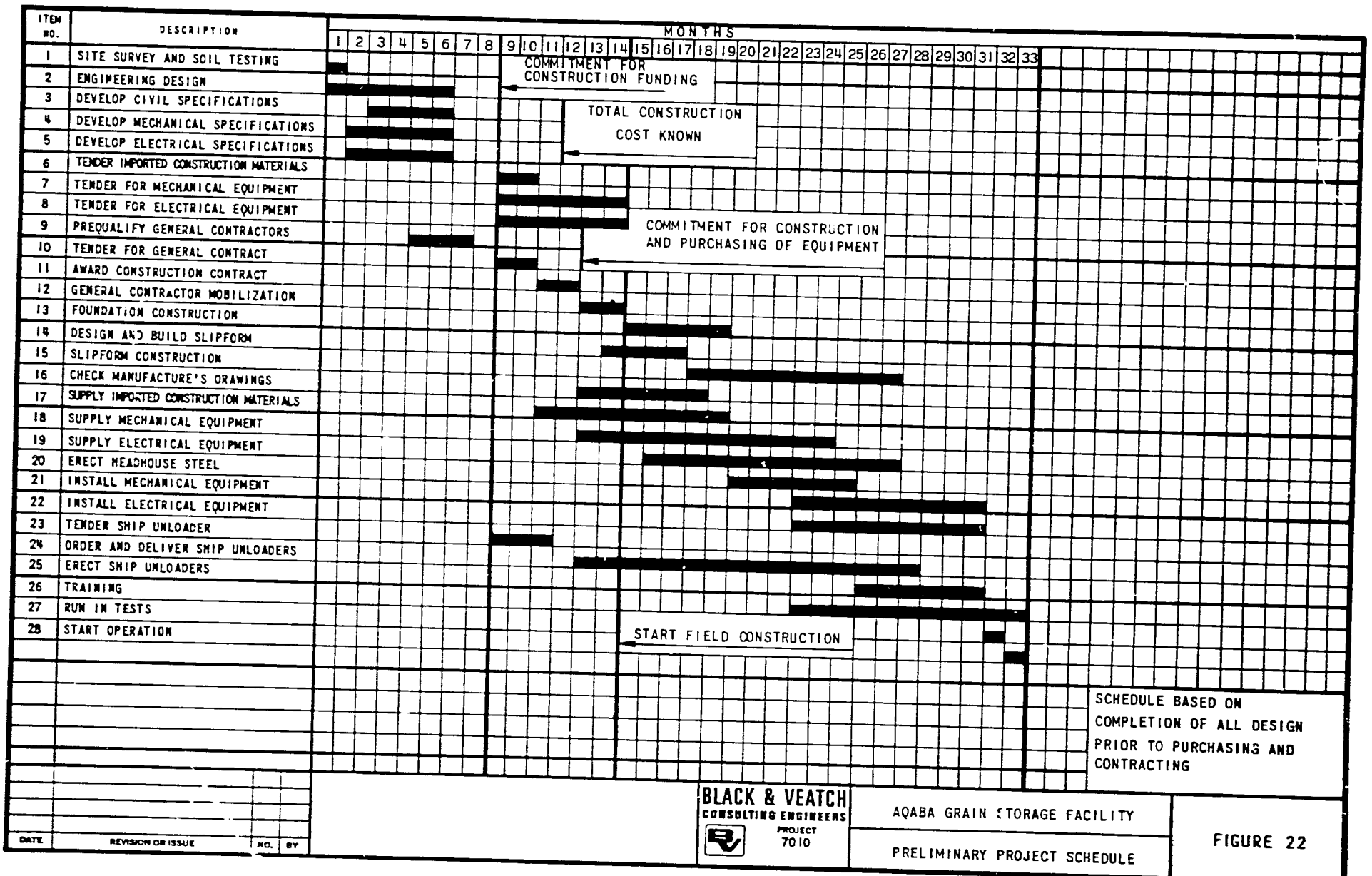
Caution must be emphasized in all concrete work in Aqaba. There have been instances in past concrete construction where the high alkaline content of the soil and/or aggregates in the Aqaba area have caused concrete to fail. Phosphate contamination of aggregates and concrete mixes can have an adverse effect in the resulting concrete. With proper control and supervision, both these problems can be avoided.

F. PROJECT SCHEDULE

The scheduling of the project is dependent on the time required to arrange financing of the initial investment. Preinvestment studies and financial commitment procedures can require a number of months before disbursements can be made. Two alternate schedules have been included as Figures 21 and 22.

The preliminary project schedule presented in Figure 21 assumes that there is no project activity until the project financing is in effect. It also assumes that the selected consulting engineer would develop the equipment specifications and purchase documents and assist the client in tendering and awarding the equipment and material contracts. These activities can be carried out within the first five-month period simultaneous to the prequalification of general contractors. This has a distinctive advantage in the overall schedule, as it permits long delivery items such as the pneumatic ship unloaders, scales, conveyors, elevator legs, structural steel, etc., which often require long delivery times, to be placed on order prior to awarding the general construction and erection contract. It is also suggested that a contract for development of the site including site fill, retaining walls and boundary fences be awarded prior to awarding the general construction and erection contract. This will permit the general contractor to commence operations on a fully developed site at the start of the tenth month of the schedule. It is anticipated that the overall project can be completed within 31 months from the time that the project financing is effective.


ITEM NO.
DESCRIPTION
MONTHS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
1 SITE SURVEY & SOIL TESTING
2 ENGINEERING DESIGN
3 DEVELOP SITE FILL CONTRACT DOC.
4 CALL TENDERS & AWARD FILL CONTRACT
5 SITE PREPARATION CONSTRUCTION
6 DEVELOP CIVIL SPECIFICATIONS
7 DEVELOP MECHANICAL SPECIFICATIONS
8 DEVELOP ELECTRICAL SPECIFICATIONS
9 TENDER IMPORTED CONSTRUCTION MATERIALS
10 TENDER FOR MECHANICAL EQUIPMENT
11 TENDER FOR ELECTRICAL EQUIPMENT
12 SUPPLY IMPORTED CONSTRUCTION MATERIALS
13 SUPPLY MECHANICAL EQUIPMENT
14 SUPPLY ELECTRICAL EQUIPMENT
15 PREQUALIFY GENERAL CONTRACTORS
16 TENDER FOR GENERAL CONTRACT
17 AWARD GENERAL CONSTRUCTION CONTRACT
18 GENERAL CONTRACTOR MOBILIZATION
19 FOUNDATION CONSTRUCTION
20 DESIGN & BUILD SLIPFORM
21 SLIPFORM CONSTRUCTION
22 CHECK MANUFACTURER'S DRAWINGS
23 ERECT HEADHOUSE STEEL
24 INSTALL MECHANICAL EQUIPMENT
25 INSTALL ELECTRICAL EQUIPMENT
26 SHIP UNLOADER TENDER DOCUMENTS
27 TENDER SHIP UNLOADER
28 ORDER & DELIVER SHIP UNLOADERS
29 ERECT SHIP UNLOADERS
30 RUN IN TESTS
31 START OPERATIONS
32 TRAINING
TOTAL CONSTRUCTION COST KNOWN
START FIELD CONSTRUCTION
COMMITMENT FOR PURCHASING OF EQUIPMENT
COMMITMENT FOR CONSTRUCTION FUNDING
SCHEDULE BASED ON START OF CONSTRUCTION AND PURCHASING PRIOR TO COMPLETION OF DESIGN
DATE
REVISION OR ISSUE
NO.
BY
BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT
7010
AQABA GRAIN STORAGE FACILITY
PRELIMINARY PROJECT SCHEDULE
FIGURE 21


ITEM NO.
DESCRIPTION
MONTHS
1 SITE SURVEY AND SOIL TESTING
2 ENGINEERING DESIGN
3 DEVELOP CIVIL SPECIFICATIONS
4 DEVELOP MECHANICAL SPECIFICATIONS
5 DEVELOP ELECTRICAL SPECIFICATIONS
6 TENDER IMPORTED CONSTRUCTION MATERIALS
7 TENDER FOR MECHANICAL EQUIPMENT
8 TENDER FOR ELECTRICAL EQUIPMENT
9 PREQUALIFY GENERAL CONTRACTORS
10 TENDER FOR GENERAL CONTRACT
11 AWARD CONSTRUCTION CONTRACT
12 GENERAL CONTRACTOR MOBILIZATION
13 FOUNDATION CONSTRUCTION
14 DESIGN AND BUILD SLIPFORM
15 SLIPFORM CONSTRUCTION
16 CHECK MANUFACTURE'S DRAWINGS
17 SUPPLY IMPORTED CONSTRUCTION MATERIALS
18 SUPPLY MECHANICAL EQUIPMENT
19 SUPPLY ELECTRICAL EQUIPMENT
20 ERECT HEADHOUSE STEEL
21 INSTALL MECHANICAL EQUIPMENT
22 INSTALL ELECTRICAL EQUIPMENT
23 TENDER SHIP UNLOADER
24 ORDER AND DELIVER SHIP UNLOADERS
25 ERECT SHIP UNLOADERS
26 TRAINING
27 RUN IN TESTS
28 START OPERATION
COMMITMENT FOR CONSTRUCTION FUNDING
TOTAL CONSTRUCTION COST KNOWN
COMMITMENT FOR CONSTRUCTION AND PURCHASING OF EQUIPMENT
START FIELD CONSTRUCTION
SCHEDULE BASED ON COMPLETION OF ALL DESIGN PRIOR TO PURCHASING AND CONTRACTING
DATE
REVISION OR ISSUE
NO.
BY
BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 7010
AQABA GRAIN STORAGE FACILITY
PRELIMINARY PROJECT SCHEDULE
FIGURE 22

It may be possible that the Government of Jordan could finance the engineering design phase of the project in advance of their commitment to finance construction of the project. This would permit the project to commence at an earlier date than expressed in Figure 21. It is assumed that construction financing will be effective at the beginning of the ninth month, at which time tenders would be sought for all equipment and materials, as well as for the general construction and erection contract. It is assumed that the general contractor could be mobilized quickly enough to do his own site preparation and, therefore, no separate contract would be initiated for the site development phase. While the overall duration of this schedule totals 33 months, the period from the finalization of construction financing to the start-up of this facility is 25 months, as compared to 31 months projected on the assumption that no activities occur prior to construction financing. Therefore, the early start approach to the project will result in the earliest start-up of the facility based on a running calendar month projection.

G. ESTIMATED CAPITAL INVESTMENT COSTS

Table 23 on page 76 is a summary of the estimated capital investment for five types of facilities which would meet the requirements for receiving storage and handling in Aqaba.

Six bagging machines with a total throughput of 864 MT per eight-hour shift have been included in the estimate. If it can be agreed that more can be shipped inland in bulk than presently anticipated, two bagging units can be eliminated, reducing the cost of the facility by approximately JD 5,300 and US $31,500.

A preliminary estimate breakdown for each of the five facilities is included in Tables 31, 32, 33, 34, and 35. These were developed from quantity take-offs, and labor rates were escalated above those being paid in the Aqaba area at the time this report was prepared.

Attempts have been made to develop the preliminary estimates as accurately as possible. Discussions with contractors and government officials in Jordan have indicated that there is a shortage of both skilled and unskilled labor in Jordan, and salaries are escalating due to the high labor demand in neighboring countries. While recent equipment and material quotations have indicated a trend toward stabilization, there is no way of accurately estimating what equipment prices will be at the time of placing actual orders.

In order to allow some margin for these unknowns, a contingency of 10% has been allocated on the equipment and national purchases as well as on the construction and erection contracts.

The following labor rates and unit prices were used in developing the estimated capital investment for each of the five facilities.

1. LABOR RATES

SKILL	UNIT
Carpenter	JD 6.000/Day
Carpenter's Helper	JD 3.500/Day
Laborer - Skilled	JD 4.000/Day
Laborer - Unskilled	JD 3.000/Day
Dozer Operator	JD 6.000/Day
Millwrights	JD 7.500/Day
Crane Operators	JD 7.500/Day
Truck Drivers	JD 4.000/Day
Electrician	JD 6.000/Day
Batch Plant Operator	JD 5.000/Day
Mechanics	JD 7.500/Day
Superintendent	JD 700/Month
Foremen- Carpenter	JD 700/Month
Electrical	JD 400/Month
Mechanical	JD 400/Month
Slipform	JD 400/Month
Rebar	JD 300/Month
Labor	JD 250/Month
Warehouse Man	JD 200/Month

2. MATERIAL PRICES

Batched Concrete 210 Kg/cm^2	JD 23.000/M^3
Cement Including Transport	JD 18.000/M.T.
Reinforcing Steel Grade 40	JD 135.000/M.T.

TABLE 31

ESTIMATED CAPITAL INVESTMENT

FOR 30,000 M.T. SLIPFORM VERTICAL STORAGE AND RECEIVING FACILITY

PLAN A

ITEM	JORDANIAN DINARS				U. S. DOLLARS				JD
	LABOR	MAT'LS.	EQUIPMENT	TOTAL	LABOR	MAT'LS.	EQUIPMENT	TOTAL	GRAND TOTAL
1. Site Preparation									
a) Earth Work	3,980	--	50,633	54,613	--	--	--	--	54,613
b) Asphalt Paving	--	8,100	14,661	22,761	--	--	--	--	22,761
2. Railroad	--	70,000	--	70,000	--	--	--	--	70,000
3. Mechanical Equipment									
a) Pneumatic Ship Unloaders	43,200	2,100	1,100	46,400	82,000	2,020,000	300,000	2,402,000	797,025
b) Receiving Equipment	43,186	550	1,350	45,086	--	400,770	67,766	468,536	191,504
c) Headhouse Equipment	41,726	1,520	1,520	44,766	16,600	446,440	73,030	538,070	212,912
d) Storage Equipment	15,915	400	400	16,715	--	311,125	52,608	363,733	130,381
e) Bagging Equipment	19,508	450	400	20,358	9,300	132,180	24,808	166,288	72,323
f) Lab, Shop Equipment, Spare Parts	2,350	--	--	2,350	--	141,000	23,841	164,841	53,863
g) Forklift Trucks	300	--	--	300	--	32,000	5,411	37,411	11,991
4. Principal Structures									
a) Conveyor Bridge	13,474	8,008	700	22,182	--	416,250	49,950	466,200	167,869
b) Headhouse	23,747	34,034	4,200	61,981	--	478,950	56,428	535,378	229,287
c) Storage	93,735	312,177	26,700	432,612	120,820	117,745	36,200	274,765	518,476
5. Ancillary Buildings & Structures									
a) Boundary Fence	4,500	2,798	720	8,018	--	14,300	3,315	17,615	13,523
b) Retaining Walls	1,474	6,235	700	8,409	--	--	--	--	8,409
c) Railway Platform	2,732	12,946	700	16,378	--	--	--	--	16,378
d) Maintenance Shop	4,146	6,991	200	11,337	--	30,789	13,162	43,951	25,072
e) Bagging Building	4,924	17,189	300	22,413	--	26,746	15,534	42,280	35,626
f) Truck Scale	2,531	4,470	220	7,221	9,300	15,000	2,536	26,836	15,607
g) Truckers Welfare Building	210	575	100	885	--	885	100	985	1,193
h) Water System	1,850	5,776	350	7,976	--	--	--	--	7,976
6. Electrical	18,524	2,000	--	20,524	--	405,697	75,200	480,897	170,804
7. Contractor's Overhead & Profit	204,128	129,705	32,488	366,321	--	--	--	--	366,321
8. Contingency	54,614	62,602	13,744	130,960	24,002	498,988	79,989	602,979	319,391
9. Engineering									
a) Design Phase	7,250	--	--	7,250	455,858	--	--	455,858	149,706
b) Construction Phase	58,800	--	--	58,800	598,250	--	--	598,250	245,753
10. Land Contingency	--	200,000	--	200,000	--	--	--	--	200,000
TOTAL ESTIMATED PROJECT BUDGET	666,804	888,626	151,186	1,706,616	1,318,130	5,488,865	879,878	7,686,873	4,108,764

TABLE 32

ESTIMATED CAPITAL INVESTMENT

FOR COMBINATION OF 10,000 M.T. VERTICAL AND 20,000 M.T. HORIZONTAL STORAGE AND RECEIVING FACILITY

PLAN B

ITEM	JORDANIAN DINARS				U. S. DOLLARS				JD
	LABOR	MAT'LS.	EQUIPMENT	TOTAL	LABOR	MAT'LS.	EQUIPMENT	TOTAL	GRAND TOTAL
1. Site Preparation									
a) Earth Work	7,980	--	57,625	65,605					65,605
b) Asphalt Paving	--	8,100	14,661	22,761					22,761
2. Railroad	--	70,000	--	70,000					70,000
3. Mechanical Equipment									
a) Pneumatic Ship-Unloaders	43,200	2,100	1,100	46,400	82,000	2,020,000	300,000	2,402,000	797,025
b) Receiving Equipment	43,186	550	1,350	45,086	27,900	400,770	67,766	496,436	200,222
c) Headhouse Equipment	43,768	1,420	1,420	46,608		438,440	78,919	517,359	208,282
d) Storage Equipment	17,730	520	470	18,720		393,610	69,740	463,350	163,517
e) Bagging Equipment	19,508	450	400	20,358	9,300	132,180	24,808	166,288	72,323
f) Lab, Shop Equipment, Spare Parts	2,350	--	--	2,350		141,000	23,841	164,841	53,863
g) Forklift Trucks & Front End Loader	450	--	--	450		42,000	7,390	49,390	15,884
4. Principal Structures									
a) Conveyor Bridge	13,474	8,008	700	22,182	--	416,250	49,950	466,200	167,869
b) Headhouse	22,659	34,034	4,200	60,893		442,700	52,078	494,778	215,511
c) Storage	65,939	269,795	12,100	347,834	62,320	162,630	75,682	300,632	441,782
5. Ancillary Buildings & Structures									
a) Boundary Fence	4,500	2,798	720	8,018		14,300	3,315	17,615	13,523
b) Retaining Walls	1,474	6,235	700	8,409					8,409
c) Railway Platform	2,732	12,946	700	16,378					16,378
d) Maintenance Shop	4,146	6,991	200	11,337		30,789	13,162	43,951	25,072
e) Bagging Building	4,924	17,189	300	22,413		26,746	15,534	42,280	35,625
f) Truck Scale	2,531	4,470	220	7,221	9,300	15,000	2,536	26,836	15,607
g) Truckers Welfare Building	210	575	100	885		885	100	985	1,193
h) Water System	1,850	5,776	350	7,976		--	--	--	7,976
6. Electrical	18,524	2,000	--	20,524		405,697	75,200	480,897	170,804
7. Contractor's Overhead & Profit	198,909	119,114	30,579	348,602					348,602
8. Contingency	52,004	57,307	12,790	122,101	19,082	508,300	86,002	613,384	313,784
9. Engineering									
a) Design Phase	7,250			7,250	455,858	--	--	455,858	149,706
b) Construction Phase	58,800			58,800	598,250	--	--	598,250	245,753
10. Land Contingency	--	200,000	--	200,000	--	--	--	--	200,000
TOTAL ESTIMATED PROJECT BUDGET	638,098	830,378	140,685	1,609,161	1,264,010	5,591,297	946,023	7,801,330	4,047,077

TABLE 33

ESTIMATED CAPITAL INVESTMENT

FOR 30,000 M.T. HORIZONTAL STORAGE AND RECEIVING FACILITY

PLAN C

ITEM	JORDANIAN DINARS				U.S. DOLLARS				JD
	LABOR	MAT'LS.	EQUIPMENT	TOTAL	LABOR	MAT'LS.	EQUIPMENT	TOTAL	GRAND TOTAL
1. Site Preparation									
a) Earth Work	9,980	--	59,933	69,913	--	--	--	--	69,913
b) Asphalt Paving	--	8,100	14,661	22,761	--	--	--	--	22,761
2. Railroad	--	70,000	--	70,000	--	--	--	--	70,000
3. Mechanical Equipment									
a) Pneumatic Ship Unloaders	43,200	2,100	1,100	46,400	82,000	2,020,000	300,000	2,402,000	797,025
b) Receiving Equipment	43,186	550	1,350	45,086	--	400,770	67,766	468,536	191,504
c) Headhouse Equipment	43,818	1,420	1,420	46,658	27,900	438,440	80,513	546,853	217,550
d) Storage Equipment	23,865	520	470	24,855	--	523,715	76,146	599,861	212,312
e) Bagging Equipment	19,508	450	400	20,358	9,300	132,180	24,808	166,288	72,323
f) Lab, Shop Equipment & Spare Parts	2,350	--	--	2,350	--	141,000	23,841	164,841	53,863
g) Forklift Trucks & Front End Loader	450	--	--	450	--	42,000	7,390	49,390	15,884
4. Principal Structures									
a) Conveyor Bridge	13,474	8,008	700	22,182	--	416,250	49,950	466,200	167,869
b) Headhouse	20,786	35,034	4,400	60,220	--	371,450	43,528	414,978	189,900
c) Storage	54,279	259,678	4,700	318,657	--	160,860	59,223	220,083	387,433
5. Ancillary Buildings & Structures									
a) Boundary Fence	4,500	2,798	720	8,018	--	14,300	3,315	17,615	13,523
b) Retaining Walls	1,474	6,235	700	8,409	--	--	--	--	8,409
c) Railway Platform	2,732	12,946	700	16,378	--	--	--	--	16,378
d) Maintenance Shop	4,146	6,991	200	11,337	--	30,789	13,162	43,951	25,072
e) Bagging Building	4,924	17,189	300	22,413	--	26,746	15,534	42,280	35,625
f) Truck Scale	2,531	4,470	220	7,221	9,300	15,000	2,536	26,836	15,607
g) Truckers Welfare Building	210	575	100	885	--	885	100	985	1,193
h) Water System	1,850	5,776	350	7,976	--	--	--	--	7,976
6. Electrical	18,524	2,000	--	20,524	--	405,697	75,200	480,897	170,804
7. Contractor's Overhead & Profit	197,572	116,835	29,356	343,763	--	--	--	--	343,763
8. Contingency	51,336	56,167	12,178	119,681	12,850	514,008	84,301	611,159	310,668
9. Engineering									
a) Design Phase	7,250	--	--	7,250	455,858	--	--	455,858	149,706
b) Construction Phase	58,800	--	--	58,800	598,250	--	--	598,250	245,753
10. Land Contingency	--	200,000	--	200,000	--	--	--	--	200,000
TOTAL ESTIMATED PROJECT BUDGET	630,745	817,842	133,958	1,582,545	1,195,458	5,654,090	927,313	7,776,861	4,012,814

TABLE 34

ESTIMATED CAPITAL INVESTMENT

FOR 30,000 M.T. STEEL VERTICAL STORAGE AND RECEIVING FACILITY

PLAN D

ITEM	JORDANIAN DINARS				U.S. DOLLARS				JD
	LABOR	MAT'LS.	EQUIPMENT	TOTAL	LABOR	MAT'LS.	EQUIPMENT	TOTAL	GRAND TOTAL
1. Site Preparation									
a) Earth Work	3,980	--	50,633	54,613	--	--	--	--	54,613
b) Asphalt Paving	--	8,100	14,661	22,761	--	--	--	--	22,761
2. Railroad	--	70,000	--	70,000	--	--	--	--	70,000
3. Mechanical Equipment									
a) Pneumatic Ship Unloaders	43,200	2,100	1,100	46,400	82,000	2,020,000	300,000	2,402,000	797,025
b) Receiving Equipment	43,186	550	1,350	45,086	--	400,770	67,766	468,536	191,504
c) Headhouse Equipment	41,726	1,520	1,520	44,766	18,600	446,440	73,030	538,070	212,913
d) Storage Equipment	21,115	520	520	22,155	--	404,625	62,608	467,233	168,164
e) Bagging Equipment	19,508	450	400	20,358	9,300	132,180	24,808	166,288	72,323
f) Lab, Shop Equipment & Spare Parts	2,350	--	--	2,350	--	141,000	23,841	164,841	53,863
g) Forklift Trucks	300	--	--	300	--	32,000	5,411	37,411	11,991
4. Principal Structures									
a) Conveyor Bridge	13,474	8,008	700	22,182	--	416,250	49,950	466,200	167,870
b) Headhouse	20,786	35,034	4,400	60,220	--	371,450	43,528	414,978	189,901
c) Storage	112,698	73,750	14,500	200,948	--	1,088,100	183,750	1,271,850	598,400
5. Ancillary Buildings & Structures									
a) Boundary Fence	4,500	2,798	720	8,018	--	14,300	3,315	17,615	13,523
b) Retaining Walls	1,474	6,235	700	8,409	--	--	--	--	8,409
c) Railway Platform	2,732	12,946	700	16,378	--	--	--	--	16,378
d) Maintenance Shop	4,146	6,991	200	11,337	--	30,789	13,162	43,951	25,072
e) Bagging Building	4,924	17,189	300	22,413	--	26,746	15,534	42,280	35,626
f) Truck Scale	2,531	4,470	220	7,221	9,300	15,000	2,536	26,836	15,607
g) Trucker's Welfare Building	210	575	100	885	--	885	100	985	1,193
h) Water System	1,850	5,776	350	7,976	--	--	--	--	7,976
6. Electrical	19,524	2,100	--	21,624	--	425,980	78,950	504,930	179,415
7. Contractor's Overhead & Profit	209,678	70,403	29,519	309,600	--	--	--	--	309,600
8. Contingency	57,389	32,952	12,259	102,600	11,920	596,651	94,829	703,400	322,412
9. Engineering									
a) Design Phase	7,250	--	--	7,250	455,858	--	--	455,858	149,706
b) Construction Phase	58,800	--	--	58,800	598,250	--	--	598,250	245,753
10. Land Contingency	--	200,000	--	200,000	--	--	--	--	200,000
TOTAL ESTIMATED PROJECT BUDGET	697,331	562,467	134,852	1,394,650	1,185,228	6,563,166	1,043,118	8,791,512	4,141,998

TABLE 35

ESTIMATED CAPITAL INVESTMENT

FOR 30,000 M.T. SLIPFORM INDIVIDUAL VERTICAL STORAGE AND RECEIVING FACILITY

PLAN E

ITEM	JORDANIAN DINARS				U.S. DOLLARS				JD
	LABOR	MAT'LS.	EQUIPMENT	TOTAL	LABOR	MAT'LS.	EQUIPMENT	TOTAL	GRAND TOTAL
1. Site Preparation									
a) Earth Work	3,980	--	50,633	54,613					54,613
b) Asphalt	--	8,100	14,661	22,761					22,761
2. Railroad	--	70,000	--	70,000					70,000
3. Mechanical Equipment									
a) Pneumatic Ship Unloaders	43,200	2,100	1,100	46,400	82,000	2,020,000	300,000	2,402,000	797,025
b) Receiving Equipment	43,186	550	1,350	45,086	--	400,770	67,766	468,536	191,503
c) Headhouse Equipment	41,726	1,520	1,520	44,766	18,600	446,440	73,030	538,070	212,912
d) Storage Equipment	15,915	400	400	16,715	--	311,125	52,608	363,733	130,382
e) Bagging Equipment	19,508	450	400	20,358	9,300	132,180	24,808	166,288	72,323
f) Lab, Shop Equipment & Spare Parts	2,350	--	--	2,350	--	141,000	23,841	164,841	53,863
g) Fork Lift Trucks	300	--	--	300	--	32,000	5,411	37,411	11,991
4. Principal Structures									
a) Conveyor Bridge	13,474	8,008	700	22,182	--	416,250	49,950	466,200	167,870
b) Headhouse	25,510	34,034	4,200	63,744	--	537,700	63,478	601,178	251,612
c) Storage	96,124	265,992	17,400	379,516	59,397	141,317	13,000	213,714	446,302
5. Ancillary Buildings & Structures									
a) Boundary Fence	4,500	2,798	720	8,018	--	14,300	3,315	17,615	13,523
b) Retaining Walls	1,474	6,235	700	8,409	--	--	--	--	8,409
c) Railway Platform	2,732	12,946	700	16,378	--	--	--	--	16,378
d) Maintenance Shop	4,146	6,991	200	11,337	--	30,789	13,162	43,951	25,072
e) Bagging Building	4,924	17,189	300	22,413	--	26,746	15,534	42,280	35,625
f) Truck Scale	2,531	4,470	220	7,221	9,300	15,000	2,536	26,836	15,607
g) Trucker's Welfare Building	210	575	100	885	--	885	100	985	1,193
h) Water System	1,850	5,776	350	7,976	--	--	--	--	7,976
6. Electrical	18,524	2,000	--	20,524	--	405,697	75,200	480,897	170,804
7. Contractor's Overhead & Profit	204,651	116,570	30,051	351,272	--	--	--	--	351,272
8. Contingency	54,876	56,035	12,525	123,436	17,860	507,220	78,374	603,454	312,015
9. Engineering									
a) Design Phase	7,250	--	--	7,250	455,858	--	--	455,858	149,706
b) Construction Phase	58,800	--	--	58,800	598,250	--	--	598,250	245,753
10. Land Contingency	--	200,000	--	200,000	--	--	--	--	200,000
TOTAL ESTIMATED PROJECT BUDGET	671,741	822,739	138,230	1,632,710	1,250,565	5,579,419	862,113	7,692,097	4,036,490

H. RECOMMENDED FACILITY

The facility recommended for construction at the Port of Aqaba is the layout shown on Plan "E" with two pneumatic ship unloading gantries providing a peak offloading rate of 400 MT/Hour. This recommendation is based on the analysis of economic and financial benefits as presented in Section I-E. This section describes general advantages of the recommended facility; defines the general standards of design and construction which should be employed; and provides outline specifications for the major component parts.

1. GENERAL ADVANTAGES

a. Modern Grain Merchandising Methods. The recommended facility is designed to encourage a gradual change to the use of modern, efficient bulk grain handling and merchandising systems, within Jordan; while at the same time, meeting the immediate needs for improvement within the framework of current methods. The facility can receive many types and grades of grain and blend grain to specified grades. The ability to determine and control the quality of grain will be a major advantage to the milling and processing industry in the future. The ability to employ both means of transport available in the country for either bulk or bagged grain provides the maximum possible flexibility in grain movement.

b. Safety. Safety of personal and control of damage to the grain and the physical plant are of primary concern. The principal source of major loss in modern grain terminal operations is fire and/or

explosion. Even though the most modern methods and standards available will be employed to reduce the risk of fires and explosions, an element of risk is still present. The recommended facility provides an increased margin of safety due to its basic configuration. By holding the grain in relatively small lots in separate silos which are separated from the headhouse, the risk of the spread of fire and explosion is greatly reduced. In addition, the structures are open to the air to the greatest extent possible. This reduces the likelihood of an accumulation of dust, allows easy detection, provides a maximum amount of explosion venting and ready access.

c. Future Expansion

i Ship unloading facilities may be expanded in the future if conditions warrant by addition of either a bucket elevator type or an additional pneumatic type ship unloader.

ii The headhouse is arranged so that it can be expanded to the north to accomodate additional bucket elevators and other equipment. The headhouse is also laid out to allow installation of an additional scale and sampling system and grain cleaning systems without any major structural change.

iii Storage may be expanded simply by the addition of more bins to the south and extension of bin top and bin bottom conveyors.

2. GENERAL DESIGN SPECIFICATIONS

a. Local Codes. At this time, a Standard Building Code is being developed by the Arab Union of Engineers. The design and construction of the grain facility must conform to this code, if adopted in Jordan, as well as any other national and local codes or laws in effect at the time the program is implemented.

Truck Dock & Bag Storage	1,500 kg/M^2
Bag Conveyor Mezzanine	1,000 kg/M^2
Shop & Parts Storage Fl.	1,000 kg/M^2
Conveyor Bridge	400 kg/M^2
Office Area, Stairs & Landings	500 kg/M^2

ii. Grain

All storage bins, hoppers and horizontal storage structures shall be designed for wheat as the stored material:

W = 48 lbs./cu. ft. = 730 kg/M^3
Ø = 28° angle of repose

Bins and hoppers shall be designed in accordance with "Proposed ACI Standard" and "Commentary" on "Recommended Practice for Design and Construction of Concrete Bins, Silos, and Bunkers for Storing Granular Materials".

iii. Wind

UBC - Wind pressure Zone 30

Maximum (North) Wind	25 km/hr (rare)
Normal (North Wind)	7 to 10 km/hr

Occasional southerly winds reach gale force four or five times per year with a total annual duration of 15 to 20 days. (Subject to verification prior to final design.)

iv. Earthquake

UBC - Seismic Zone 3

v. Drainage

Annual Rainfall - Less than 20 mm
Maximum Rainfall Intensity - 34 mm/hr

vi. Temperature - Humidity

Max. Temperature - 46° C
Min. Temperature - 0° C (extremely rare)
12 to 72% relative humidity

vii. Sea Conditions

Low Tide 0 meters - Admiralty Datum Chart
High Tide 1.10 meters - Admiralty Datum Chart

Altitude 30 meters above sea level

The Gulf of Aqaba is generally calm, with storm conditions being produced only by southerly winds.

viii. Dust

Prevailing northerly winds cause a fine sand dust to be generally present in the air at all times. In addition, powdered phosphate is exhausted into the air from receiving and shiploading operations to the south of Berth 1.

ix. Bulk Handling Capacity

The design of all mechanical equipment shall be based on wheat at 48 lbs/cu.ft.

x. Electrical

Electrical Power Service will be 380 volt, 3 phase, 50 cycle.

xi. Mechanical Equipment Design

a) All equipment shall be designed to handle any whole stock including wheat, corn and soybeans..

b) The equipment shall not be designed to handle soft stock (soybean meal), rice for human consumption, feed pellets or other similar materials..

c) Spouting slope shall be a minimum of 8 vertical to 12 horizontal.

d) All sloping spouting shall be rectangular 12 gage steel with removable tops and shall be lined with 1/4 inch thick mild steel on bottoms and sides. All vertical spouting shall be round or square, similar to rectangular.

b. Foreign Codes. Codes, regulations and standards for the design and construction of grain facilities vary, to some extent, from one country to another. The Consultant is most familiar with those currently in force in the United States of America and, therefore, has based the preliminary design on the following,

i. Uniform Building Code (UBC)
ii. American Concrete Institute (ACI)
iii. American Institute of Steel Construction (AISC)
iv. National Fire Protection Association (NFPA)
v. National Electrical Code (NEC)
vi. Occupational Health and Safety Act (OSHA)

The design and construction of the grain facility at Aqaba should be based on these standards, or similar standards which may be in force in England or Europe. The consulting engineer charged with responsibility for design and construction supervision of the facility should recommend the applicable codes and standards to the client.

c. Specific Design Criteria. The consultant has reviewed local conditions and collected information from various sources relative to specific design criteria that would apply to the grain facility at Aqaba. The following criteria are recommended as the basis for the design of the Aqaba grain terminal:

i. Live Loads (in addition to equipment)

Roof Load	100 kg/M^2
Storage Bin Deck	500 kg/M^2
Headhouse Roof	500 kg/M^2
Headhouse Upper Floors	500 kg/M^2
Bagging Floor	1,000 kg/M^2
Headhouse Ground Floor	1,000 kg/M^2

e) Rubber liners shall be installed at all impact points and change of flow direction points.

f) Gates and valves shall be of "Rack and Pinion" or Pan Valve type.

g) Remote operated gates shall be powered by Compressed Air or Electric Motors.

h) Belt conveyor troughing idlers shall be 45° equal length offset type.

i) All conveying equipment(belt conveyors, chain conveyors, bucket elevator leg, etc.) shall be designed with a minimum capacity factor of 125% above the noted flow requirement.

j) All spouting shall be designed on a basis of 60 bushels per square inch of spout cross section area.

k) All motor horsepower ratings shall be designed with a minimum factor of 115% above maximum brake horsepower.

l) All power transmission components shall be based on motor horsepower for basic selection.

m) All speed reducers shall be designed for 24 hour service.

n) All roller chain drives shall be designed for a minimum service factor of 1.2 and multiple strand factor as may apply.

o) All V-belt drives shall be designed for a minimum service factor of 2.0 and a minimum of two belts.

3. OUTLINE SPECIFICATIONS

a. Dock

Design - By Consultant

Material Purchasing - By General Contractor

Construction - By General Contractor

New rails will be installed on the land-side to widen the gage and comply with the requirements of the new gantries and the load carrying capacity of the dock. In addition, the water-side rail may be replaced or modified, if required, to accommodate the gantry wheels and "hold down devices". Slots and/or openings will be cut in the dock to accommodate electrical cables. Preliminary analysis of the dock structure indicates that anticipated gantry loads can be accommodated by the existing structure if the gantry design and wheel spacing is controlled.

b. Ship Dischargers

Performance Specifications, General Arrangement and Design Approval, by Consultant

Purchasing by Client with Consultant's Assistance

Design, Fabrication and Erection by a Prequalified Supplier

The ship dischargers shall consist of two separate gantries, each equipped with two separate pneumatic systems. Each pneumatic system shall have a minimum peak conveying capacity of 100 MT per hour of wheat at 730 kg/M^3. Each pneumatic system shall be composed of a boom-supported suction pipe capable of unloading 30,000 ton vessels of either bulk carrier or tanker hull configuration.

A blower with motor, filter, receiver and air lock for discharge of the grain to the transfer conveyor.

Suitable attachments for ship clean-up. Each gantry shall be a complete operating unit with all necessary electrical equipment, dust control and noise suppression devices.

The discharge from both pneumatic systems on one gantry shall be directed to a drag-chain conveyor mounted on a power-operated boom. The drag chain conveyor shall discharge to a belt conveyor mounted near

the eave of Transit Shed No. 1. The transfer conveyor will be capable of being retracted vertically. Dust collection at the point of transfer between the transfer conveyor and the pick-up conveyor shall be a part of the gantry dust control system.

Each gantry will be self-propelled and mounted on railroad-type wheels. Each gantry shall be equipped with two 5 metric ton capacity power-operated booms suitable for unloading general cargo from ships when the gantries are not in use for grain.

No part of the gantry shall project more than 0.5 M beyond the center of the water-side rail when the booms are stowed.

c. Receiving Conveyor System

Design -- By Consultant

Mechanical Equipment, Structural Steel and Sheeting Purchasing, by Client with Consultant's Assistance

Construction -- By General Contractor

i. Pick-up Conveyor

The pick-up conveyor will be a covered belt conveyor supported on structural steel near the eave of Transit ShedNo. 1. It will be equipped to receive movable rail-mounted belt loaders attached to the transfer conveyor from the gantries. The structure will include a continuous walkway on the land-side of the conveyor connected with the harbor master's dock at the north end and a new support tower at the south end.

ii. Conveyors from Berth to Headhouse

An inclined belt conveyor system shall be installed to convey grain from the discharge of the pick-up conveyor to the receiving surge bin in the headhouse. Two conveyors in "series" are recommended in order to avoid one very long single belt and to allow a

change in alignment of the bridge. These belt conveyors will be enclosed by a half-round corrugated metal cover. The conveyor will be supported on a structural steel box-truss bridge. The box-truss bridge will be supported on structural steel towers and "A" frame bents. A continuous walkway will be provided adjacent to the conveyor. Stairs to grade will be installed in the tower located at the ship berth and the tower located near the power plant.

d. Headhouse

Design - By Consultant

Mechanical Equipment, Structural Steel, Reinforcing Steel and Sheathing Purchasing by the Client with the Consultant's Assistance

Construction - By General Contractor

The headhouse will be a tower structure located at the north end of the vertical grain storage. Its purpose is to house and support the principal bulk handling and bagging equipment.

1) Principal headhouse mechanical equipment is as follows:

i. Bucket Elevators

Two-belt-bucket elevators with individual drives mounted on the headhouse drive floor -- steel casing, full height.

ii. Sampler

Automatic spout-type, cross-cut sampler and sample divider; located so that the discharge of the divider will spout by gravity into the main grain stream ahead of the bulk weigher system. Sample system to be controlled from laboratory and samples to be delivered by gravity spout to the laboratory.

iii. Bulk Weigher System

Automatic load cell type. Bulk weigher system complete with upper garner, weigh hopper and lower garner. The upper garner and weigh hopper to be equipped with automatic discharge gates. System to be controlled and read from the grain terminal master control panel.

iv. Distributor

Electric powered rotary distributor of heavy-duty design to be operated from the grain terminal master control panel.

v. Diverter Valves

All headhouse diverter valves to be electric or compressed air-powered, controlled from the grain terminal master control panel.

vi. Magnet

Suspended-type electromagnet at discharge of receiving belt conveyor.

vii. Bulk Rail and Bulk Truck Loading

Loading spout from the surge bin will discharge into a "dead-box" equipped with a retractable loading spout and chain wheel-operated rack and pinion gate. Both will be operated from ground level at the rail bulk loading point.

viii. Bagging

The bagging system shall be composed of six separate bagging machines, each consisting of a bagging scale, sewing head and sewing belt. Each machine will be properly equipped for two-man operation and capable of producing five 100 kg bags of wheat per minute. All six bagging machines will discharge bagged grain to a belt conveyor system which will deliver the bags to the rail dock, truck dock, drive-through truck loading area or the bagged grain warehouse.

ix. Dump Pit

A dump pit will be provided to allow return of spilled grain to the system.

x. Future Cleaner

The headhouse shall be designed to accommodate future installation of a grain-cleaning system.

2) Headhouse Bins

i. Receiving Bins

2 Bins - 80 MT capacity, electric-powered rack and pinion gate at discharge with high, low and intermediate bin level detection.

ii. Bulk Rail Loading Surge Bins

2 Bins - 40 MT capacity, manual rack and pinion gate at discharge with manually operated pan valve for reject grain return and high and low bin level detection. One of the bins will be arranged to be used for either rail or truck loading.

iii. Bulk Truck Loading Surge Bin

1 Bin - 40 MT capacity manual rack and pinion gate at discharge with high bin level detection.

iv. Bagging Surge Bins

3 Bins - 80 MT capacity, electric-powered double rack and pinion gates at discharge controlled at bagging floor.

All headhouse bins to be bolted steel of heavy-duty design, 45° hopper bottom and sloping top.

3) The headhouse shall be structurally separate from the vertical storage unit. The basement and lower two stories shall be of cast-in-place, reinforced concrete frame and walls. The third story through the roof shall be structural steel frame with checkered plate

or expanded metal floors. The bucket elevator drive floor shall be cast-in-place, reinforced concrete on steel beams. The scale floor through drive floor shall be enclosed with metal or transite siding. The structure shall be designed to accommodate future expansion to the north.

The headhouse shall include a full height stair and 455 kg capacity caged personnel elevator operating between the ground level floor and the sampler floor.

e. Vertical Storage

Design - By Consultant

Mechanical Equipment, Structural Steel and Reinforcing Steel Purchasing by the Client with the Consultant's Assistance

Construction - By General Contractor in Association with Foreign Slipform Contractor

Slipform Design and Supply - By General Contractor and Slipform Contractor

The vertical grain storage units shall be a poured-in-place reinforced concrete structures constructed by the slipform method. The structures will be composed of individual circular "bins" approximately 10 meters in diameter and 36 meters high. Supported, conical steel hopper "bin bottoms" will be constructed within the bins so as to form a relatively open "basement" area for installation of reclaim belt conveyors and allow discharge of all of the grain stored within the bins by gravity. Bins shall be arranged in two parallel rows and will be equipped with two parallel reclaim belt conveyors. The bins will

discharge grain through manually operated rack and pinion gates to a belt conveyor.

Filling of the storage bins will be accomplished by two drag chain conveyors on the bin deck, equipped with manually operated rack and pinion gates. Each conveyor shall be arranged so that it can spout into one row of bins.

The bin deck shall be water-proofed with a suitable reflective type membrane roofing.

The unit will be equipped with suitable access to the interior of the bins, temperature detection system, fumigation system, venting and safety features including roof handrails and escape ladders.

f. Bag Storage and Truck Loading Building

Design - By Consultant

Mechanical Equipment, Structural Steel and Sheathing Purchasing by the Client with Consultant's Assistance

Construction - By General Contractor

The bag storage building shall be an open-sided, pre-engineered steel frame structure with steel panel roof. Chain link fence side walls shall be installed for security. The floor shall be a concrete slab on fill at truck loading dock height above outside grade. A concrete floor mezzanine will be constructed on the north end of the building to support the bag belt conveyor and to store empty bags. Chutes will be installed to discharge directly from the bag belt conveyor to trucks, or to first floor level for movement by pallets and forklift into storage.

g. Maintenance Shop and Office

Design - By Consultant

Mechanical Equipment, Structural Steel, Sheathing and Finish Materials Purchasing by the Client with Consultant's Assistance

Construction - By General Contractor

The shop building and office shall be a pre-engineered standard steel building with steel panel roofing and siding. The building shall be designed to serve three purposes: spare parts warehouse, maintenance shop and office. Office functions will include the general business office, the grain laboratory and the main control room. All of these office areas shall be heated and air conditioned. The maintenance shop shall be equipped with suitable tools and metal working equipment consistent with routine needs of the facility.

h. Truck Scale

Design - By Consultant

Mechanical Equipment Purchasing by the Client with Consultant's Assistance

Construction - By General Contractor

The truck scale will be a 3 by 18 meter platform, load cell or mechanical type scale. A scale office and truck control office will be located adjacent to the scale platform.

i. Dust Control

Performance Specifications, General Arrangement and Design Approval by Consultant

Purchasing by Client with Consultant's Assistance

Design and Fabrication by a Prequalified Supplier

Installation by General Contractor

The dust control system shall be a complete filter collection system designed according to current accepted practice and standards in the United States of America. All collected dust shall be returned to the grain stream.

j. Ancillary Features

i. Separate trucker and employee welfare facilities shall be provided.

ii. The grain facility will depend on the Port Authority Fire Department for primary fire protection. However, the grain facility will be equipped with suitable dry chemicals, hand-held fire extinguishers. If the Fire Department requires fire water distribution on the grain silo site, it will be provided by the Port Authority.

iii. The entire silo site will be protected by a security-type chain link fence for the full perimeter of the property line.

iv. The grain facility will provide and maintain only the roads which are within the boundaries of the silo site. These roads will be asphalt or concrete-paved.

v. Domestic water and sewage requirements for the grain facility are minimal, and it is assumed that these services can be provided by connection to the existing port system.

vi. All storm water drainage will be by surface grading for runoff to the northeast corner of the silo site.

k. Electrical

Design - By Consultant

Materials Purchasing by Client with the Assistance of the Consultant

Installation by a Sub-Contractor to the General Contractor

i. Power

The grain facility will have two transformer substations, one located on Berth 1 and the second located within the storage compound. It is anticipated that primary power will originate at the existing power station and will be distributed each way along the elevated receiving conveyor bridge to the substations. The connected load will be approximately 2,300 horsepower.

ii. Control

All major items of equipment will be controlled or monitored from a graphic control panel located in the control room. Specifically, all bulk conveying machinery, remote operated valves, distributors, headhouse bulk weigher and remote operated gates will be controlled from the graphic control panel. Specific equipment items which will be operated locally but will be monitored at the control panel include the ship unloading gantries, bagging system and bulk loading systems. All equipment will be electrically interlocked to provide added safety to the personnel and equipment.

iii. Lighting

All areas will be lighted as required to facilitate efficient and safe operation 24 hours a day.

iv. Communications

The grain facility will be equipped with a complete telephone system to provide efficient communications between all operating points. Public address systems and warning signal devices shall be installed in appropriate areas.

I. ORGANIZATION AND TRAINING PROGRAM

Training of operators is an important phase of any efficient silo operation. It is recommended that operating personnel be assigned to the consultant during the mechanical erection phase of the project to assist on inspection of the equipment. It is also recommended that specific operators be assigned to the contractor's crew during the erection of the pneumatic ship unloaders, truck scale, personnel elevator and temperature detection system which will all be installed under the direction of the supplier's technicians.

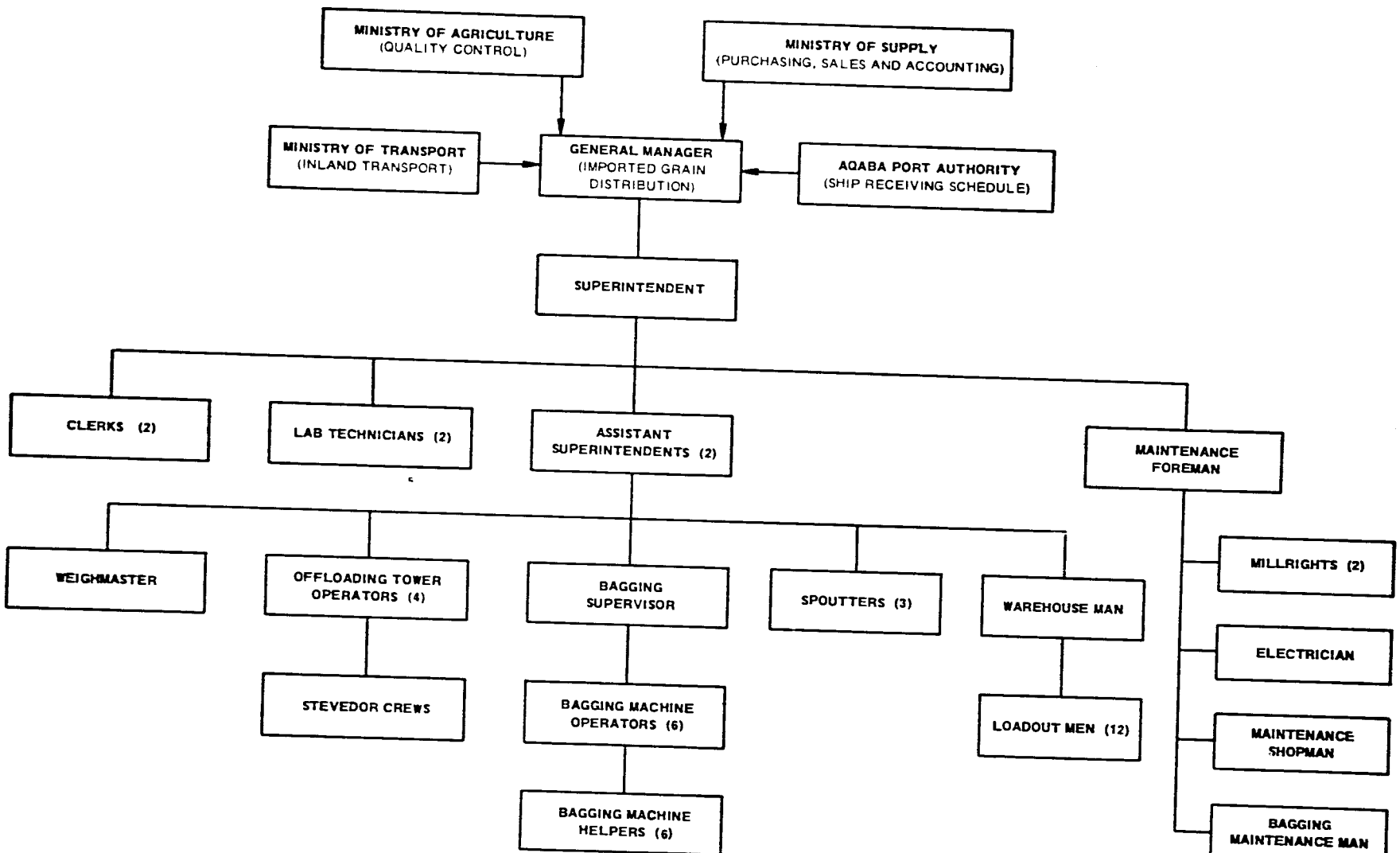
It is also suggested that selected operators visit a similar silo in one of Jordan's neighboring countries for a short period to observe operations, providing this can be arranged.

A recommended organization chart for the proposed Port of Aqaba Grain Terminal is shown as Figure 23.

AQABA GRAIN STORAGE FACILITY

PROPOSED OPERATING ORGANIZATION

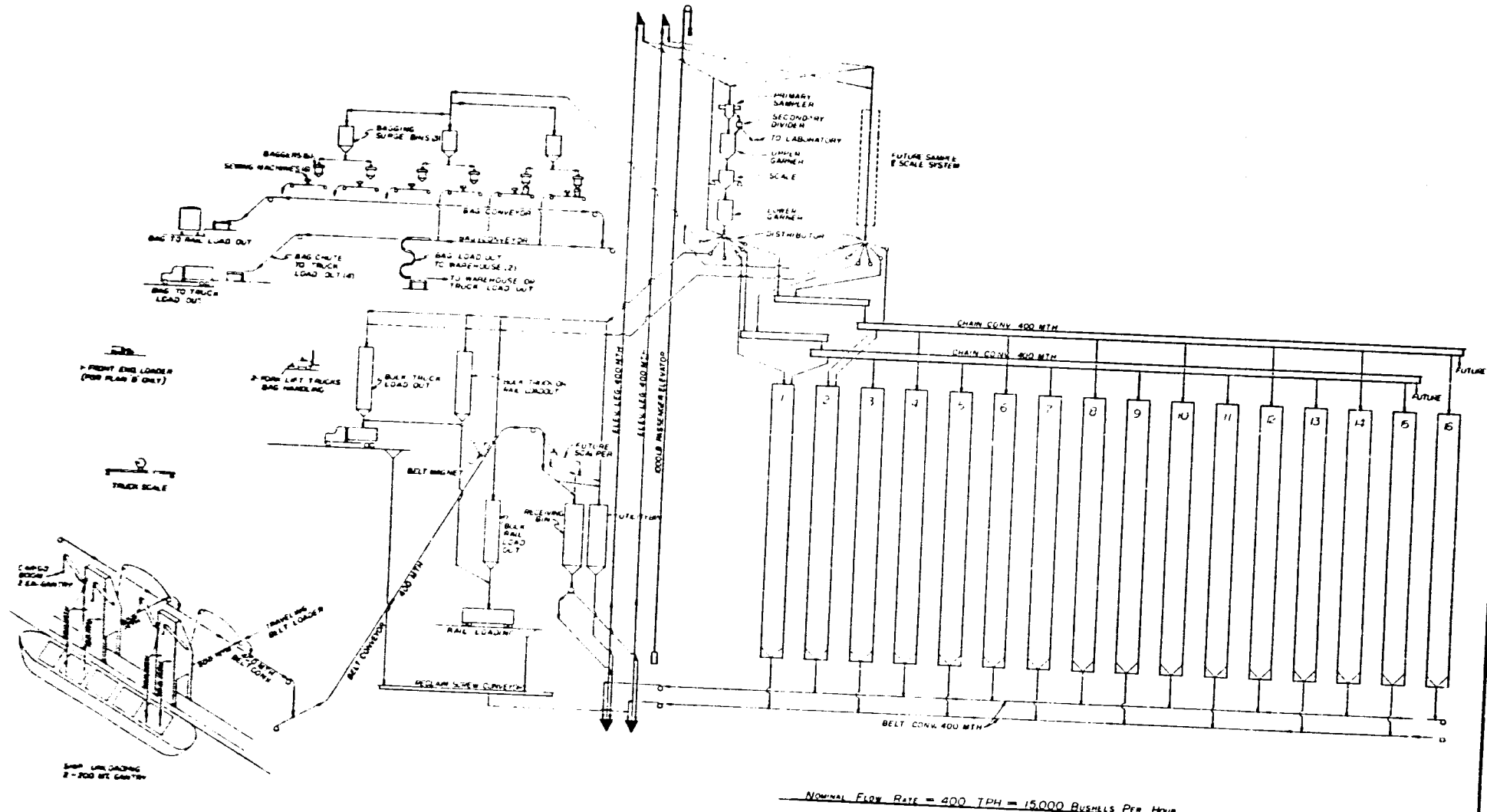
FIGURE 23

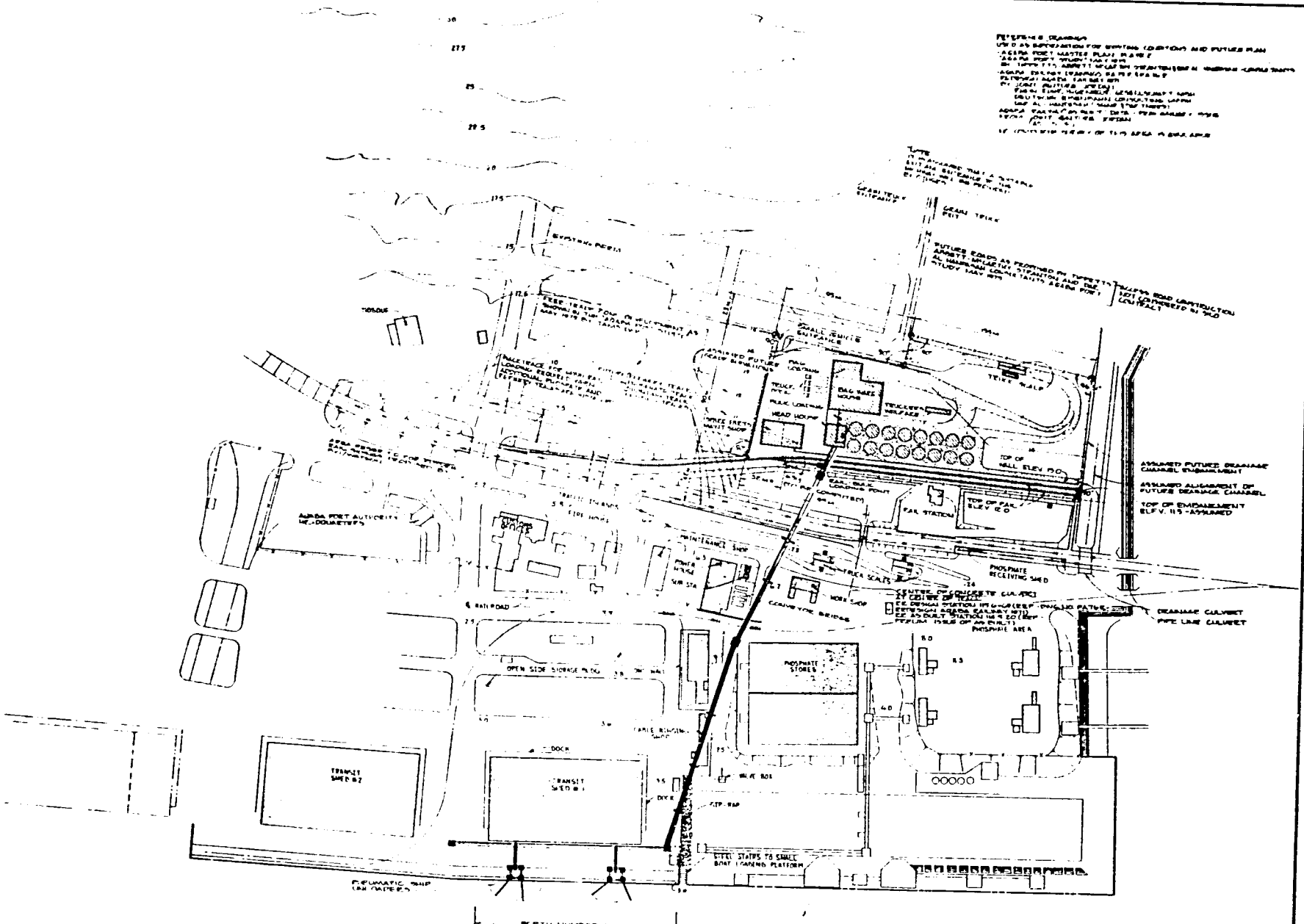


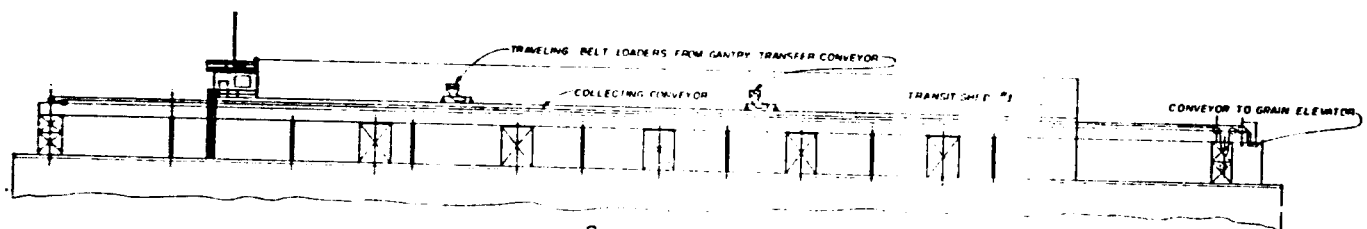
J. PRELIMINARY LAYOUT DRAWINGS

The preliminary drawings of the arrangements described earlier in this section are included. They are entitled as follows:

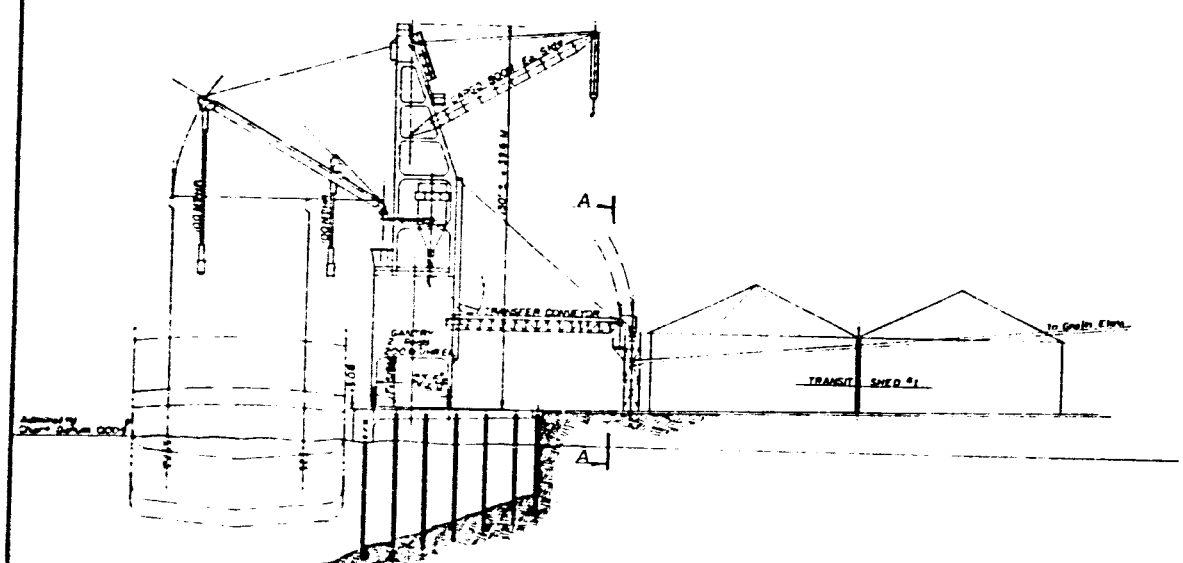
1. Flow Diagram 30,000 MT Silo - Plan "E"
2. Site Plan - "E"
3. Ship Unloading System
4. Site Survey - Receiving Area
5. Lower Bin Plan "E"
6. Typical Sections - Plan "E"
7. Silo Site Plans "A" thru "D" and Storage Transverse Sections


BAGGING SURGE BINS (3)
BAGGERS (8)
SEWING MACHINES (8)
BAG CONVEYOR
BAG TO RAIL LOAD OUT
BAG CHUTE TO TRUCK LOAD OUT (4)
BAG LOAD OUT TO WAREHOUSE (2)
TO WAREHOUSE OR TRUCK LOAD OUT
BAG TO TRUCK LOAD OUT
1 - FRONT END LOADER
2 - FORK LIFT TRUCKS BAG HANDLING
BULK TRUCK LOAD OUT
BULK TRUCK OR RAIL LOADOUT
TRUCK SCALE
BELT MAGNET
FUTURE SCALPER
RELIEVING BIN
BULK RAIL LOAD OUT
RAIL LOADING
REGULAR SCREW CONVEYOR
BELT CONVEYOR 400 MTH
TRAVELING BELT LOADER
BELT CONV.
SHIP UNLOADING 2 - 700 MT. GANTRY
ELEV. LEG 400 MTH
ELEV. LEG 400 MTH
COOLER RECEIVER ELEVATOR
PRIMARY SAMPLER
SECONDARY DIVIDER
TO LABORATORY
UPPER GARNER
SCALE
LOWER GARNER
DISTRIBUTOR
FUTURE SAMPLE & SCALE SYSTEM
CHAIN CONV. 400 MTH
CHAIN CONV. 400 MTH
FUTURE
FUTURE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
BELT CONV. 400 MTH
NOMINAL FLOW RATE = 400 TPH = 15,000 BUSHELS PER HOUR
SCALE
WATSON International, Inc.
BLACK & VEATCH INTERNATIONAL
ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX
FLOW DIAGRAM
30000 MT SILO
PORT OF AQABA
HASHEMITE KINGDOM OF JORDAN
1


GRAIN PIT
GRAIN TRUCK
TRUCK RAMP
BAG MATE HOUSE
HEAD HOUSE
TOP OF MILL ELEV 15.0
RAIL STATION
TOP OF RAIL ELEV 6.0
PHOSPHATE RECEIVING SHED
TRUCK SCALES
MAINTENANCE SHOP
POWER HOUSE
SUB STA
RAILROAD
OPEN SIDE STORAGE BLDG
PHOSPHATE STORES
PHOSPHATE AREA
DOCK
TRANSIT SHED #2
TRANSIT SHED #1
VALVE BOX
PIPE RAMP
STEEL STAIRS TO SHACK BOAT LOADING PLATFORM
PNEUMATIC RAMP (ON WHEELS)
ASSUMED FUTURE DRAINAGE CHANNEL ENGINEMENT
ASSUMED ALIGNMENT OF FUTURE DRAINAGE CHANNEL
TOP OF EMBANKMENT ELEV. 11.5 - ASSUMED
DRAINAGE CULVERT
PIPE LINE CULVERT
WATSON International, Inc.
CONSULTING ENGINEERS
OVERLAND PARK, KANSAS
BLACK & VEATCH INTERNATIONAL
ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX
SITE PLAN - E
PORT OF AQABA
HASHEMITE KINGDOM OF JORDAN
2

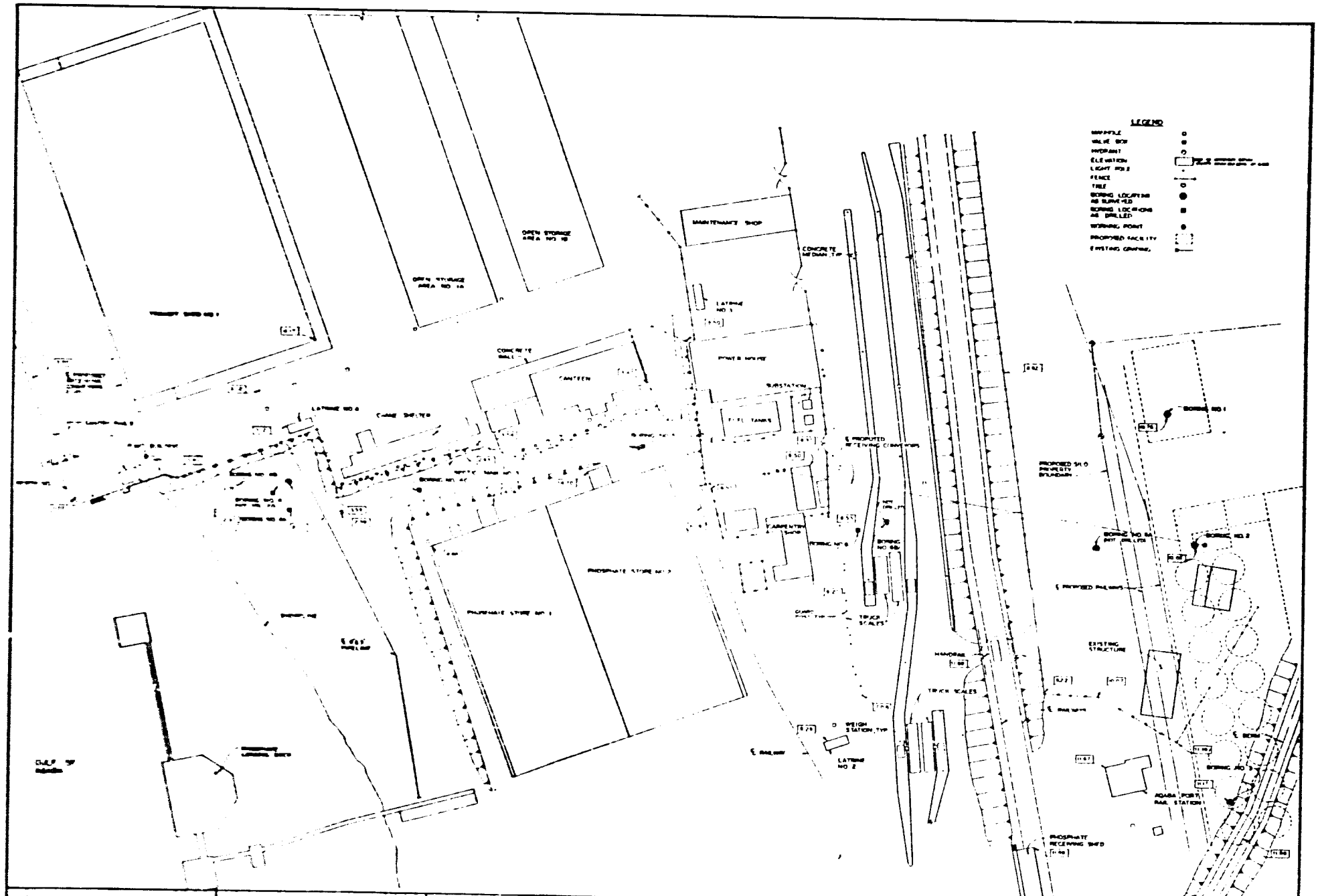


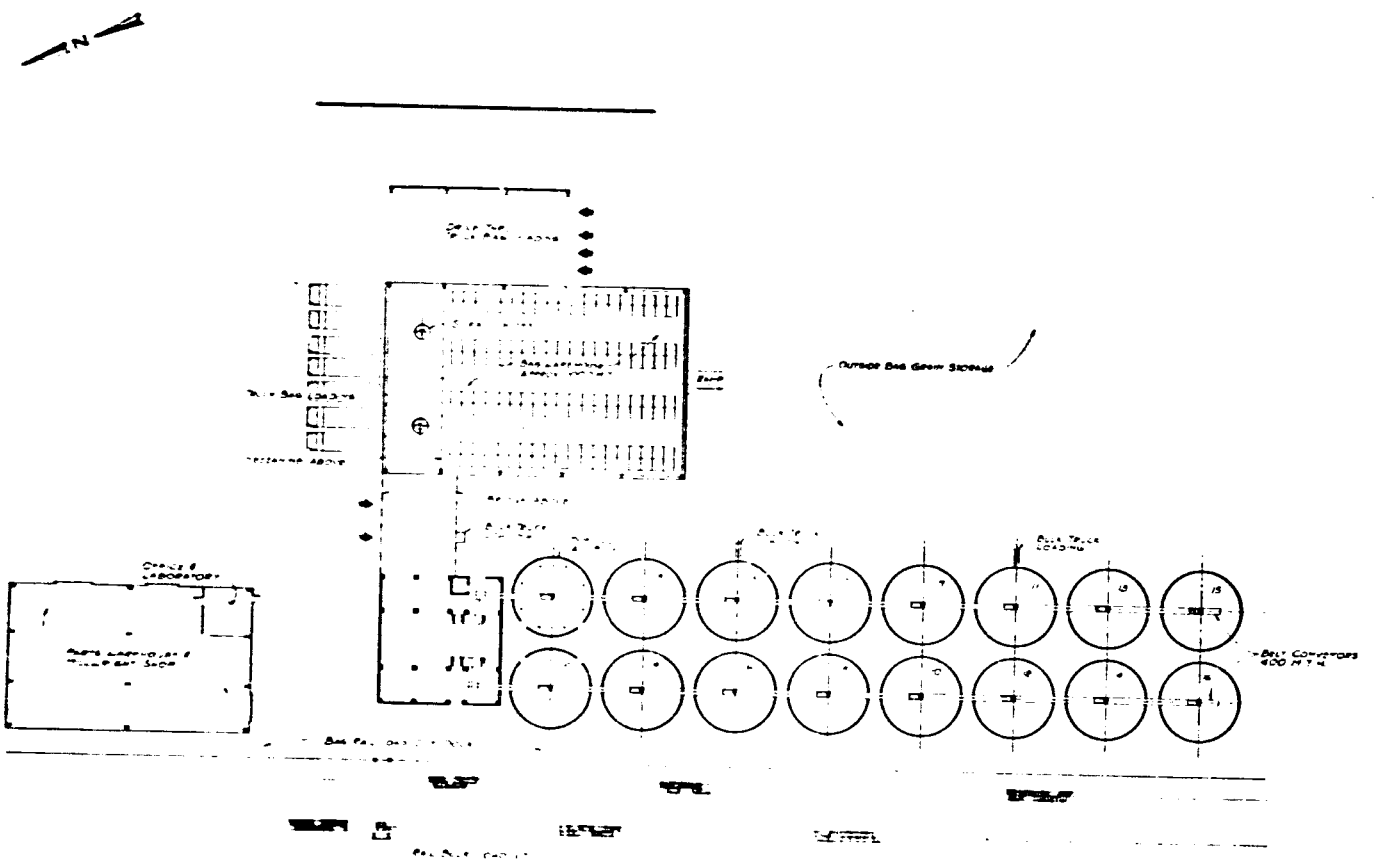
SECTION "A-A"
1:20 0"



ELEVATION THRU DOCK

		SCALE AS NOTED	WATSON International, Inc.	BLACK & VEATCH INTERNATIONAL	ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX	SHIP UNLOADING SYSTEM PORT OF AQABA HASHEMITE KINGDOM OF JORDAN	3


LEGEND
MAINTENANCE SHOP
OPEN STORAGE AREA NO 1A
OPEN STORAGE AREA NO 1B
CONCRETE MEDIAN TYP
LATRINE NO 1
CONCRETE WALL
CANTEEN
CARE SHELTER
SUBSTATION
FUEL TANKS
PROPOSED RETENTION STRUCTURE
CARPENTER SHOP
PHOSPHATE STORE NO 2
PHOSPHATE STORE NO 1
TRUCK SCALES
WEIGH STATION TYP
LATRINE NO 2
HANDRAIL
TRUCK SCALES
PROPOSED SILO PROPERTY BOUNDARY
BORING NO 1
BORING NO 2
PROPOSED RAILWAYS
EXISTING STRUCTURE
AQABA PORT RAIL STATION
PHOSPHATE RECEIVING SHED
GULF OF AQABA
BLACK & VEATCH INTERNATIONAL
ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX
SITE SURVEY RECEIVING AREA PORT OF AQABA HASHEMITE KINGDOM OF JORDAN
4



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CONSULTING ENGINEERS
OVERLAND PARK, KANSAS

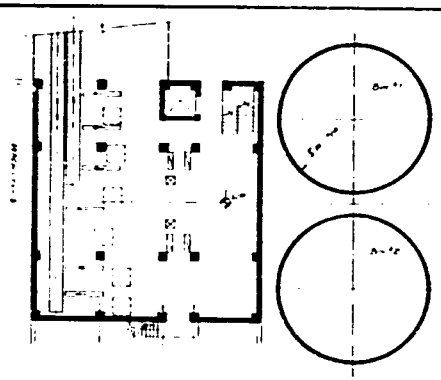
BLACK & VEATCH INTERNATIONAL
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX

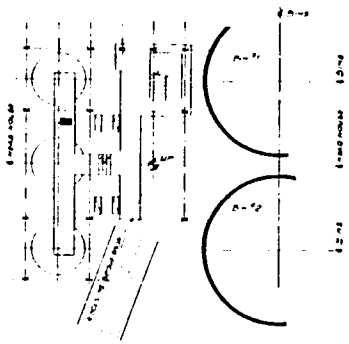
LOWER BIN PLAN "E"
PORT OF AQABA
HASHEMITE KINGDOM OF JORDAN

1010

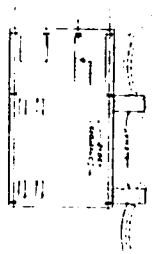
5



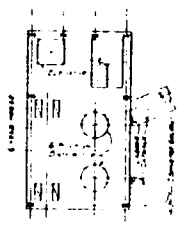
BAGGING FLOOR



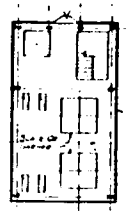
LOADOUT BIN DECK



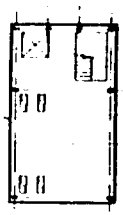
BIN DECK FLOOR



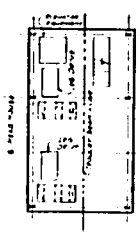
DISTRIBUTOR FLOOR



UPPER GARNER FLOOR
SCALE FLOOR
LOWER GARNER FLOOR

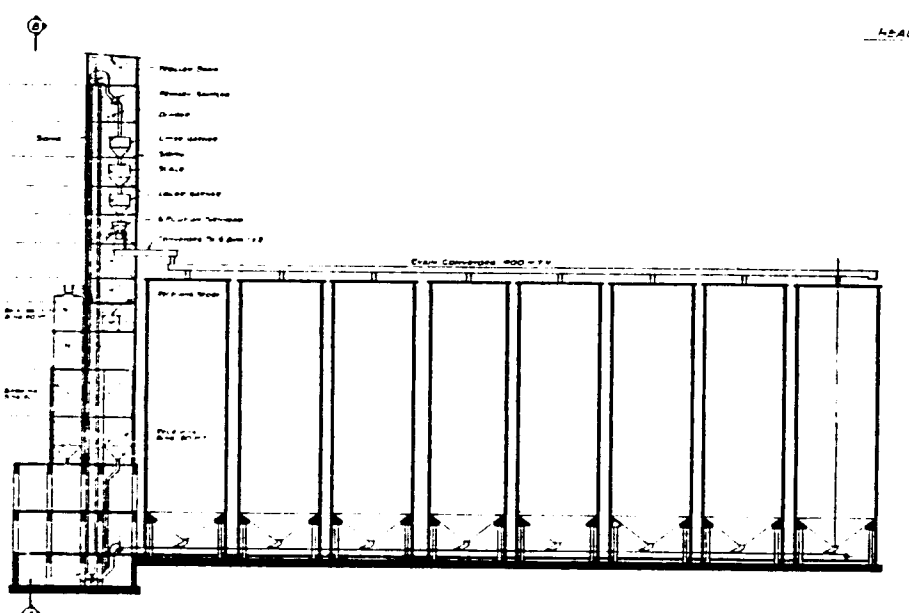


SAMPLER FLOOR

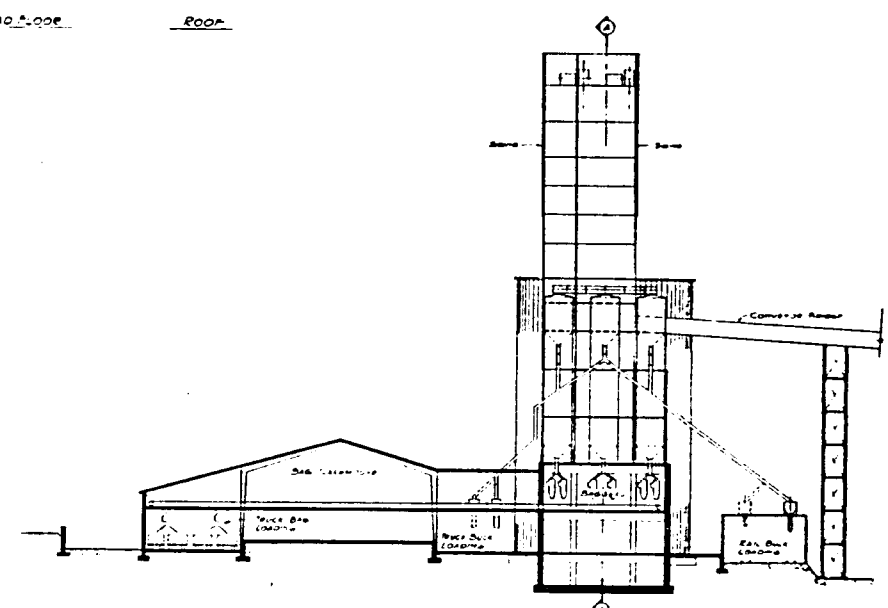


HEAD FLOOR

ROOF

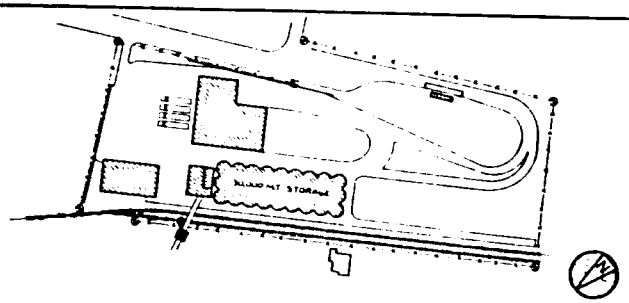


SECTION A-A
1"=20'

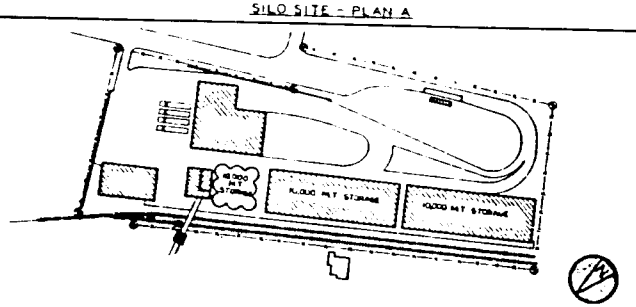


SECTION B-B
1"=20'

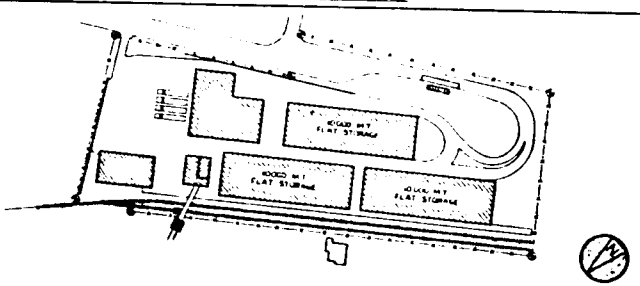
SCALE: 1/32"=1'-0" UNLESS OTHERWISE NOTED	WATSON International, Inc. CONSULTING ENGINEERS OVERLAND PARK, KANSAS		BLACK & VEATCH INTERNATIONAL CONSULTING ENGINEERS	ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX	TYPICAL SECTIONS PLAN "E" PORT OF AQABA HASHEMITE KINGDOM OF JORDAN	TOVO 6



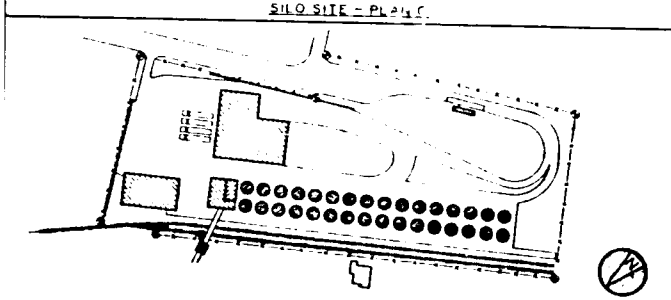
SILO SITE - PLAN A



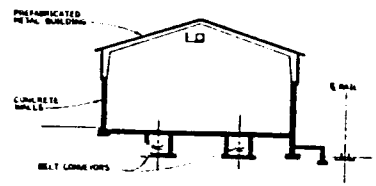
SILO SITE - PLAN B



SILO SITE - PLAN C

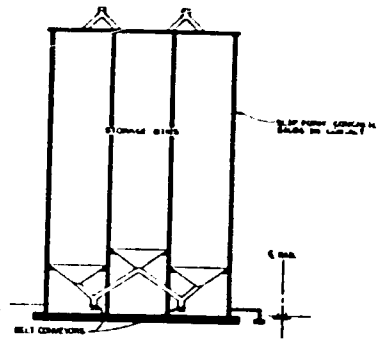


SILO SITE - PLAN D



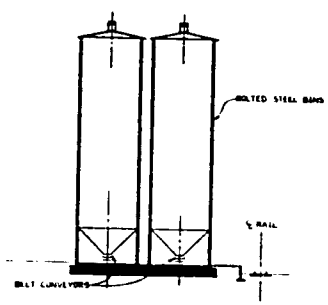
TRANSVERSE SECTION - HORIZONTAL STORAGE

PLANS "B" & "C"



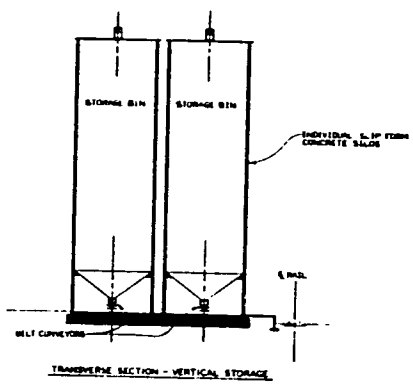
TRANSVERSE SECTION - VERTICAL STORAGE

PLANS "A" & "B"



TRANSVERSE SECTION - VERTICAL STORAGE

PLAN "D"



TRANSVERSE SECTION - VERTICAL STORAGE

PLAN "E"

SCALE	BLACK & VEATCH INTERNATIONAL	ECONOMIC FEASIBILITY & PRELIMINARY ENGINEERING STUDY FOR PROPOSED GRAIN STORAGE COMPLEX	SILO SITE PLANS A - D & STORAGE TRANSVERSE SECTIONS PORT OF AQABA HASHEMITE KINGDOM OF JORDAN	7918	7

APPENDIX I

APPENDIX I

RENOVATION AND EQUIPPING OF METAL SILOS

IRBID JORDAN

A - GENERAL

The Consultant has visited the grain storage facility at Irbid and has surveyed 10 metal silos which are only partially erected and not in use for grain storage. In addition, the Consultant has reviewed a report entitled "A Proposal to Equip Metal Silos in Jordan with Aeration and Temperature Monitoring Equipment" prepared by the Food & Feed Grain Institute, Kansas State University, Manhattan, Kansas, in August 1968. It is apparent that these silos have never been used due to certain operational as well as structural problems.

B - OPERATIONAL PROBLEMS

The Kansas State University report indicates that grain stored in silos of the same type at Ruseifa was lost as a result of deterioration. Furthermore, there is at present, no efficient means of handling grain into or out of the silos.

C - STRUCTURAL PROBLEMS

According to reports received by the Consultant, the roof structures as originally constructed were not adequate and failed due to winds.

D - CURRENT CONDITION

At present the silos are in poor condition and not suitable for use. Only one silo has the roof in place and all silos have small holes in

the side walls. Some additional roof material is on the site but is in poor condition.

E - RENOVATION AND EQUIPPING

The new equipment and renovation work necessary to place the silos in operation is shown on Drawings A1, A2 and A3. The operating procedures and necessary testing equipment are specified in the Kansas State University Report.

F - COST ESTIMATE

The estimate of cost to carry out the renovation work and purchase the necessary equipment to place all 10 silos in operation is as follows:

	JD	US$
Structural Repair	5,352	
Equipment	1,350	14,910
Contractor's Overhead & Profit	3,251	7,230
Engineering Cost	500	2,500
Total Costs	10,453	24,640

Total Cost JD18,153

G - RECOMMENDATIONS

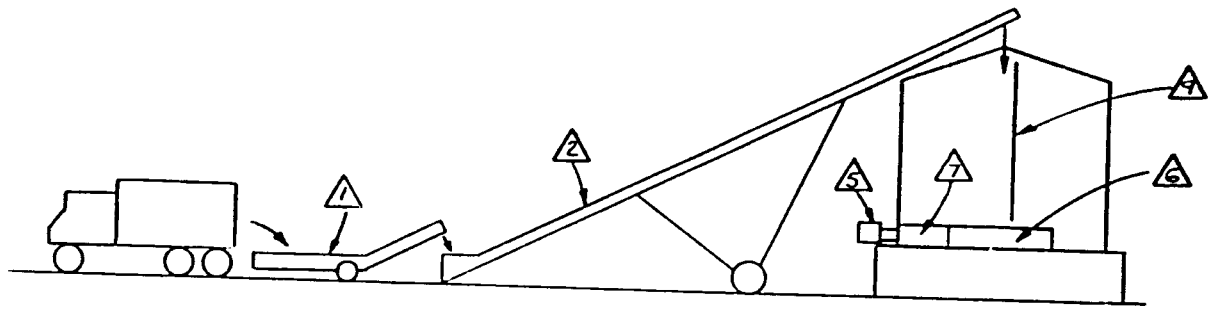
The Consultant recommends that the test as specified in the Kansas State University report be carried out by modifying one or two silos. If the test is successful, the balance of the silos should be renovated, equipped, and placed in operation. Supervision of the test, detailed design of the renovation work and detailed equipment selection, should be

carried by the Consultant employed to implement the Port of Aqaba Grain Terminal program, in order to keep engineering costs to a minimum.

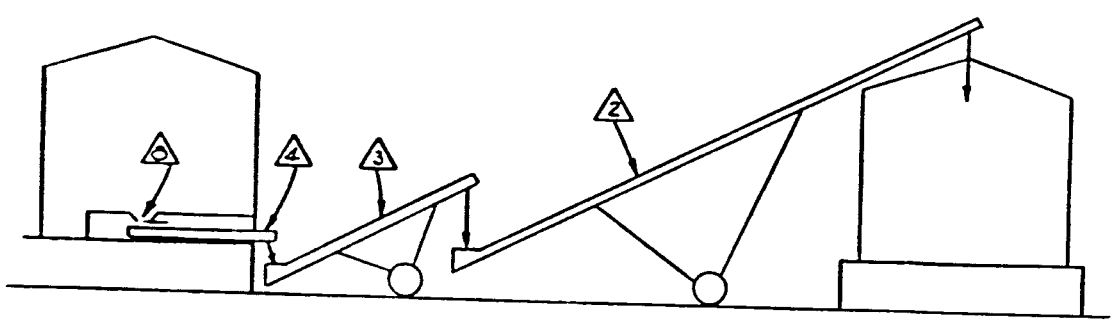
H - BENEFITS

By placing these silos in operation, 1000 MT of bulk grain storage would be available for an approximate capital cost of JD 18.153 per metric ton. In addition, this facility would provide a facility for training in bulk grain storage management and introduce an inexpensive type of bulk grain storage into Jordan.

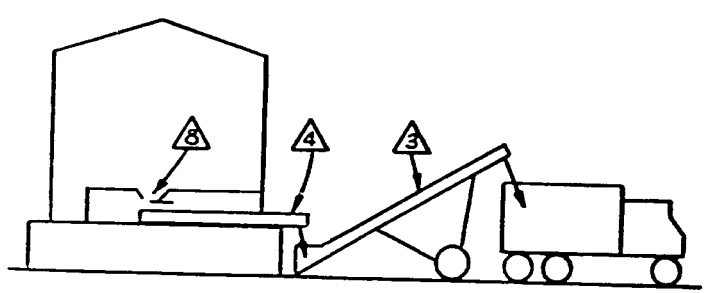
1. TRUCK AND CAR UNLOADER - PORTABLE
2. INCLINED SCREW CONVEYOR - PORTABLE
3. INCLINED SCREW CONVEYOR - PORTABLE
4. BIN UNLOADING SCREW CONVEYOR - PORTABLE
5. AERATION FAN - PORTABLE
6. PERFORATED AERATION DUCT
7. SOLID DUCT
8. SLIDE GATE
9. TEMPERATURE DETECTION SYSTEM



BIN LOADING OPERATION



BIN TRANSFER OPERATION



BULK TRUCK LOADING OPERATION

NO.	DATE	REVISIONS	DWN	CK	ACC	APP

15-8014-12-015

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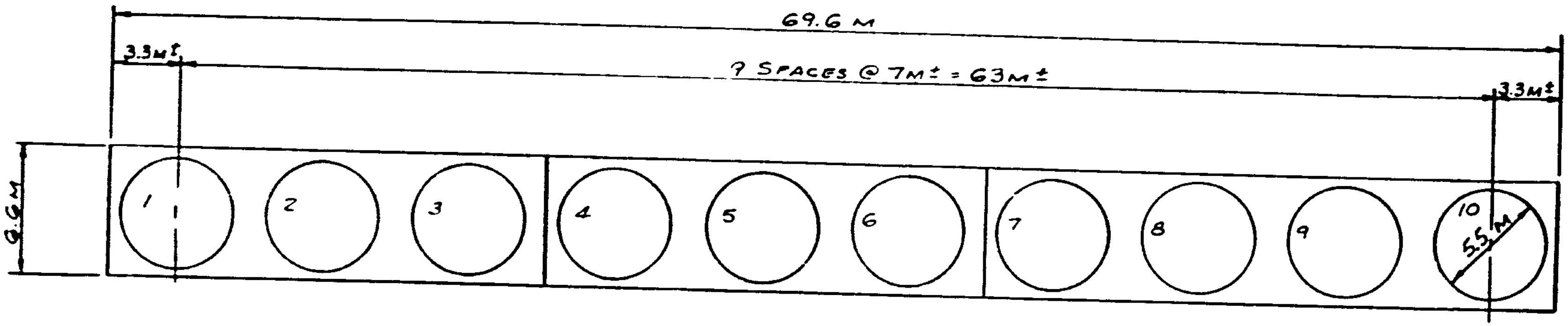
OVERLAND PARK, KANSAS

BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT 7010

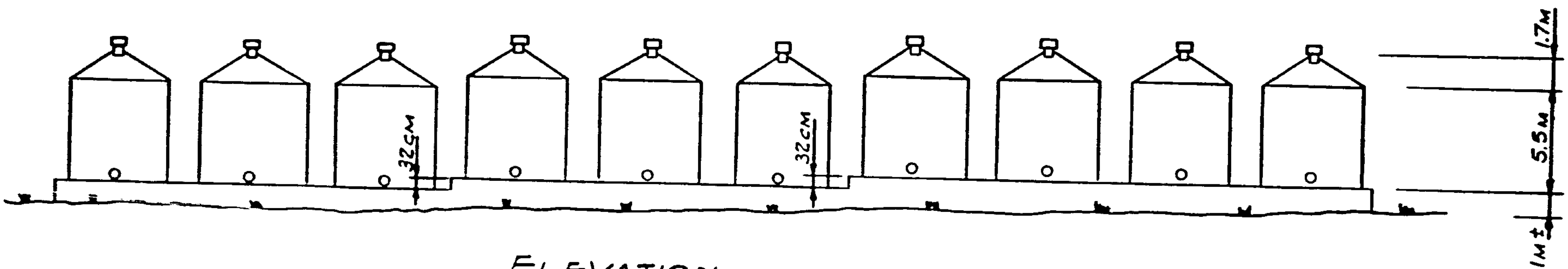
FLOW DIAGRAMS

RENOVATION & EQUIPPING OF METAL SILOS - IRBID, JORDAN

A1



PLAN
1:250



ELEVATION
1:250

DATE	REVISIONS	DWN	CK	ACC	APP

75-0014-17-015

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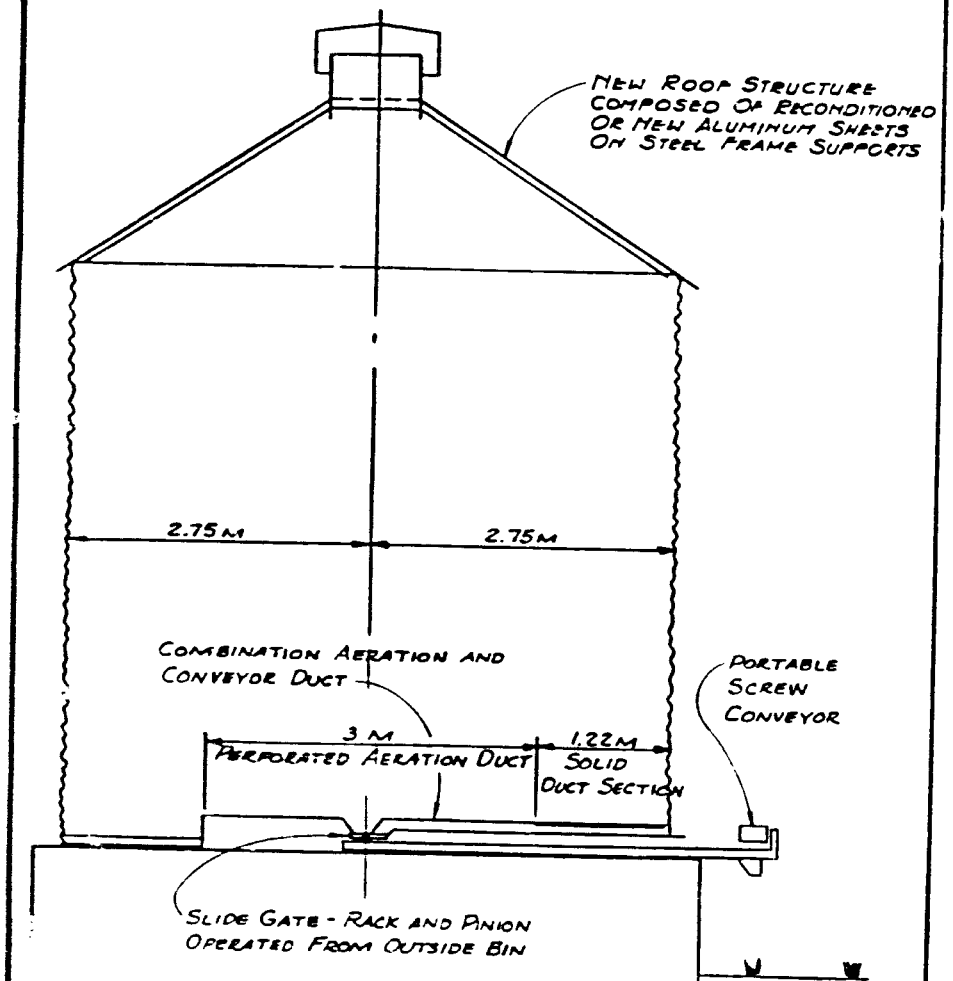
PROJECT 7010

PLAN AND ELEVATION

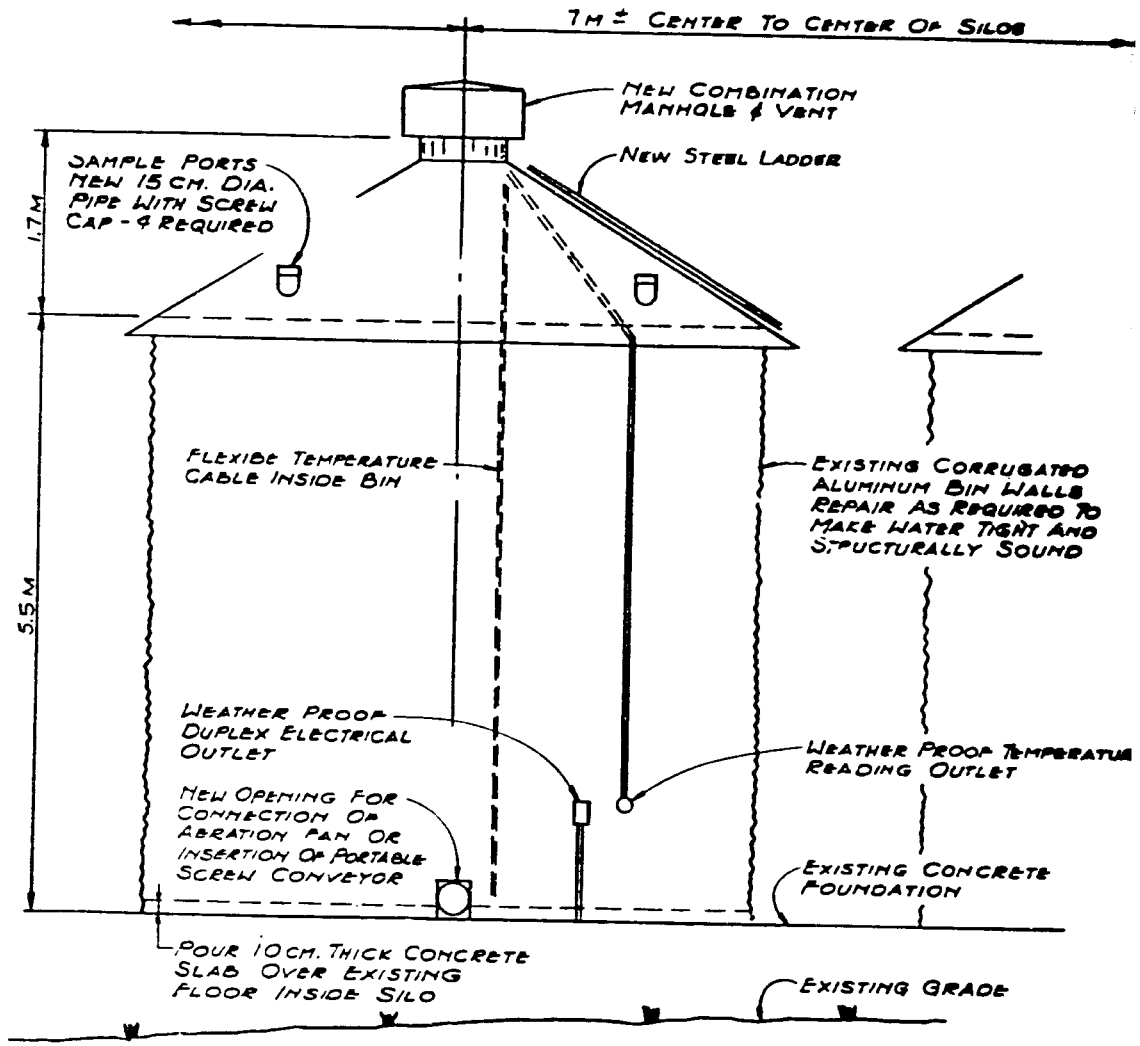
RENOVATION & EQUIPPING OF METAL SILOS - IRBID, JORDAN

A2



Section A-A

Scale 1:50



Typical Elevation

Scale 1:50

No.	Date	Revisions	Dwn	Ck	Acc	App

15-8014-11-015

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Elevation and Section

Renovation & Equipping Of Metal Silos - Irbid, Jordan

A3