PD AAR-844

JACOBS INTERNATIONAL INC.

LOM-41463

FINAL FEASIBILITY REPORT

ARAB POTASH PROJECT

EXECUTIVE SUMMARY

Jacobs International Inc.
Pasadena, California, U.S.A.

Sir Alexander Gibb & Partners
Reading, England

Technical Services Office
Amman, Jordan

December 1977

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GLOSSARY

AGP	Sir Alexander Gibb and Partners, civil engineering consultants to Jacobs International Inc.
APC	The Arab Potash Company Ltd.
Aqaba	Mediterranean port from which APC potash will be shipped.
Carnallite	Double salt of potassium and magnesium ($MgCl_2 \cdot KCl \cdot 6H_2O$). This is the form in which potassium values will be harvested from the solar evaporation system and fed to the process plant for conversion to potassium chloride (KCl).
c. i. f.	"cost, insurance, and freight." Used to designate a price delivered to the buyer's port, with seller having responsibility for transportation, losses in transit, etc.
Civil Works	Used in this study to designate access roads, the solar evaporation system, and the town for housing construction and operating personnel.
Economic Analysis	Analysis of project economics from the viewpoint of the overall Jordanian economy, including APC and the Government of Jordan. It excludes taxes and other transfer payments from costs, includes at full economic value any subsidies or services provided at less than economic prices, and expresses monetary values in constant 1977 world currency values.
Economic Rate of Return	A discounted cash flow rate of return on total investment (100% equity basis), based on the revenues and costs developed in the economic analysis.

Expatriate	Personnel hired outside of and imported into Jordan.
Financial Analysis	Analysis of project cash flows from the viewpoint of the Arab Potash Company, its investors, and its lenders. It includes all revenue and cost flows actually incurred, including taxes, subsidies, inflation, and any projected temporary price distortions.
Financial Rate of Return	Discounted cash flow rate of return based on actual projected cash flows including escalation. The financial rate of return on total investment assumes 100% equity ownership; the financial return on equity includes the effects of debt leverage.
f. o. b.	"free on board." Used to designate a price delivered aboard ship at seller's port, with buyer taking responsibility for further transportation, losses in transit, etc.
H.V.A.C.	Engineering term designating heating, ventilating and air conditioning.
JEC	Jacobs Engineering Co. , a division of Jacobs Engineering Group Inc.
JII	Jacobs International Inc. , a division of Jacobs Engineering Co.
KCl	Potassium chloride, the most commonly used form of "potash," a term used to refer to several potassium-containing chemicals used primarily for fertilizers.
KEG	A European association of potash producers who cooperate in matters affecting market share, price, etc.
$KMgSO_4$	Potassium magnesium sulfate, one of the non-chloride types of potash. Less expensive and contains less potassium than potassium sulfate.

K_2SO_4	Potassium sulfate, the primary non-chloride form of potash. More expensive and much less extensively used than potassium chloride (Muriate).
K_2O	Potassium oxide. Used as a common reference for expressing the potassium content of various potassium containing chemicals.
KWH	Kilowatt hour, a measure of electrical energy
Lisan	A peninsula on the east coast and near the south end of the Dead Sea, at which point the width of the Sea narrows to 4 kilometers. The solar evaporation system will be located just south of the Lisan.
Local	A term referring to personnel or goods native to or hired in Jordan.
Local-in-Training	A local worker who is acting as a counterpart or understudy during his training period. He is not yet covering a job position and therefore represents an 'extra' employee beyond normal staffing requirements.
MM	Used to represent "million."
MW	Megawatt, a unit of electrical power.
Muriate	Chloride. Commonly refers to the potassium chloride form of potash.
Pans	A term referring to the shallow ponds utilized for solar evaporation.
Potash	A generic term referring to potassium-bearing chemicals, most often applied to potassium chloride and potassium sulfate.
Precarnallite	Refers to brine or ponds in the evaporation stage just preceding the point of carnallite deposition. Up to this point, the salt crystallizing out of the brine has been sodium chloride.

Process Plant	The facilities utilized to produce marketable potash from the carnallite harvested from the solar evaporation system. To be located about 2 kilometers north of the eastern end of the solar evaporation system.
Safi	Town about 7 kilometers southeast of the process plant, forming one end of the Safi-Aqaba highway.
Tonne	Metric ton.

OVERVIEW

We have completed for The Arab Potash Company Ltd., after two years of study, our final feasibility report on a project to produce 1,200,000 metric tons per year of potash from Dead Sea brine This executive summary highlights the important results of that study. The main report presents complete field work results and a thorough analysis of the technical, marketing and economic aspects of the project.

Our financial and economic analysis indicates that this venture will provide an attractive rate of return. The financial rate of return for the project varies from 17.8 percent on total investment (100% equity basis) to 22.6 percent on equity if the project were 60 percent debt-financed at 7 percent interest. The economic rate of return, which considers the benefits of the project to the overall Jordanian economy by discounting the effects of inflation, subsidies, taxes, and temporary price distortions, is 11.9 percent.

The project has excellent resistance to potential variations in price, production volume, costs, and schedule. At the projected 1985 sales price of $80 per metric ton f.o.b. Aqaba (1977 dollars), it could meet its financial commitments when operating at 50% of capacity. This insensitivity to negative factors, combined with the attractive rate of return and a very strong competitive posture, makes this an excellent financial venture.

The project is technically sound. The solar evaporation and refining systems are well understood and are very similar to those being successfully employed at the Dead Sea Works Limited.

Construction will be complete by mid-1982, and the first product will become available in late 1982, with rated production of 1.2 million metric tons per year in early 1985.

The capital cost of the Arab Potash project is $275,000,000 on a 1977 cost basis. During the engineering and construction period, the cost will escalate by $49,000,000, giving a total fixed capital cost of $324,000,000. This does not include pre-startup costs, interest during construction, working capital, or modifications after startup. About 20% of the total fixed capital would be local costs.

The total amount to be financed is as follows:

Original Fixed Capital	$324,364,000
Post-Startup Modifications	4,708,000
Working Capital	31,874,000
Preoperating and Startup	22,355,000
Interest Through Startup Year	35,112,000
TOTAL AMOUNT TO BE FINANCED - ESCALATED	$418,413,000
ROUNDED TO	$420,000,000

I for 1,200,000 Tons

The total of $420,000,000 includes escalation, beyond 1977 costs, of $64,000,000 ($49,000,000 on fixed capital and $15,000,000 on other costs). The total also includes $35,000,000 of interest accruing before loan capitalization.

The total cash cost of product delivered to the port is tabulated below.

SUMMARY OF TOTAL CASH COST PER METRIC TON

F.O.B. VESSEL, AQABA
$U.S./METRIC TON

	1.2 Million Metric Tons/Year KCl	
	1977 Cost Level	1982 Cost Level
Plant Production Cost	13.21	19.79
Trucking to Aqaba	3.04	4.66
Storage, Handling & Loadout	2.15	2.53
APC Head Office Costs	1.00	1.42
TOTAL COST	19.40	28.40

World demand for potash is expected to increase at an annual rate of 4.5% over the next 10 years and reach 45 MM metric tons K_2O (75 MM metric tons KCl) by 1990. At that time, world capacity is projected to reach 40.2 MM metric tons as K_2O (67 MM metric tons KCl), based upon known reserves and defined expansions, excluding this project. This leaves a production shortfall of 8 million metric tons of KCl for Arab Potash and presently undefined projects to supply.

In 1985, the capacity of the proposed Arab Potash project will comprise about 2 percent of total world demand and about 17 percent of the Indo-Asian market where most of its product is expected to be sold.

Market analysis shows that the Indo-Asian market will easily absorb the full output of the Arab Potash facility and that a $5 per ton ocean freight advantage over Canadian potash will permit high netbacks in this region. Therefore, this is a primary market target for Arab Potash. However, the project's low costs delivered aboard ship at Aqaba will let it compete with Canada for export markets anywhere in the world.

Canadian potash will be the main competitor to Arab Potash in the Indo-Asian region. Using 1977 currency values, we have projected that prices for Canadian potash f.o.b. Vancouver will be $75 by 1985. Because the Arab Potash product will have a $5 per metric ton ocean freight advantage over Canada in the Indo-Asian market, the f.o.b. Aqaba netback would be $80 per metric ton for competitive delivered prices.

The outstanding competitive feature of the Arab Potash project is its ability to deliver potash aboard ship at a cash cost, excluding depreciation and debt service, of $18 per metric ton of potassium chloride, expressed in 1977 dollars. This is $15 per ton below the cost of Canadian product loaded aboard ship at Vancouver, which will permit APC to compete with Canada for essentially any export market. This cost advantage will increase with inflation.

Sensitivity analysis indicates that product price and production volume are the most important variables, followed by capital investment; production and delivery costs, and year of completion. However, this project is fortunately not very sensitive to any of these variables.

Our conclusions and recommendations, based on this final feasibility study, are as follows:

(1) The project is technically sound and there are no significant problems associated with the engineering or design. The evaporation system has great flexibility from an operational point of view, and the processing facilities use techniques presently in common usage in commercial operation.

(2) Our analysis of markets indicates that the entire output of the plant could be marketed in the Indo-Asian sphere where the Arab Potash product would enjoy an ocean freight advantage of $5 per ton over Canadian potash. We also estimate that Jordanian potash will maintain a cost advantage over Canadian potash of approximately $15 per ton loaded aboard ship, which will permit it to compete with Canada in essentially any export market served by water transportation. This will put APC into an extremely strong defensive position in the event of price competition caused by any temporary oversupply.

(3) The project is financially sound, with an attractive 17.8% financial rate of return on total investment. The 1.2 million metric ton per year installation has a total capital involvement of $420,000,000, based on fully escalated costs. The capacity is expandable with a modest increase in capital, and simulation studies indicate that the ultimate capacity of the scheme will be on the order of 1.7 million metric tons per year of potassium chloride. At such a capacity, the project would show substantially more attractive returns.

(4) The Jordanian balance of trade will be sharply improved by this project. Once it is in full operation, it will generate annual export sales of $96,000,000 expressed in 1977 dollars. This will be offset by annual imports of approximately $12,000,000 to give an overall increase of $84,000,000 per year. include FEX loan (pri) ?

In our financial analysis, we have presented a conservative projection of the likely economic conditions of capital cost, selling price, operating costs, etc., which will determine the rate of return on investment. We have studied the effect of wide variations in these factors and found that the project is quite insensitive to them. On the basis of these findings, we conclude that the project is viable.

In order to realize the benefits of this project as soon and as fully as possible, we recommend that APC proceed now to implement the following:

a) Develop firm financing plan.

b) Prepare and implement a marketing plan.

c) Assign APC staff to supervise and coordinate engineering activities at the offices of the consultant.

d) Proceed with Phase II procurement and construction in accordance with the overall project schedule.

e) Finalize the contract operating agreement.

In addition to the above activities, it is essential that the Government of Jordan provide storage and loading facilities at Aqaba, satisfactory road completions and land concessions, and power availability from the Jordanian Electrical Authority, in accordance with the project schedule.

Are these in project economic calculation?

INTRODUCTION

Commercial recovery of potash from the Dead Sea was first considered in the early 1920's. Initial potash recovery from the Sea by solar evaporation was started in 1930 by Palestine Potash Ltd., reaching 110,000 metric tons per year of low grade potash (50% K_2O) in facilities at both the north and south ends of the Sea by the late 1930's. Those facilities also recovered approximately 1,000 metric tons per year of bromine.

In 1948, the north end facilities were destroyed, and the south end facilities were abandoned and lay idle for several years. The Dead Sea Works Limited on the other side of the Truce Line was formed in 1952, and modest commercial production was reestablished by the mid-1950's. Through a series of expansions, the current production capacity of the Dead Sea Works Limited has increased to approximately 1,200,000 metric tons per year. Additional expansion currently in progress is scheduled to bring the total capacity of the Dead Sea Works Limited to 1,500,000 metric tons per year.

In 1956, The Arab Potash Company (APC) was founded to develop a potash industry in Jordan. During the late 1950's, technical evaluation and design studies were undertaken for a 250,000 metric tons per year plant and tender documents were prepared. However, no tenders were solicited since the estimated capital requirements indicated that the project was not economically sound at that production rate. In June of 1964, Jacobs Engineering Co. (JEC) was selected by U. S. AID to undertake an independent technical and economic review and evaluation of the project. This work utilized the services of JEC and their civil engineering consultants, Sir Alexander Gibb & Partners (AGP) of London. As a result of this review the production capacity of 500,000 metric tons per year was recommended as the minimum economic size.

Following that review, in August of 1965 JEC, again utilizing AGP as civil consultants, prepared a detailed engineering and economic feasibility report for APC. The scope of this detailed work included site investigations, soil testing, solar evaporation testing, seepage studies and preliminary design and cost estimates. The feasibility report included estimates for both 500,000 and 1,000,000 metric ton capacities. That report concluded that economically accessible markets existed for the full 1,000,000 metric tons and that the superior economics of such a plant represented a viable project. In 1967, JEC began the first-phase engineering of a facility to recover 1,000,000 metric tons per year of potash from the Dead Sea. However, implementation of the project was halted by the 1967 hostilities.

In November of 1973, Jacobs was asked by APC to submit a proposal for reactivating the project. The preliminary economic review, submitted in May, 1974 reconfirmed the attractiveness of the project.

In November, 1974 the National Planning Council requested proposals on a world-wide basis to implement the project in a phased approach. In March, 1975 we submitted our proposal, again with AGP as our civil consultants. We were then selected in September, 1975 to prepare this Phase I Feasibility Study. The scope of the study covered engineering, market survey, capital cost estimate, economic analysis and a major field work program which included the following:

a) Further detailed investigations of evaporation rates of brines at different concentration in test pans within a specially constructed testing station at the site.

b) Collection of meteorological data from a station also constructed at the site.

c) A brine sampling program in the sea around the Lisan to establish the intake point.

d) The construction of a camp and support facilities at the Numeira fan.

e) The construction and testing of trial dikes in the soft mud foreshore of the southern basin.

f) Extensive subsurface investigations over the project area including salt cutting trials near the center of the basin.

g) Hydrological studies to assess the future levels of the Dead Sea.

h) Hydrogeological investigations to establish the optimum methods of supplying the fresh water requirements for the project.

Subsequent to the issuance of the Preliminary Feasibility Report for Phase I in 1976, a decision was taken to increase the plant capacity to 1,200,000 metric tons per year. A study comparing this with the 1,000,000 metric tons per year plant indicated that the additional capital cost had a favorable impact on the economics.

PROJECT DESCRIPTION

The principal objective of this project is to develop in Jordan a potash export industry which will contribute to her financial self-sufficiency by reducing her balance of trade deficit and dependence on foreign aid.

To accomplish this objective, the Arab Potash project will utilize two natural resources, the vast brine reserves of the Dead Sea and the unique solar evaporation area at the south end of the Dead Sea, to produce 1.2 million metric tons per year of potassium chloride, the most popular form of potash fertilizer.

Production will be expandable to a potential capacity of 1.7 million metric tons per year of potash as brine levels in the salt pan are raised and with the addition of a fourth carnallite pan and expansion of the refinery.

The principal works to be constructed at the south end of the Dead Sea are as follows:

1) Solar evaporation pans for the concentration of the brines. These are formed by enclosing areas for each stage of the evaporation process with low dikes. Approximately 65 km of dike are required in the solar evaporation pan system.

2) A brine transfer system which is required to bring the brine from the nearest suitable source at the south end of the Sea. The intake is located near the northern end of the Lisan peninsula, and a canal 10 km long will be used to transfer the brine to the main salt pan. From there, a series of pump stations will transfer the brine from one pan to the next as the specific gravity increases until the carnallite point is reached.

3) A harvesting system for dredging the carnallite deposited in the carnallite pans and transporting it along the dikes in pipelines to the processing plant located on the Wadi Qunaiya alluvial fan.

4) A processing plant to produce fertilizer grade potash from the harvested carnallite. The plant will include facilities for steam and power generation and for water treatment.

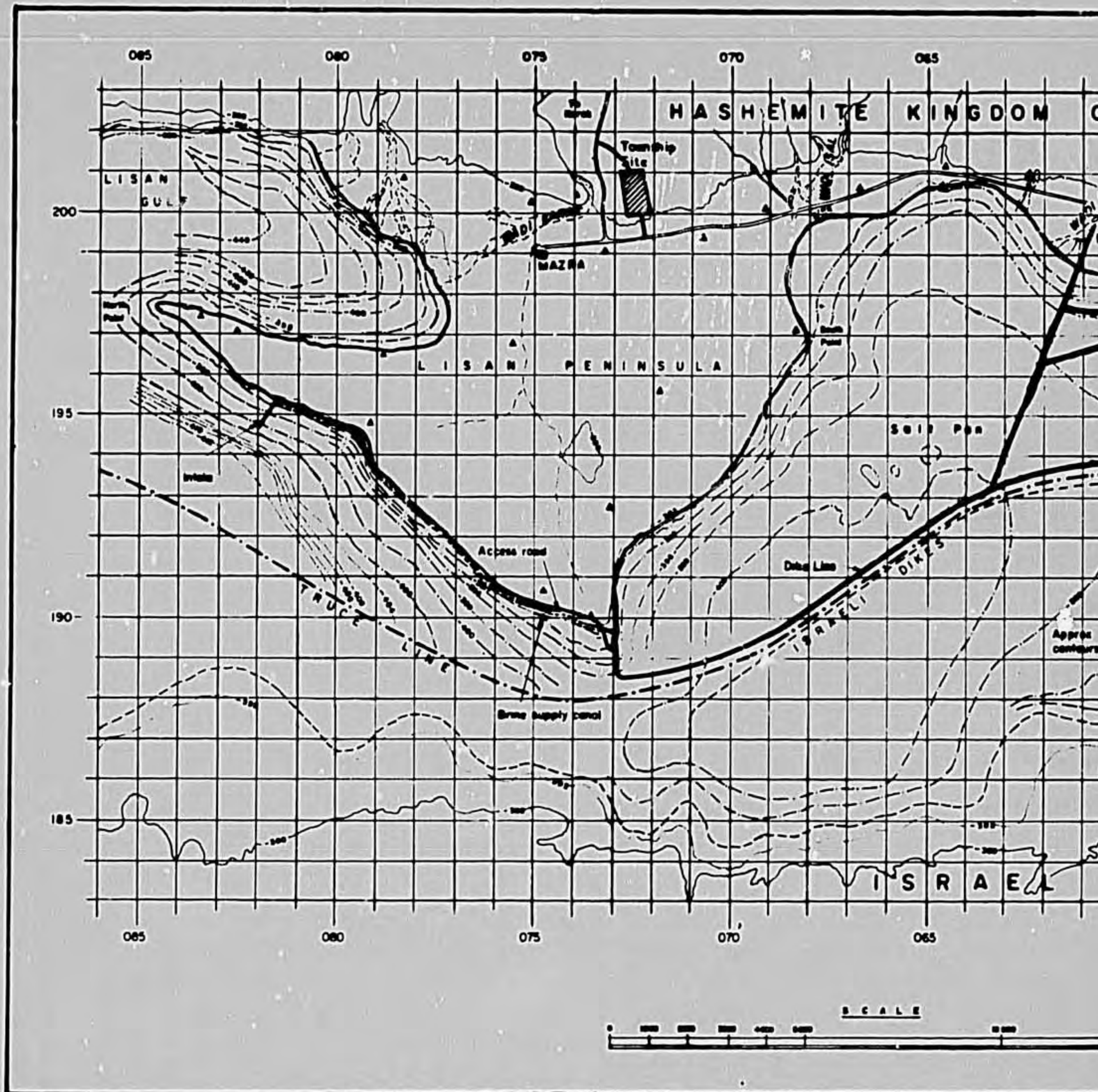
5) A town will be constructed on a site located on the western side of Ghor Dra, approximately 20 km north of the plant site. The township with all necessary community facilities and services will first house the construction staff and later the Arab Potash Company's plant operators and administrative personnel. Drawing 1407-KE-120 shows the overall layout of the project. The processing steps are well known and are presently utilized in commercial production.

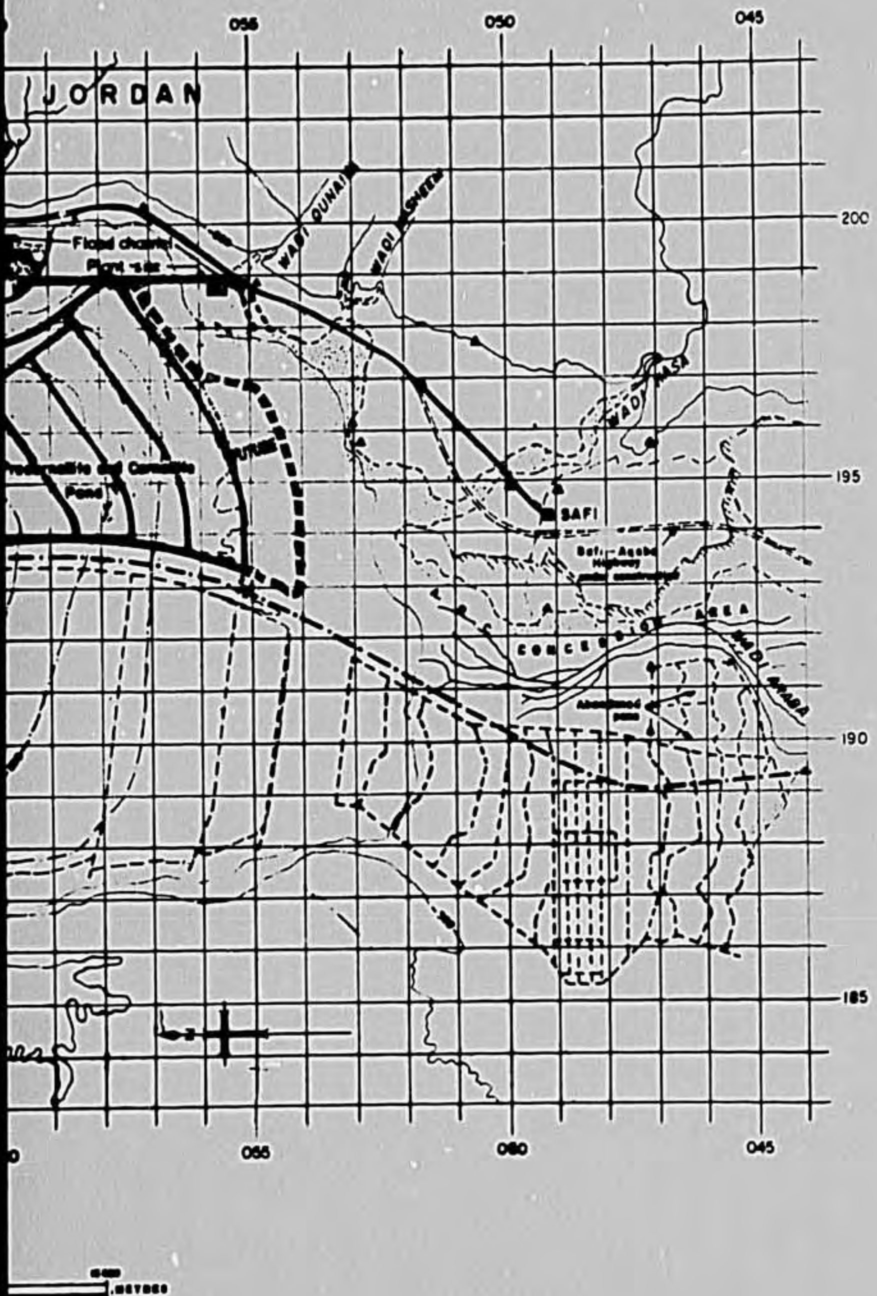
Dead Sea brine will be pumped and transported by 10 kilometers of canal to the salt pan where concentration and precipitation of common salt will take place. The brine will then be pumped through intermediate pans to the carnallite pans, where carnallite will be precipitated. Carnallite is a double salt of potassium chloride and magnesium chloride ($KCl \cdot MgCl_2 \cdot 6H_2O$).

Carnallite slurry is dredged and pumped to the refinery, which is to be located about 1 kilometer from the nearest carnallite pan. Waste brine from the carnallite pans will be returned to the Dead Sea. In the future, the residual brine can provide the feedstock for processing plants to extract the bromine, magnesium and other chemicals contained in the Dead Sea brine. Thus, the potash plant should be considered the first stage in the development of an important chemical complex of worldwide significance.

In the refinery the carnallite double salt will be decomposed with water and the pure potash will be crystallized, filtered, dried and sent to storage. A separate power station will provide steam and a portion of the electrical requirement of the project.

The bulk potash will be hauled by truck down the Safi-Aqaba road to the Port of Aqaba where it will be unloaded into a receiving, storage, screening, bagging, and shiploading facility which is to be built by the Government of Jordan. The Aqaba storage and loading facility will be capable of loading ships at 1500 to 2000 tons per hour and will be capable of handling ships of up to 50,000 ton capacity with an eventual capability of handling 100,000 ton ships.


085
080
075
070
065
HASHEMITE KINGDOM
Township Site
LISAN GULF
200
MAZRA
LISAN PENINSULA
195
Salt Pan
Intake
Access road
Dike Line
ISRAELI DIKES
TRUCE LINE
190
Approx contours
Brine supply canal
185
ISRAEL
SCALE



LEGEND :-

- Existing Asphalt Road
- Existing tracks
- Contours from aerial photography (1966)
- Contours from soundings (1966)
- ▲ Survey stations established in 1966 (some destroyed)

NOTES:

1. Approximate brine level in Southern Basin AUG.77. -398·3 to -398·9
2. Dead Sea level North of Lisan OCT.77. -399·7

HASHEMITE KINGDOM OF JORDAN

ARAB POTASH COMPANY

POTASH PROJECT BASED ON DEAD SEA BRINE

SITE PLAN

JACOBS INTERNATIONAL INC.
PASADENA CALIFORNIA U.S.A.

SCALE AS SHOWN

DATE NOV 1977

CONSULTING ENGINEERS
READING AND LONDON
ENGLAND

1407-KE-120

PROJECT SCHEDULE

We have developed the master schedule shown on the following page, based on the instruction to proceed with Phase II engineering as of 5 November 1977.

This schedule shows the following target dates for contract awards:

Township	1 May 1978
Civil Works	1 January 1979
Power Plant	1 January 1980
Process Plant	1 January 1980

Construction of the township is scheduled to complete the houses on a progressive basis to allow their use to house Arab Potash Company staff plus the engineer's and contractor's supervisory personnel during the total project construction period.

With contract awards as shown above, the scheduled completion dates will be as follows:

Township	1 May 1980
Civil Works	1 April 1982
Power Plant	1 April 1981
Process Plant	1 May 1982

With the completion of the work as outlined above, and introduction of brine to the first carnallite pan by August 1980, the first product will become available in late 1982, with rated production of 1.2 million metric tons per year projected in early 1985.

JACOBS ENGINEERING CO.

LEGEND

I INQUIRY ISSUE
A APPROVAL ISSUE
D DESIGN ISSUE
C CONSTR ISSUE
BS BID SUMMARY
S/C SUBCONTRACT

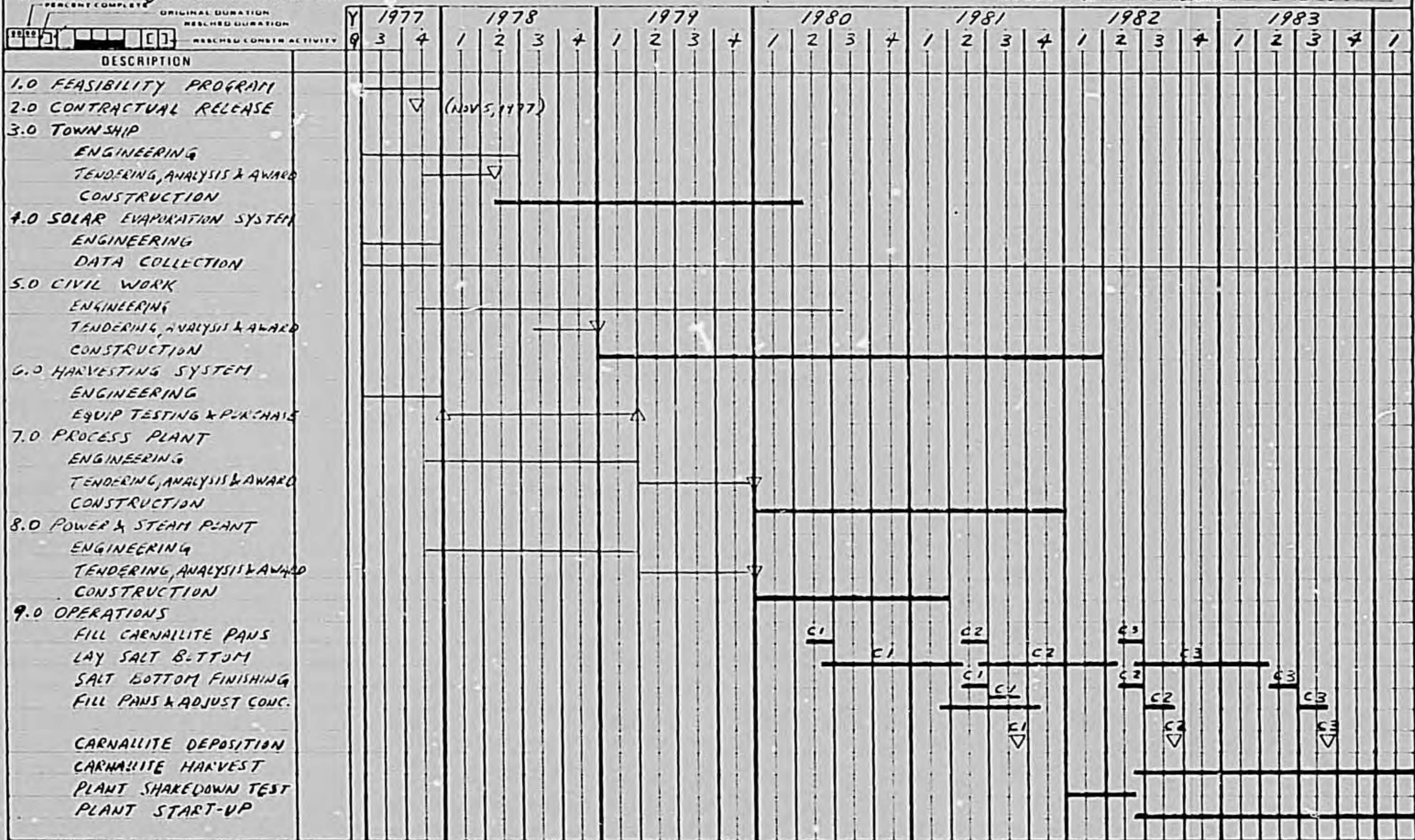
○ SCHEDULED DELIVERY
RESCHEDULED DELIVERY
SCHED PURCH EQUIP MAT'L S/C
RESCHED PURCH EQUIP MAT'L S/C
SCHED VENDOR DWG DUE DATE
RESCHED VENDOR DWG DUE DATE

SCHEDULED ENGR ACTIVITY
SCHEDULED CONSTR ACTIVITY
RESCHEDULED ACTIVITIES
COMPLETED ACTIVITIES

PROJECT SCHEDULE

— OVERALL —

CUSTOMER ARAB POTASH CO LTD
TYPE OF UNIT POTASH PLANT
JOB NUMBER 02-1407
ORIGINAL ISSUE 2-15-78 BY DD
REVISION 0 (FOR REPORT) DATE 2-15-78



CAPITAL COST

Table 1 shows the capital cost estimate summary for the master schedule, including escalation through completion of construction. This total estimated cost is US $324,000,000 escalated or $275,000,000 in 1977 dollars. This estimate does not include pre-startup operating costs, working capital, interest on the loans and APC staff costs. The estimate has been prepared in sufficient detail and definition and with enough investigation of all cost-affecting factors, to provide a firm basis for evaluating project profitability.

We estimated the unit costs of the various items that will be required to complete the civil and mechanical construction. The quantities to which we applied these unit costs were derived from takeoffs based on flow diagrams, dike sections, layouts and plot plans, specifications, electrical diagrams, and preliminary designs as required.

The trend of material and labor costs is constantly upward. The estimate was based on current December 1977 rates, but the capital cost will actually be incurred between 1978 and 1983.

We have applied the following escalation percentages for local and foreign costs in estimating financial expenditures.

(1) International Labor and Materials:
1978 (7-1/2%), 1979 (7-1/2%), 1980 (7%), 1981 and beyond (7%).

(2) Domestic Jordanian Labor:
1978 (17%), 1979 (14%), 1980 (12%), 1981 and beyond (9%).

Included in the capital cost estimate are a number of items of infrastructure. These are listed below with their estimated costs. The total cost of these infrastructure facilities included in the estimate with the associated contingency, escalation and engineering services is $93,500,000 U.S.

		US $
(a)	Power Plant, Distribution & Jordan Electric Authority Charges	25,000,000
(b)	Township	21,300,000
(c)	Water Supply and Treatment System	1,500,000
(d)	Roads	2,300,000
(e)	Potash Trucks, Maintenance and Tools	5,700,000
(f)	Buildings, Sanitary Systems and Fences	1,700,000
	Sub Total	57,500,000
	Contingency	3,700,000
	Engineering Services	4,300,000
	Escalation	28,000,000
	TOTAL	93,500,000

The three tables on the following pages show the total cost broken down in the following ways:

1) By primary project categories.

2) Phased over appropriate years for both non-escalated and escalated basis.

3) Itemized by category into local and foreign costs.

TABLE 1

CAPITAL COST ESTIMATE

Estimate Summary	US $
Phase I Costs	10,000,000
Access Roads	2,000,000
Phase II Civil Works	138,403,000
Total Mechanical Works	95,169,000
Potash Product Trucks	3,562,000
Phase II Pro-services, Project Management, Field Staff	21,230,000
Jordan Electric Authority (escalated)	5,000,000
TOTAL ESTIMATED COST	275,364,000
Escalation	49,000,000
TOTAL ESTIMATED COST - ESCALATED	324,364,000
TOTAL CAPITAL COST - ROUNDED OFF	324,000,000

Fin Table shows 11 mill

Estimates for Contract Services
Finance + Accounting
Advisory - Technical
Operating

TABLE 2

PHASED CAPITAL COST EXPENDITURES

YEAR		US $ 1977 BASIS	US $ ESCALATED BASIS
1976/77		11,000,000	11,000,000
1978		17,865,000	18,636,000
1979		125,564,000	142,217,000
1980		74,290,000	91,559,000
1981		35,241,000	46,742,000
1982		5,214,000	7,419,000
1983		1,190,000	1,791,000
	TOTAL	270,364,000	319,364,000
Jordan Electric Authority			5,000,000
			324,364,000

TABLE 3

LOCAL & FOREIGN EXCHANGE

Estimate Summary	Local Cost	Foreign Cost
Phase I Costs	4,500,000	5,500,000
Access Roads	1,000,000	1,000,000
Phase II Civil Works	20,056,000	118,347,000
Total Mechanical Works	17,231,000	77,938,000
Potash Product Trucks	128,000	3,434,000
Phase II Pro-services, Project Management, Field Staff	4,458,000	16,772,000
Escalation	13,296,000	35,704,000
TOTAL ESTIMATE SUMMARY - ESCALATED	60,669,000	258,695,000
TOTAL ESTIMATE SUMMARY - ROUNDED OFF	61,000,000	259,000,000
Jordan Electric Authority $5,000,000	Fxcluded	Excluded

PRODUCTION COST

The production costs presented in this section were developed for 1977 cost levels, then escalated to future levels. They are based on a comprehensive training, startup, and early operating program administered by a contract operating organization. This will ensure efficient startup and early operation by experienced personnel, rapid and thorough training of local personnel, and provide for complete phasing out of expatriates over a 4-year period following the startup year. The current consulting contract between The Arab Potash Company Ltd. and Jacobs International Inc. provides for establishing an operations agreement under which Jacobs would provide such an organization. A proposed agreement including specific terms and production guarantees has been submitted to APC.

The production costs discussed in this section include all cash costs directly attributable to production, including direct labor costs, indirect fringes and overheads, maintenance materials, fuels, electric power, chemicals, supplies, and plant insurance. Other costs such as depreciation, preoperating and startup costs, operating contract fees, and APC head office costs are incorporated later in the project economics developed in Section 8.0 of this report.

Estimated costs for producing 1.2 million metric tons/year of potassium chloride are presented in Table 4, expressed in 1977 dollars. The table shows costs at capacity for both initial staffing and mature plant staffing (full expatriate phaseout). However, it should be pointed out that design production is not actually projected until 1986, and mature plant staffing will not be reached until the beginning of 1987.

The difference between initial and mature staffing reflects a 4-year phased transition from 156 expatriates plus 80 locals-in-training, to 156 fully trained locals. The locals-in-training are counterparts who are understudying expatriates for approximately one year before taking responsibility for a job position, resulting in some duplication of manpower for approximately one year.

TABLE 4

PRODUCTION COSTS $/METRIC TON
1.2 MILLION METRIC TONS/YR KCl

	1977 Cost Basis	
	Mature Staffing	Initial Staffing
Salaried Personnel	0.74	2.93
Operating Labor	1.12	2.78
Maintenance Labor	1.17	2.86
Maintenance Materials	2.53	2.53
Fuels	4.41	4.41
Electrical Power	1.78	1.78
Chemicals	0.46	0.46
Supplies & Miscellaneous	0.50	0.50
Insurance	0.50	0.50
	13.21	18.75

The most striking feature of the tabulated production costs is the predominance of energy costs. Fuel and power account for 47% of the total 1977-basis cost with mature staffing. Personnel-related costs follow at 23%, and maintenance materials account for 19%. All other cash production costs taken together account for only 11% of the total.

TRANSPORTATION COST

Product transportation costs play an extremely important role in the economics of this project. For competing in export markets, total cost delivered aboard ship supplants production costs as the primary competitive element. This all-in cost plus ocean freight costs then determines the export markets which the project can supply most effectively.

The costs of trucking potash to Aqaba and of storage and loading at the port are direct charges against the sales revenue f.o.b. ship at Aqaba. The effect of ocean freight costs is less direct, depending on whose ships are used, whether sales are contracted on an f.o.b. or c.i.f. basis, and what concessions are required to develop business in a given market.

We estimate the cash cost of trucking potash from Safi to Aqaba at $2.54 per metric ton on a 1977 dollar basis tabulated below. This excludes capital charges, since the original and replacement costs of the truck fleet are already included in the project capital expenditure schedule. Estimated port charges of $2.15 per metric ton will increase total delivery cost to $4.69 per metric ton excluding ocean freight. For the project economic analysis, which evaluates overall effects on the Jordanian economy, a government-paid road maintenance cost estimated at $0.50 per metric ton has been added to increase total cost of delivery aboard ship to $5.19 per metric ton.

The project financial analysis, which takes the viewpoint of APC and its investors, excludes the road maintenance charge.

no depreciation

	$1000/Yr	$/Metric Ton
Truck Maintenance	1435	1.20
Driver Costs (101 people)	667	0.56
Diesel Fuel @ 37¢/gal	617	0.51
Tires & Lube Oil	254	0.21
Registration & Insurance	78	0.06
	3051	2.54

In the Indo-Asian market area, product shipped from Aqaba would have a weighted average ocean freight advantage of approximately $5 per metric ton over product shipped from Vancouver. For a given delivered price to consumers, this translates into a $5 advantage in product price f.o.b. port versus Canadian potash.

Ocean transportation is not treated as a direct cost in our evaluation, which is based on selling the product f.o.b. Aqaba. However, these costs are important in determining the geographical areas in which the product can best compete in terms of the consumer's delivered costs, and in determining what price can be negotiated for the product. Table 5 shows distances to selected ports from Aqaba and Vancouver. Vancouver is the shipping point for Canadian potash, which dominates the Indo-Asian markets of particular importance to this project.

TABLE 5

Distances between Loading Ports and Importing Location
Nautical Miles

Importing Location	Origin: Aqaba	Origin: Vancouver
Mombasa (East Africa)	2,800	11,000
Bombay (India)	2,900	9,500
Madras (India)	3,900	8,700
Singapore	4,900	7,100
Pusan (South Korea)	7,400	4,600
Niigata (Japan)	7,900	4,200
Fremantle (Australia)	7,100	8,400
Melbourne (Australia)	8,700	7,300
Baltimore (U.S.)	5,800	6,000
New Orleans (U.S.)	6,700	5,500

Ocean freight rates prevailing in 1976 and early 1977 are presented below. The ocean freight market during this period has been depressed, and these rates probably demonstrate the minimum differentials which can be expected.

Indicative Ocean Freight Rates
For Potash in 1976 - 1977
(U.S. dollars per metric ton)

	Loading Port	
Discharging Area	Aqaba	Vancouver
India	9-10	20-25
Singapore	14-15	15-16
Japan	16	13-15*
Korea	15	10-11
Australia	14-15**	18-20
Southeast U.S.	9-10	8-9

* small cargoes
** West Coast

Ask Mike Paulsen what this really means.

These above rates relate to cargoes fixed in the open freight market for a single voyage, with the following vessel sizes reflecting the norm for the trade.

Indian Subcontinent	10,000 - 15,000 tons
Singapore	15,000 - 20,000 tons
Japan	10,000 - 15,000 tons
South Korea	20,000 tons
Australia	20,000 - 25,000 tons
United States	20,000 - 25,000 tons

Arab Potash will have the greatest ocean freight advantage over Canadian material in the Indian Subcontinent, East Africa, and the Middle East. In these areas, APC's advantage will amount to approximately $13 per metric ton. APC will have smaller advantages in Western Australia (about $4/ton) and Southeast Asia ($1/ton), and it will be at a disadvantage in Korea ($4/ton), Japan ($2/ton), and the Southeast United States ($1/ton).

The market plan, to be discussed in a subsequent section of this Executive Summary, calls for selling 40-45% of total APC output in India, East Africa and the Middle East. About 25% will go into the somewhat disadvantageous

Japan/Far East area, but this will be balanced by about 25% going into the freight advantageous areas of Western Australia and Southeast Asia. The net result will be a weighted average ocean freight advantage of approximately $5 per metric ton in the selected markets.

Any material going into Eastern U.S. ports will compete on a nearly even ocean freight basis with ocean-shipped product from Vancouver, although it will be at some small freight disadvantage as compared to potash shipped from Europe and Russia. Penetration of ocean-shipped potash into interior U.S. markets traditionally served by rail-shipped product from Saskatchewan and Carlsbad is expected to increase over the next decade.

MARKET ANALYSIS

We retained British Sulphur Corporation, Ltd. to supplement our own extensive background and to prepare an analysis of world potash markets for this study. Their report, which has been updated and expanded since our preliminary report of December, 1976 contains the following sections and is appended to the main report.

(1) Current and Future Capacity
(2) World Potash Supply
(3) Current Potash Demand
(4) World Potash Supply/Demand Forecast
(5) Potassium Sulphate
(6) Arab States Potash Consumption
(7) Profiles of Potash Markets in the Indian/Pacific Ocean Region
(8) Marketing Strategy for APC

Potash is a generic term applied to several compounds containing varying percentages of potassium. Because these are somewhat interchangeable sources of potassium, it is customary to discuss market quantities in terms of equivalent potassium oxide (K_2O). One ton of commercial potassium chloride, which is the form of potash to be produced by the proposed project, contains approximately 0.6 tons of equivalent K_2O. Thus, a market for 720,000 metric tons of K_2O is equivalent to the entire output of the proposed 1,200,000 tons/yr. project.

World sales of potash are expected to increase from a 1976/77 level of 24 million metric tons of K_2O to 30.5 million metric tons in 1980/81 and 38.3 million metric tons in 1985/1986. During this time, world capacity, exclusive of undefined new facilities and the Arab Potash project, is expected to increase from a level of 27.5 million metric tons of K_2O in 1976/77 to 32.3 million metric tons in 1980/81 and 36.5 million metric tons in 1985/86 based upon expansion of existing facilities and new facilities to process known reserves. By 1980, world capacity utilization will return to 95%, the level at which point shortages and sharp upward price pressures developed in 1975/76. Thereafter, project demand will exceed nominal capacity in the early 1980's unless additional production facilities are constructed.

In order to meet projected 1985 demand for 38.3 million metric tons of K_2O without exceeding 95% capacity utilization, 11.5 million metric tons of annual capacity must be added to that which is presently existing. About 85% of this new capacity will be constructed based on the proven reserves of Canada and Russia.

The natural market for potash shipped from Aqaba is in the Indian/Pacific Ocean region, which is presently supplied primarily by Canada. Jordanian potash will have a large ocean freight advantage (about $13/metric ton) on the Indian subcontinent and East Africa, and it will compete on an approximately equal basis with Canada in other areas of that region.

The primary potential market for this project approximately is as follows:

	Million Metric Tons/yr	
	KCl	Equivalent K_2O
India	0.5	0.30
Japan/Far East	0.3	0.18
Southeast Asia	0.2	0.12
Oceania	0.1	0.06
Middle East, East Africa	0.1	0.06
	1.2	0.72

The total market available in this area will be 3.9 million tons of K_2O in 1985.

By 1985, when the proposed project achieves full design production, this will correspond to about a 25% market share on the Indian subcontinent, about 15% in Japan/Far East, about 25% in Southeast Asia, about 12% in Oceania, and about 20% in East Africa and the Middle East. These market shares correspond to an overall regional market share of 18%, which we believe is attainable. No credit has been taken for sales into the large eastern U.S. market, although we believe this project can be competitive delivered to U.S. eastern ports. (See Section 8.0 discussion of competitive position.) In the Indo-Asian market, potash shipped from Aqaba will have an ocean freight advantage of $5 per ton over product loaded in Vancouver. With modest reductions in netback, the Arab Potash project can compete in essentially all import markets.

Based on elimination of present potash over-supply by the early 1980's, we predict that prices expressed in 1977 dollars will increase by 1985 from the present $50 - $55 per metric ton KCl f.o.b. Vancouver to at least $75 per metric ton f.o.b. Vancouver. Because of an ocean freight advantage in the Indo-Pacific region, the price f.o.b. Aqaba should be $5 higher at $80 per metric ton KCl. These prices are expressed in 1977 dollars and will escalate with world inflation. These are netback prices after any sales commissions paid to agents or dealers. Based on our analysis of future costs of existing and new plants, we believe this selling price can be characterized as conservative.

The key element determining future price of potash is the price structure needed to encourage investment in new facilities in Canada. Capital cost of new facilities is $180 per annual metric ton. With working capital of $10 per annual ton, cash operating costs of $14.50 per metric ton, and rail freight and port handling charges totaling $19 per metric ton, a minimum price of $80 per metric ton f.o.b. ship Vancouver is needed to support investment in new mines. This is based on a nominal 10%

depreciation charge of $18 per ton and a bare minimum simple (not DCF) return on investment of 15% before taxes. However, because incremental expansions or new mines in well developed areas may require somewhat less investment, and because there may be a tendency for existing producers to accept lower profits in order to protect their market share, we have selected $75 per metric ton of potassium chloride as the projected export price f.o.b. Vancouver in 1985. This extra element of conservatism substantially increases our confidence in the projected price structure on which the project economics are based.

Future capacity to produce potash is tabulated in Table 6. The totals include projected expansions but exclude China and the Arab Potash project. The most important projected developments between 1977 and 1990 include a doubling of Russian capacity (adding 8.2 million metric tons K_2O per year) and a 40% increase in Canadian capacity (adding 2.6 million metric tons K_2O/year). These two countries account for 94% of the total projected world capacity increase from 28.7 to 40.2 million metric tons per year during this 13-year period. Their combined share of total capacity will increase from 55% to 66%, not taking into account the Arab Potash project or any undefined expansions.

World potash demand recovered in 1975/76 from the 1974/75 drop caused by price increases in 1973, and it is expected to resume a growth rate of about 6% per year. It should reach 30.5 million metric tons K_2O in 1980, 38.3 million tons in 1985, and 45 million tons in 1990. Forecasts of future world potash demand are presented in Table 7 and supply/demand is presented in Table 8.

TABLE 6

WORLD POTASH CAPACITY 1975/76-1990/91

(Future Projections)

('000 tonnes K_2O)

	1976/77	1977/78	1978/79	1979/80	1980/81	1985/86	1990/91
France	2,100	2,200	2,200	2,200	2,200	2,000	1,500
West Germany	2,700	2,700	2,700	2,700	2,700	2,700	2,700
Italy	240	260	280	280	280	400	400
Spain	670	740	800	800	800	1,000	1,200
United Kingdom	100	300	400	500	600	800	1,000
German D. R.	3,200	3,300	3,400	3,500	3,600	3,850	4,000
U.S.S.R.	8,250	8,800	9,500	10,100	10,800	13,800	17,000
Israel	720	720	720	720	900	900	900
Congo	300	--	--	--	--	--	--
Canada	6,570	6,900	7,150	7,380	7,380	8,500	9,500
United States	2,600	2,735	2,735	2,735	2,735	2,500	2,000
Total	27,450	28,655	29,885	30,915	31,995	36,450	40,200

TABLE 7

WORLD DEMAND FOR POTASH SALTS 1976/77 - 1990/91
('000 tonnes K_2O)

	1976/77	1977/78	1978/79	1979/80	1980/81	1985/86	1990/91
World	24,000	25,510	27,120	28,730	30,500	38,325	44,950
West Europe	5,270	5,465	5,720	6,020	6,375	7,275	8,060
East Europe	9,630	10,325	10,840	11,440	12,045	14,720	16,450
Africa	320	400	450	520	570	820	1,100
North America	5,220	5,490	5,840	6,070	6,390	7,770	9,020
Latin America	1,010	1,160	1,310	1,480	1,680	2,650	3,300
Asia	2,250	2,440	2,620	2,830	2,040	4,590	6,450
Oceania	300	320	340	370	400	500	570

TABLE 8

WORLD POTASH SUPPLY/DEMAND BALANCE 1976/77-1990/91

('000 tonnes K_2O)

	1976/77	1977/78	1978/79	1979/80	1980/81	1985/86	1990/91
Capacity	27,450	28,955	30,185	31,215	32,295	36,450*	40,200*
Production	24,080	25,660	27,280	28,890	30,680	38,890	45,620
Sales	24,000	25,510	27,120	28,730	30,500	38,325	44,950
Demand	22,846	24,296	25,827	27,366	29,046	36,500	42,810
- Fertilizer	22,171	23,586	25,082	26,586	28,226	35,500	41,660
- Industrial	675	710	745	780	820	1,000	1,150
Production, % of capacity	88	89	90	93	95	107	113

* excludes unattributed capacity and Arab Potash Project

JACOBS INTERNATIONAL INC.

PROJECT ECONOMICS

The Arab Potash project provides an excellent return on investment and shows exceptional resistance to unfavorable variations in price, capacity, capital, and production costs. Its low cost for product delivered aboard ship will place it in an extremely strong competitive position.

Our financial analysis shows that the project will provide a ~~17.8%~~ financial rate of return on total investment. This rate of return includes the effects of inflation on costs and revenues. If the project is ~~60%~~ 55 debt financed at ~~7%~~ 8 interest with a 14-year repayment period beginning two years after plant startup, the financial return on equity investment would be 22.6%, and the project could meet its financial obligations at a production rate of 600,000 metric tons per year, or 50% of capacity.

The economic rate of return, adjusted to remove the effects of inflation, is 11.9%. Economic analysis deals with the direct effects of this project on the Jordanian economy. Costs are adjusted to eliminate subsidies or temporary imbalances, and government taxes are excluded from the cost stream. The economic rate of return is based on total investment without regard to project financing, and is arrived at by reducing all cash flows to constant 1977 currency values in order to eliminate inflationary effects. For this project, the economic rate of return differs from the financial rate of return on total investment primarily in that it excludes projected inflationary effects and income taxes.

The actual project financing plan has not yet been firmed up, but it is likely to include a combination of loans, with World Bank funds at 10% effective interest, U.S. AID funds and Arab Funds at interest rates in the ~~6%~~ 5 range, and other commercial sources at about 10% interest. These loans will probably differ in the types of expenditure covered, the grace period, and the repayment period. We, obviously, are not attempting to predict those rates but as a simplified approximation of the overall effects of such a combined plan, we have employed the following as a basis for this evaluation.

(1) Expenditures through 1978 will be financed from equity funds. Thereafter debt and equity funds will come in on a fixed ratio basis. We have assumed a single loan, with 7% interest accruing through 1982, the startup year. Interest will thereafter be paid annually, beginning at the end of 1983.

(2) The loan will be capitalized at the end of the second full calendar operating year and will thereafter be repaid in equal annual installments over a 14-year period, with the first payment coming at the end of 1985.

(3) The ratio of long term debt to the total of long term debt plus equity shall not exceed 60/40 at the end of any calendar year. This corresponds approximately to financing 55% of post-1978 capital expenditures with debt, 45% with shareholder equity. Capitalization of the accrued interest and other funds required as in (4) will bring the debt to 60%.

(4) Just prior to the year when loan repayment begins, sufficient shareholder equity and loan funds will be brought in to cover needed capital expenditures, working capital and startup plant modifications over the following two years. Thus, total funds drawn from lenders and shareholders will cover all needs for fixed capital, working capital, and startup costs through the fifth operating year (including the partial startup year).

The total financing required for the project is as follows, based on the foregoing financial plan.

		U.S. $
Original Fixed Capital, 1977 Basis		274,800,000
Post-Startup Modifications, 1977 Basis		3,000,000
Working Capital, 1977 Basis		18,400,000
Pre-operating & Startup, 1977 Basis		17,300,000 — Breakout
Escalation		69,800,000
Capitalized Interest		35,100,000
	Total	418,400,000
Total Financing Requirements - Rounded Off		420,000,000

+ Other costs required to support project Port etc. - Ext Road -

The financial and economic analysis evaluated cases. For each of the cases considered, we have employed our financial computer model to develop year-by-year financial results, including production cost statement, income statement, cash flow statement and balance sheet. It also records the debt/equity ratio, debt service coverage by annual and cumulative cash flow, current and quick ratios, and simple ROI (Annual income/Gross fixed plus working capital). We have established the following financial results.

Financial rate of return on total investment	17.8%	
Financial rate of return on equity	22.6%	
Maximum Long Term Debt/LTD plus Equity, %	60.0	(1983)
Expenditures financed with paid-in equity, $MM	189.1	(49%)
Expenditures financed with debt, $MM	194.2	(51%)
Debt at time of loan capitalization, $MM	229.3	(1984)
Minimum times debt service covered		
by annual cash flow after working capital additions	1.0	(1983)
by cumulative cash reserves	1.4	(1983)

Selected economic results for three cases considered in our economic analysis are as follows:

	Case 3 No Escalation	Case 4 Escalated	Case 5 Escalated and Deflated
Rate of Return 100% Equity Basis	12.6%	19.7%	11.9%
Payout Time After Beginning of Plant Startup	6.5 yr	5.0 yr	6.8 yr

These results, free of debt leverage, portray a solid and attractive investment, with an economic rate of return of 11.9% (Case 5). The unescalated Case 3, often used as an approximation of the economic rate of return, is slightly higher at 12.6%.

The escalated Case 4 has a rate of return of 19.7%, which as expected, exceeds the others by roughly the world inflation rate.

We have considered the sensitivity of the project to 20% variations in product sales price, plant capacity, capital investment and the total of production, transportation and shiploading costs. In addition, we have considered the effect of starting up the plant one year later or earlier than the scheduled August, 1982.

The effects of varying the 1985 sales price by $16 per metric ton (20%) from the $80 per ton figure (f.o.b. Aqaba, 1977 dollars) are tabulated below. Coincidentally, the $96 price is approximately what would be needed to encourage private investment in new capacity in a 50% income tax environment. Because of this latter factor, our judgement is that price fluctuations will tend toward the plus side.

Effects on the economic rate of return and the financial return on equity are shown graphically in Figure 8.5-1. These and some other effects on financial performance are also tabulated below.

	Sensitivity to Price		
Output	1,200,000 Metric Tons/Yr		
Price, 1977 $	64	80	96
1987 $ (6th yr)	123	154	184
Economic Return	8.4%	11.9%	14.9%
Financial Return on Equity	17.2%	22.6%	26.9%
Minimum Debt Coverage (1983)	0.7	1.4	2.2
Maximum Debt/Debt + Equity (1983)	60.4	59.7	57.1

As expected, financial and economic performance is more sensitive to price than to any other single variable, and the economic rate of return would dip to 8.4% at the $64 price. However, the project could still meet its financial obligations except for a temporary shortfall in 1983.

The effects of a 20% variation in the plant's production capability are tabulated below and shown graphically in Figure 8.5-2.

	Sensitivity to Capacity		
Price after 1985	$80/tonne f.o.b. Aqaba, 1977 $		
Production after 1985 Thousands of Metric Tons/Yr	960	1200	1440
Economic Return	9.4%	11.9%	14.4%
Financial Return on Equity	19.0%	22.6%	24.6%
Minimum Debt Coverage (1983)	1.2	1.4	1.5
Maximum Debt/Debt + Equity (1983)	59.8	59.7	58.7

For the ranges considered, the project meets all commitments and stays within accepted limits for debt coverage and solvency. A 20% variation in plant output has substantially less effect than a 20% variation in price.

The effects of varying by 20% the investment in the solar evaporation system and the process plant are tabulated below and shown graphically in Figure 8.5-3.

	Sensitivity to Fixed Capital		
Price after 1985	$80/tonne f.o.b. Aqaba, 1977 $		
Production after 1985	1,200,000 Metric Tons/Yr		
Fixed Capital, Escalated, $MM	259.5	224.4	389.2
Economic Return	14.5%	11.9%	9.9%
Financial Return on Equity	26.4%	22.6%	19.6%
Minimum Debt Coverage (1983)	1.8	1.4	1.2
Maximum Debt/Debt + Equity	59.2	59.7	60.1

For the range considered, the project meets all commitments and stays within accepted limits for debt coverage and solvency. A 20% variation in fixed capital has less effect than a similar variation in either price or capacity.

The effects of a 20% variation in the total of production, delivery, storage, and loading costs are relatively small, as shown on Figure 8.5-4.

The effects of starting production one year earlier or later than August, 1982, assuming no change in loan capitalization, payback schedule, or unescalated capital expenditure are tabulated below and are shown graphically on Figure 8.5-5.

	Sensitivity to Startup Year		
Price after 1985	$80/tonne f.o.b. Aqaba, 1977 $		
Production after 1985	1,200,000 Metric Tons/Yr		
Startup Year	1981	1982	1983
Economic Return	13.0%	11.9%	11.2%
Financial Return on Equity	24.1%	22.6%	21.2%
Minimum Debt Coverage	1.3	1.4	2.0
Maximum Debt/Debt + Equity	58.9	59.7	60.1

The late startup case remains viable and could meet its obligations under the assumed conditions. Of course, if the date for initial interest payment were not shifted forward, the project could obviously not pay interest out of current cash generation in the startup year.

The Jordanian balance of trade will be sharply improved by this project. Once it is in full operation, it will generate annual export sales of $96,000,000 expressed in 1977 dollars. This will be offset by annual imports of approximately $12,000,000 to give an overall increase of $84,000,000 per year.

In the foregoing financial analysis, we have presented a conservative projection of the likely economic conditions of capital cost, selling price, operating costs, etc., which will determine the rate of return on the investment. We have studied the effect of wide variations in these factors and found that the project is quite insensitive to them. We have concluded therefore that the project is viable.

However, we feel strongly that the project should also be examined from another standpoint. How competitive is it? In other words, in a period of temporary aberration in markets, price, or other factors, how does this project stand vis-a-vis all other major production plants? It is important to know this because if the cash costs including debt service are competitive with or lower than the major competition, it provides an underlying assurance of great value to the project.

The outstanding competitive feature of the Arab Potash project will be its ability to deliver potash aboard ship at a cash cost of $18 to $19 per metric ton of potassium chloride, expressed in 1977 dollars. This is a full $15 per ton below the cost of present Canadian product loaded aboard ship at Vancouver, which will permit APC to compete with Canada for essentially any export market. This advantage would increase with inflation.

The cost advantages discussed above will put APC into an extremely strong defensive position in the event of price competition caused by any temporary over-supply. The project would still be generating $15 - $20 per ton of cash before debt service at prices which would leave nothing in the pockets of a Canadian producer. By the time the project is operational, this differential will increase to about $24 - $32 per ton, providing a full cover for APC's debt service requirements of $27 per ton. Thus, APC will have a very great defensive advantage over a Canadian producer with debt service requirements on new facilities, and they will even be on an equal defensive footing with Canadian producers with paid-off debt. This is a remarkable position for a new venture. Knowledgeable competitors will become fully aware of this and will therefore not be likely to initiate price reductions in an attempt to exclude APC from the market.

EFFECT OF PRODUCT SALES PRICE ON PROJECT PROFITABILITY

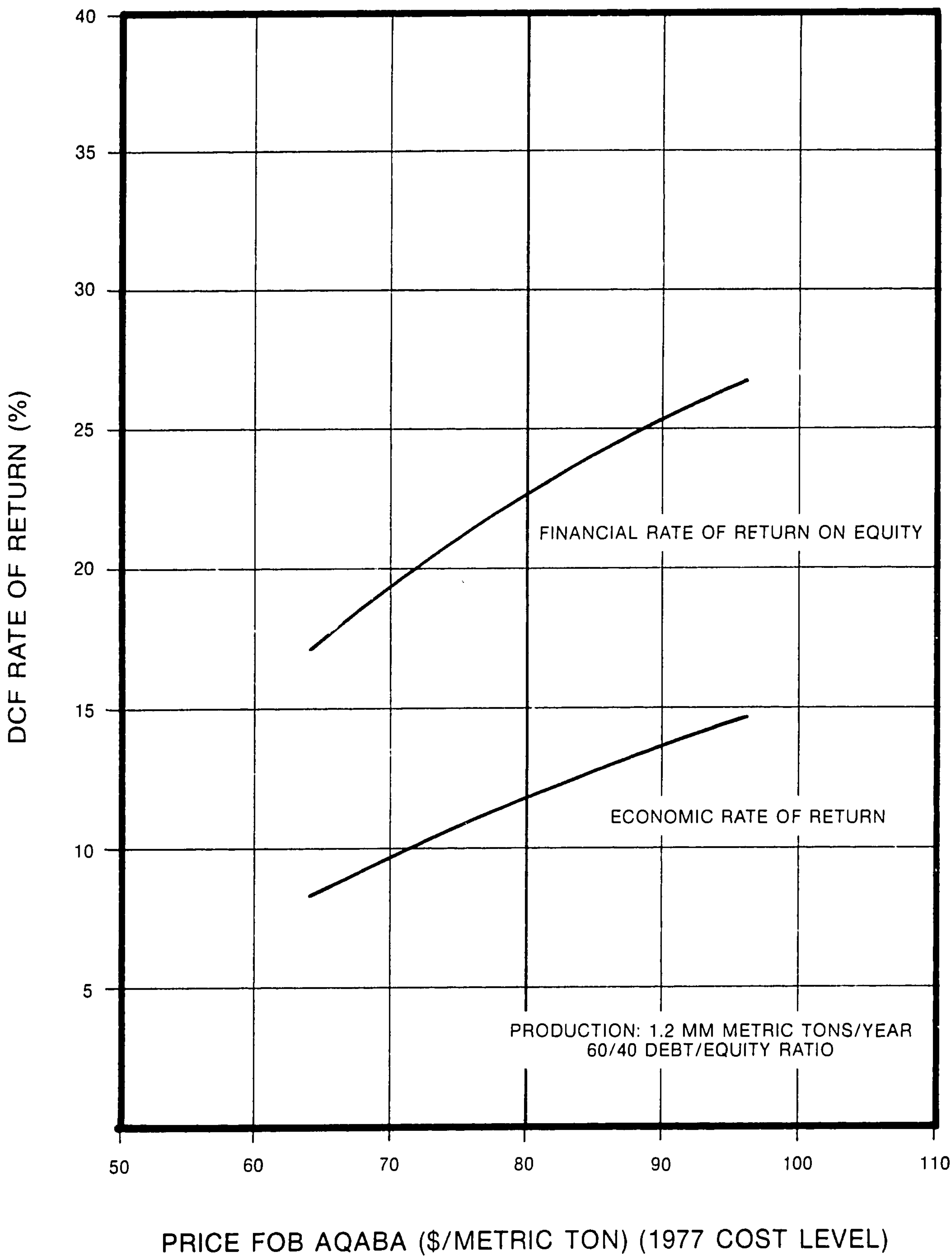


FIGURE 8.5-1

EFFECT OF PLANT OUTPUT ON PROJECT PROFITABILITY

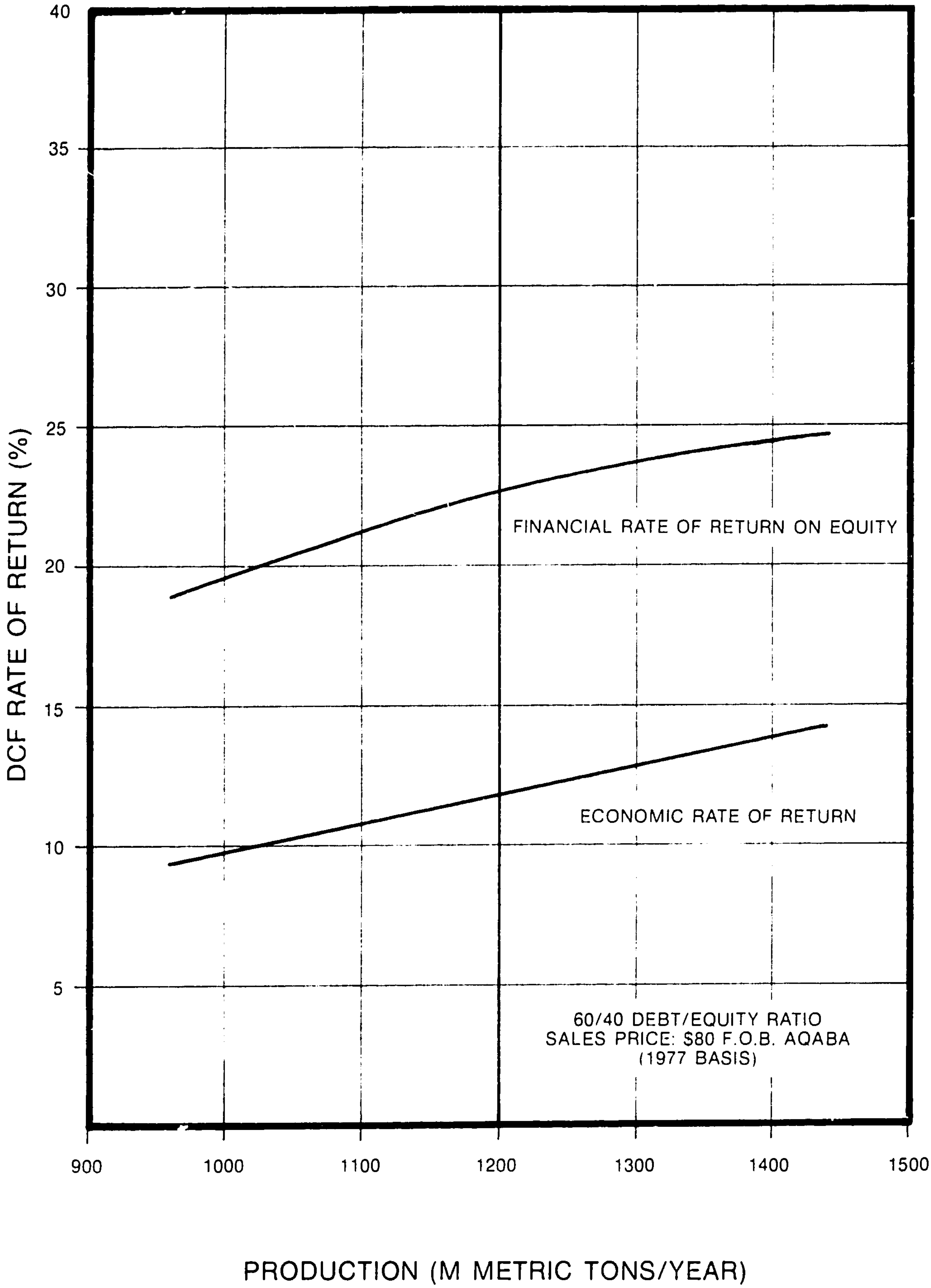


FIGURE 8.5-2

EFFECT OF FIXED CAPITAL INVESTMENT ON PROJECT PROFITABILITY

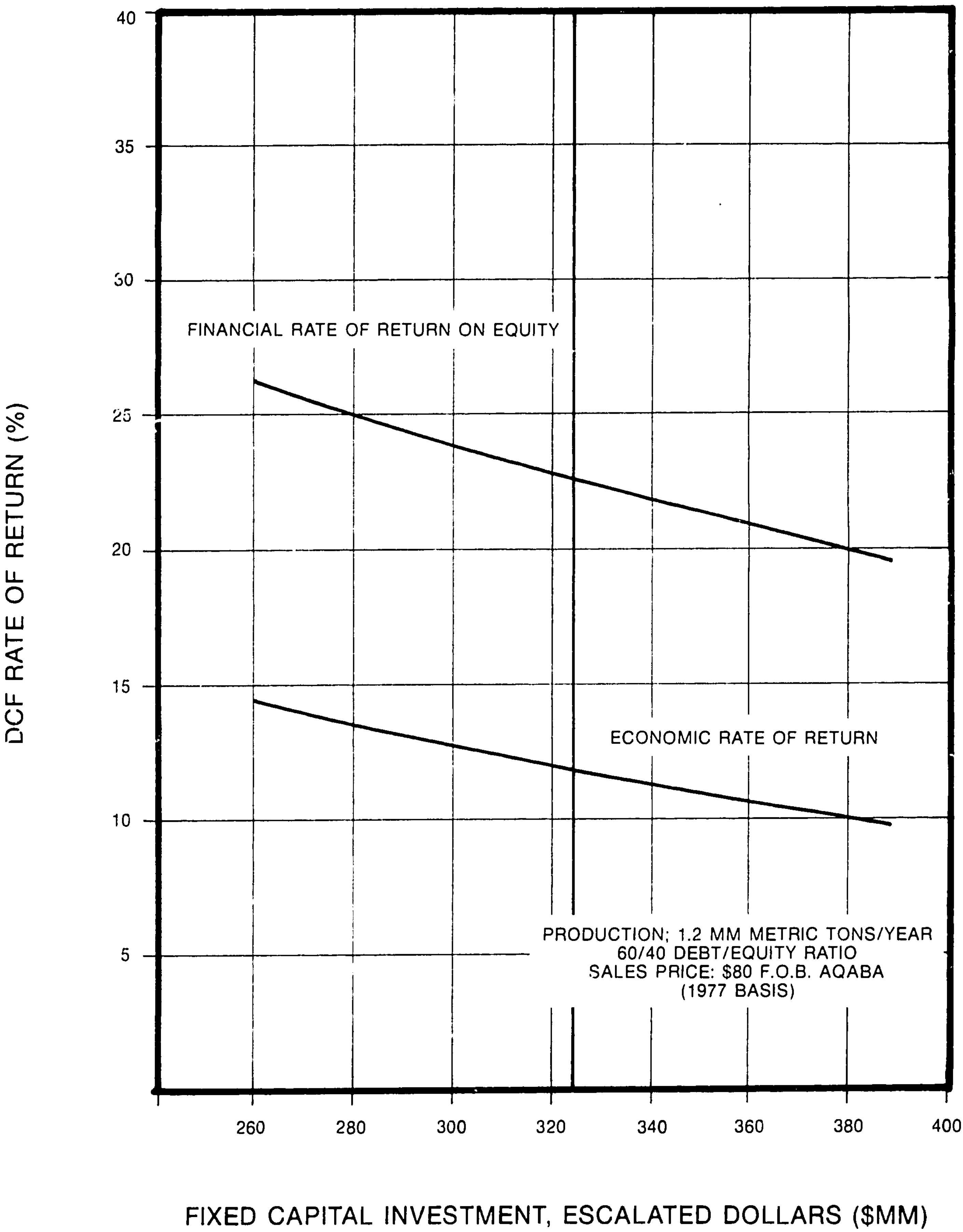


FIGURE 8.5-3

EFFECT OF TOTAL COST OF PRODUCTION, DELIVERY, STORAGE, & LOADING ON PRODUCT PROFITABILITY

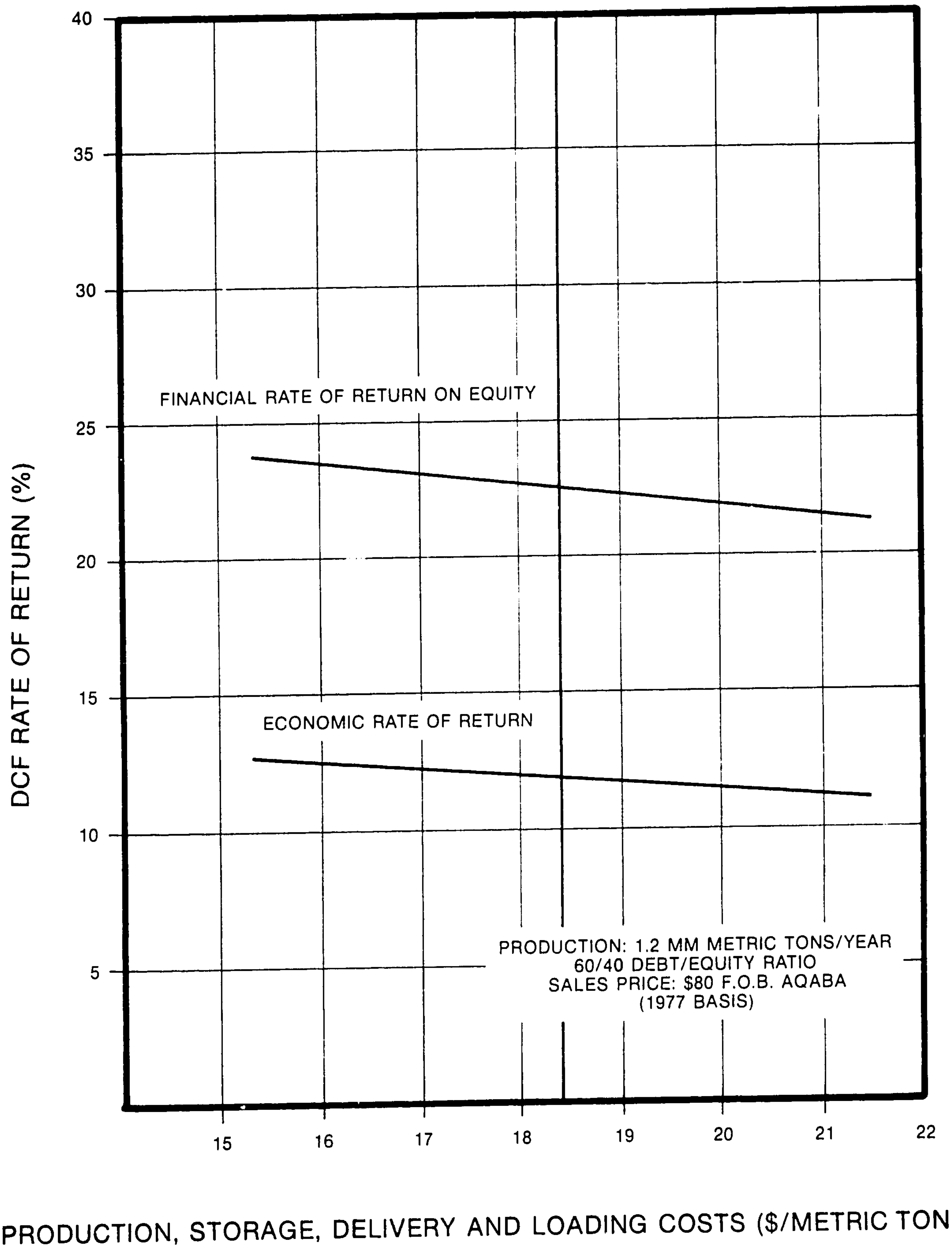


FIGURE 8.5-4

EFFECT OF STARTUP YEAR ON PROJECT PROFITABILITY

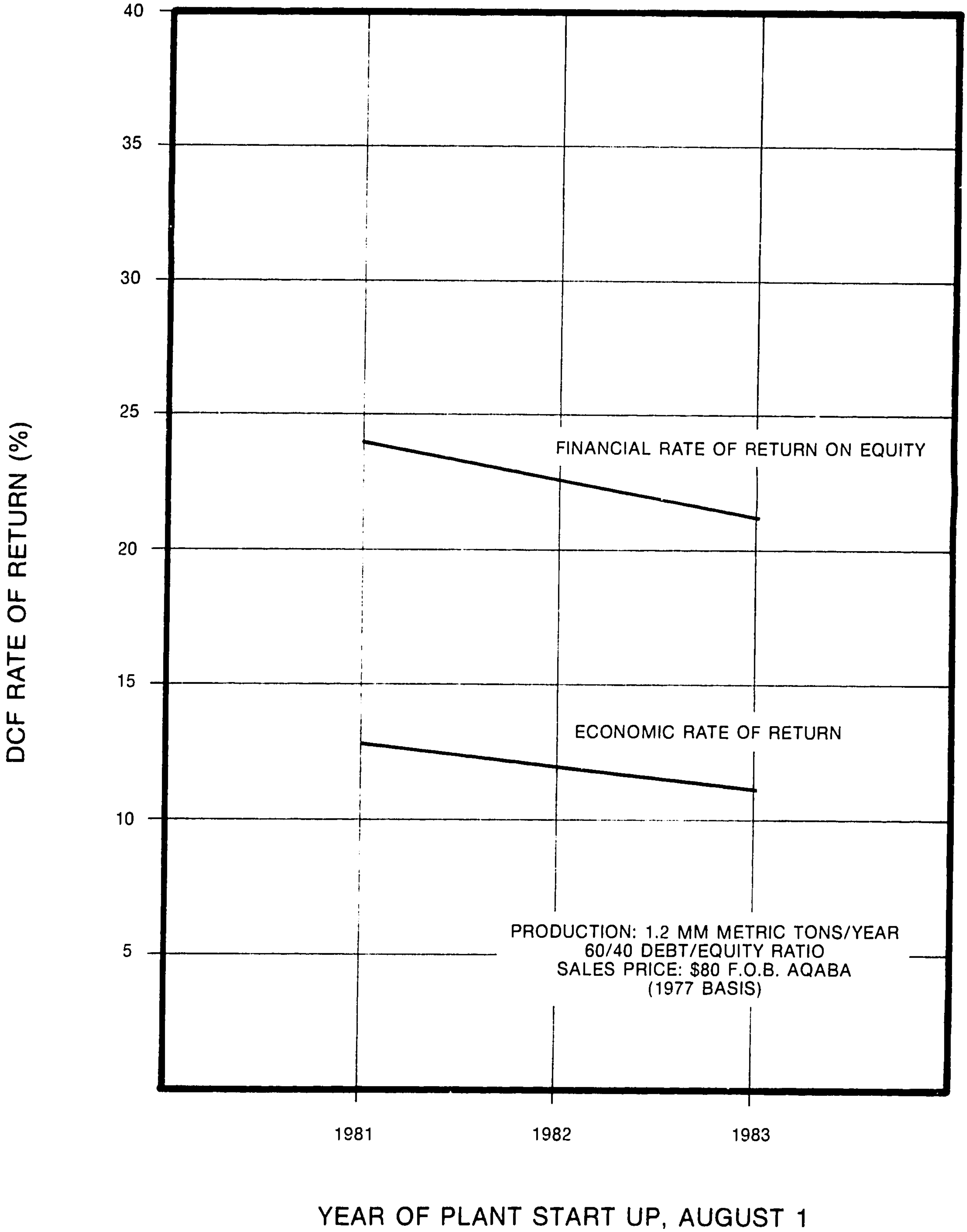


FIGURE 8.5-5