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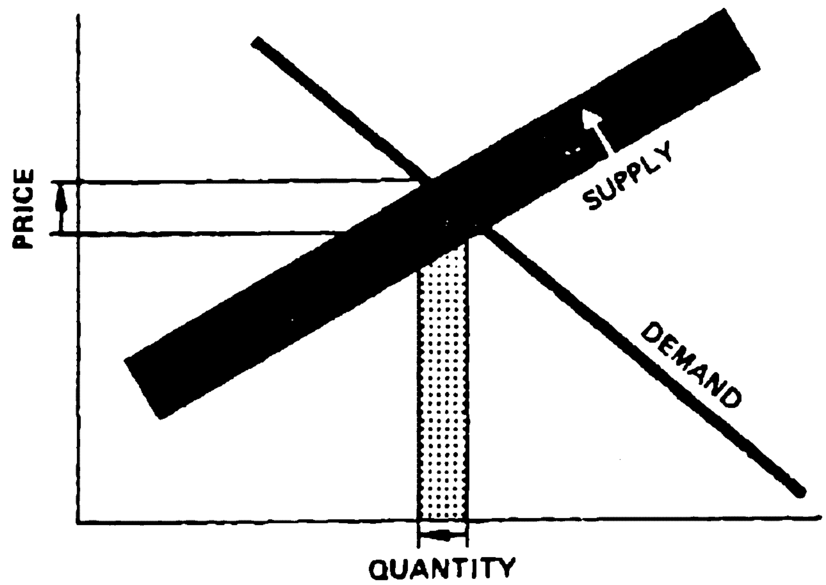

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Economic Analysis of the Phosphate Subcategory of the Fertilizer Manufacturing Industry

Louisiana Phosphoric Acid Plants

Prepared for
U.S. Environmental Protection Agency
Office of Analysis and Evaluation
Washington, D.C. 20460

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PREFACE

This document is a contractor's study prepared for the Office of Analysis and Evaluation of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impacts which could result from point source remedial control options considered for four phosphoric acid manufacturers located in Louisiana. The remedial control options were considered when these four phosphoric acid plants experienced difficulties greater than anticipated by EPA and the companies when BPT and BAT discharge limitations were promulgated in 1974.

Presented in the study are the investment and operating costs associated with the various remedial control options which were developed independently. These cost estimates are supplemented by estimates of the broader economic effects which may result from the various remedial control options considered. The study estimates the impacts on product prices, product availability, employment and the continued viability of the affected plants for each of the remedial control options.

The study has been prepared with the supervision and review of the Office of Analysis and Evaluation of EPA. The work was completed under Contract No. 68-01-6744 by Development Planning and Research Associates, Inc. (DPRA). The report was prepared by Donald J. Wissman, Craig E. Simons and Robert J. Buzenberg of DPRA and completed in February, 1984.

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EXECUTIVE SUMMARY

A. Introduction

This report analyzes the economic impact of various point source control alternatives for the Phosphate Subcategory of the Fertilizer Manufacturing Industry. It focuses on the impacts resulting from the remedial control options currently under consideration for the four phosphoric acid plants located in Louisiana. The four companies and their plant locations are listed below:

Company	Plant location
Agrico Chemical Company	Donaldsonville, LA
Allied Corporation	Geismar, LA
Beker Industries	Taft, LA
Freeport Minerals	Uncle Sam, LA

This action has become necessary because these four phosphoric acid plants have experienced difficulties greater than originally anticipated by the representatives of EPA and the Companies when developing the "no discharge" status as promulgated in 1974. The present effluent guidelines are based upon prevailing industry practices which involve recycle of the water and land disposal (stacking) of the gypsum by-product.

Due to unique conditions associated with the bearing strength of the Louisiana soils and the abnormally high rainfall, several gypsum stack failures have occurred in recent years. The occurrence of these failures, in spite of conscientious management of the stacks by soil experts and use of modern monitoring and management techniques, suggests that the issue of zero discharge and gypsum stack management should be re-examined for these four plants.

The purpose of this report is to provide an economic analysis of the various remedial regulatory options under study for the four phosphoric acid plants. The direct firm level impacts as well as the overall industry impacts are examined.

Because of the time and information constraints involved in the preparation of this report, the major emphasis has been to present an overview of the present state of the fertilizer industry, focusing on the phosphate sector. Secondary data is then used to estimate the impact of the various remedial alternatives on the four plants under study.

The control options used in the report were developed by the Effluent Guidelines Division in association with the Technical Contractor, Frontier Technical Associates, Inc. (FTA). Also, FTA developed cost estimates of the alternatives that were deemed to be technically feasible. The costs of the remedial options were applied to the financial profits of the individual plants and the resulting impacts studied.

It is well to note that in a report of this nature, a number of simplifying assumptions must be made that would not be necessary with the availability of more detailed primary information. However, we believe the assumptions are realistic and the accuracy of the impacts as developed are within reasonable limits.

B. Industry Description

The fertilizer industry is comprised of establishments primarily engaged in manufacturing nitrogen, phosphorus, and potassium fertilizer. The focus of this report is on the production of an intermediate chemical, phosphoric acid, which is used in the manufacture of phosphate fertilizer. Raw materials used in the production of phosphate fertilizer are phosphate rock, principally mined in Florida, and sulfuric acid. Intermediate and final products, for purposes of this study, are divided into three segments, each of which have minor variations. These segments are phosphoric acid and superphosphoric acid, normal and triple superphosphate, and ammonium phosphates.

1. Industry Structure, Capacity and Utilization

For purpose of this analysis the primary emphasis is on the phosphoric acid plants. The Tennessee Valley Authority (TVA) reports there are thirty-two active plants in this sector having a total capacity of over 11.5 million tons of P_2O_5 in 1983. Fifteen plants are located in Florida which represent 63 percent of total production capacity. Four plants are located in Louisiana, representing nearly 1.8 million tons P_2O_5, or 15.4 percent of total capacity. The remaining plants are located in the southern and western areas of the country.

Total phosphoric acid plant capacity has increased steadily during the past ten years. In 1973 total capacity was just over 6.4 million tons of P_2O_5 or only 56 percent of current capacity. Presently, there is significant over capacity in the industry. This is caused by decreases in phosphate demand due to depressed farm prices and a sluggish export market. Capacity utilization rates, currently 60 to 70 percent, averaged nearly 90 percent during the period from 1973-1981. However, TVA does not project any changes in capacity through 1985 due to over-capacity and market conditions.

2. Financial Characterization of the Industry

Financial data specific to the phosphoric acid segment of the phosphate fertilizer industry or even the phosphate fertilizer industry itself are not available. However, reasonably detailed profitability data are available for the fertilizer industry as a whole. (Cost data are not as plentiful.)

Return on net worth experienced by integrated companies fertilizer producers in the industry (principally phosphate and nitrogen manufactures) has ranged from 27.4 percent in 1980 to -2.9 percent just two years later. Before tax profit on sales and net worth, as compiled by the Fertilizer Institute for these integrated companies, are presented below:

Year	Before tax profit on sales (percent)	Before tax profit on net worth (percent)
1982	-1.05	-2.9
1981	8.79	12.2
1980	14.72	27.4
1979	11.73	20.6

In the past, profitability has been high enough to attract additional capital into the phosphate industry, which is exemplified by the increased capacities, particularly in the phosphoric acid and ammonium phosphate segments of the industry. Current low rates of profitability indicate why investment in expansion has decreased.

C. Production, Consumption, and Pricing of Phosphate Products

1. Production of Phosphate Fertilizer Products

The production of most phosphate fertilizer products increased from 1970 through 1980. Phosphate rock production grew from 38.7 million tons of rock to 60.0 million tons in 1980. Wet process phosphoric acid production grew at an average annual rate of 7.5 percent while the production of finished fertilizers increased at an average annual rate of 5.5 percent from 1970 through 1980.

After 1980, production of all products declined. The decline in production of phosphate products in 1981, 1982, and into 1983 corresponded in part to decreased domestic demand and a softening in the export market.

2. Consumption of Phosphate Fertilizer Products

The domestic consumption of phosphate fertilizer, like production, increased steadily through the seventies from 4.5 million tons of P_2O_5 in 1970 to a peak in 1979 of 5.6 million tons. This represents an increase of slightly over 2 percent per year. Consumption since that time has declined to 4.8 million tons in 1982.

There are two major reasons for the above trends. First, the average fertilizer application rate per unit of production steadily increased during the 70s, but leveled off in the 1981-1983 period. Fertilizer experts generally believe this leveling trend will continue. A second major determinate of domestic consumption is the total acreage planted. Beginning in 1972, total acreage planted in the U.S. increased steadily from 283 million acres in 1972 to 356 million in 1981. At that point the USDA increased various acreage set-aside programs to reduce production. Although consumption over the next 2 to 3 years is uncertain, it is likely that the rate of increase in phosphate use will be lower than the rate experienced in the 1970s.

3. International Trade and Competition

The U.S. is a major exporter of phosphate materials, annually exporting about 40 percent of production in recent years. These exports include a mix of materials, including phosphate rock, phosphoric acid, concentrated superphosphates, and ammonium phosphates. While exports of phosphate materials in all forms have increased, the higher valued products, particularly ammonium phosphates, have become an increasingly important part of total exports.

Exports of total phosphate fertilizer materials increased steadily until 1981 when total exports declined sharply. Because the U.S. dollar has been so strong on international monetary markets, U.S. phosphate has not been as attractive to foreign countries. Meanwhile other countries have been moving to increase phosphate productive capacities. These countries include Morocco, Senegal, Brazil, and Tunisia.

4. Phosphoric Acid Prices

Phosphoric acid prices are not widely published, partially because much of the phosphoric acid produced in the U.S. is used by the producing companies, hence few actual sales are made. Quoted prices may not accurately represent transaction prices because of price discounting practices. Quoted phosphoric acid prices in October 1983 declined in both real and nominal terms, reflecting the overall decrease in demand for phosphate fertilizers. We expect this price to return to higher levels as the phosphate fertilizer industry recovers.

D. The Louisiana Plants

Two basic scenarios were developed to illustrate the financial conditions of the Louisiana plants. The first, based upon 1982/83 conditions in the industry, showed the plants operating in a deficit position. The second was based upon industry conditions over the 1977 to 1981 period with the industry operating at a profit. The results of the second scenario are shown on Table A. Under this scenario, pretax profit margins were estimated to range from $7.50 to $10.95 per ton of 54% P_2O_5 phosphoric acid.

Table A. Estimates of average sales and cost experiences of four Louisiana phosphoric acid plants in 1979 to 1981. 1/

Item	Unit	$/Unit	Plant							
			Agrico Chemical		Allied Corporation		Beker Industries		Freeport Minerals	
			Per ton (dollars)	Annual 2/ (million $)	Per ton (dollars)	Annual 2/ (million $)	Per ton (dollars)	Annual 2/ (million $)	Per ton (dollars)	Annual 2/ (million $)
Sales	1 ton (54% P_2O_5)	172.80	172.80	115.2	172.80	46.0	172.80	132.5	172.80	216.0
Variable Costs										
Phosphate Rock	1.75 tons	24.00 3/	42.00	28.0	42.00	11.2	42.00	32.2	42.00	52.5
Transportation	1.75 tons	5.00	8.75	5.8	8.75	2.3	8.75	6.7	8.75	10.9
Sulfur	.50 tons	115.00	57.50	38.3	57.50	15.3	57.50	44.1	57.50	71.9
Power	120 kwh	0.04	4.80	3.2	4.80	1.3	4.80	3.7	4.80	6.0
Chemicals	-	-	2.00	1.3	2.00	0.5	2.00	1.5	2.00	2.5
Labor	-	-	13.00	8.7	15.00	4.0	12.00	9.2	13.00	16.3
Other	-	-	8.00	5.3	8.00	2.1	8.00	6.1	8.00	10.0
Total Variable Cost			136.05	90.6	138.05	36.7	135.05	103.5	136.05	170.1
Fixed Costs										
Depreciation			3.80	2.5	2.75	0.7	4.50	3.4	2.50	3.1
Taxes, Interest, Insurance			5.00	3.3	3.50	0.9	6.00	4.6	3.00	3.7
Maintenance			4.00	2.7	7.00	1.9	4.00	3.1	7.00	8.8
Overhead			13.00	8.7	14.00	3.7	13.00	10.0	14.00	17.5
Total Fixed Costs			25.80	17.2	27.25	7.2	27.50	21.1	26.50	33.1
Income (Loss) Before Taxes			10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Income Taxes 4/			3.80	2.6	2.60	0.7	3.60	2.8	3.60	4.5
Net Margins (Losses)			7.15	4.8	4.90	1.4	6.65	5.1	6.65	8.3

1/ Assumes the phosphoric acid produced is sold at quoted market rates.

2/ Annual production is calculated at 90 percent of capacity. Capacity ratings are as follows, expressed in thousand tons P_2O_5: Agrico 400, Allied 160, Beker 460, and Freeport 750. This converts to the following production capacity expressed as phosphoric acid, 54 percent P_2O_5: Agrico 741, Allied 296, Beker 852, and Freeport 1389.

3/ FOB Tampa.

4/ Average income tax rate estimated at 35 percent.

E. The Remedial Control Options

The critical factor in the continued operation of these four plants is the ability to store on land the gypsum by-product generated with the production of phosphoric acid. If environmentally acceptable and economically feasible alternatives are not available, these four plants will have to discontinue the manufacture of phosphoric acid. The data below show the remaining life of the gypsum stacks under normal operating rates if all of the gypsum is stored in these stacks.

Plant	Remaining stack capacity
Agrico Chemical Company	2.5 to 3 years
Allied Corporation	13 years
Beker Industries	2 months
Freeport Chemical	6 years

Source: "Technical Memorandum," August 1983.

All of the plants are currently stacking the gypsum except the Beker Industries plant which discharges into the Mississippi River.

The Effluent Guidelines Division considered different remedial options for control of the gypsum slurry and other wastes from the four Louisiana phosphoric acid plants. These options are:

1. discharge effluent and solids to the Mississippi River (raise pH from ∿1.5 to 6.5 prior to discharge),
2. ocean disposal of gypsum solids by barge,
3. barging the solids up or down the river to an alternate disposal site,
4. transporting dried solids to a disposal site (sanitary landfill) by truck,
5. use of a slurry pipeline to transport solids to an alternate disposal site,
6. reuse waste material,
7. use wetlands as disposal sites,
8. stabilization alternatives,
9. underground injection alternatives, and
10. discontinue operations.

Options 1 through 5 are considered technically feasible by EGD and the estimated costs for implementing these options were developed by the Technical Contractor and used to estimate the associated economic impacts. Options 6 through 9 were judged to be not feasible for technical reasons and associated costs were not developed.

Should the four plants be allowed to discharge directly, the question of the related cost savings is then appropriate. According to preliminary estimates, the costs for maintaining an active gypsum stack amounts to roughly $1.00 per ton of phosphoric acid (54 percent P_2O_5). Approximately one-half of that cost would be necessary for continued stack maintenance even though new additions of gypsum would not be added.

F. Projected Economic Impacts

The imposition of remedial options to control the current problems related to wastewater and waste gypsum management at the Louisiana Phosphoric Acid plants will result in economic impacts for the four plants. The expenditures for the remedial options will not improve operating efficiency but will result in increased costs to produce a unit of product. Three levels of impacts were examined. First we examined the increase in revenue required to maintain the profitability of the plants at baseline levels (no control options) and then we examined the possibility of passing these costs on to the end users. Second, the profit and loss situation for each of the plants under the various alternatives was examined, and third the industry production effects were examined.

Since we do not have detailed financial performance data on the plants, a basic assumption was made that the plants are as profitable as the industry average in the integrated company, basic producer category of the fertilizer industry. This may or may not be true. Nevertheless, it does allow a realistic look at the economic and financial impacts of the remedial options.

1. Price Effects

One economic indicator that is extremely useful is the estimated price increase that is required to offset the added cost of the remedial alternatives. The various control options result in an increase in production cost from $20.00 to $83.00 per ton of phosphoric acid (54 percent P_2O_5). This translates to a pretax increase of 12.3 to 49.9 percent depending on the alternative. Option 1 which calls for raising the pH of the gypsum slurry to 6.5 and then discharging the slurry into the Mississippi River is the least expensive alternative.

The phosphate fertilizer industry is competitive, produces a relatively homogenous product and currently has excess capacity. Further, the four Louisiana plants which are affected to not have a unique position in any of the geographical markets. Hence, it is doubtful that these plants could pass the costs of the remedial control options forward in the form of higher prices in other than token amounts.

2. Financial Effects

The profit and loss situation for each of the plants under the various remedial options is summarized on Table 8 below. Only the optimistic scenario was used as the short-term scenario currently prevailing in the industry would only show more negative results. The results indicate that if the plants are required to implement remedial control options they will be placed in a significant net operating loss situation and be forced to cease operations.

3. Production Effects

Assuming that the Louisiana phosphoric acid plants cannot remain competitive under the conditions of the remedial control options, we make the worst case assumption that they will close when they have no more room to store the waste gypsum. This will mean that if these plants operate at near capacity levels the Beker Chemical plant will close in 1984, and the Agrico Chemical plant will close in 1986 or 1987. (The other plants can remain in operation until 1990 or beyond, hence we will not consider the effects of their closure.)

Direct effects--employment. In addition to the financial loss associated with the potential plant closures, the closures would result in the loss of a substantial number of jobs. According to EGD the plants employ the following approximate number of people:

Plant	Approximate number of employees
Beker	400
Agrico	400
Allied	200
Freeport	500

Obviously if a plant closes, the jobs accounted with that plant will be lost. Since each of these plants are located in small communities, opportunities for immediate reemployment are not good.

Industry effect. Under the worst case scenario, the Beker Chemical plant located in Taft, Louisiana would probably be forced to discontinue operation if not allowed to continue discharging its gypsum slurry into the Mississippi River. This loss in industry capacity would mean that utilization rate in the industry would probably increase from a projected baseline in 1984 of 80 percent to 83-84 percent. We do not believe there would be any industry wide production effects resulting from the remedial control options in 1984. The Agrico plant closure would increase industry utilization by another 3-4 percent.

Table B. Effects on profit resulting from Remedial Control Options

Item	Agrico Chemical per ton (dollars)	Agrico Chemical annual (million $)	Allied Corporation per ton dollars	Allied Corporation annual (million $)	Beker Industries per ton dollars	Beker Industries annual (million $)	Freeport Minerals per ton dollars	Freeport Minerals annual (million $)
	Option 1 - Discharge Effluent and Gypsum Solids Into the Mississippi River 1/							
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	25.68	19.0	20.84	6.2	21.78	18.6	20.56	28.6
Net profits (loss)	(14.73)	(11.6)	(13.34)	(4.1)	(11.53)	(10.7)	(10.31)	(15.8)
	Option 2 - Ocean Disposal of Gypsum Solids 1/							
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	79.77	59.9	58.70	17.4	65.34	55.7	62.61	87.0
Net profits (loss)	(68.82)	(52.5)	(51.20)	(15.3)	(55.09)	(47.8)	(52.36)	(74.2)
	Option 3 - Barging the Gypsum to a Site Up or Down the Mississippi River 1/							
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	83.52	61.9	63.27	18.7	70.42	60.0	67.49	93.7
Net profits (loss)	(72.57)	(54.5)	(55.77)	(16.6)	(60.17)	(52.1)	(57.24)	(80.9)
	Option 4 - Transportation of Gypsum by Truck to Alternative Disposal Sites 1/							
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	64.53	47.8	39.83	11.8	83.11	70.8	54.72	76.0
Net profits (loss)	(53.58)	(40.4)	(32.33)	(9.7)	(72.86)	(72.9)	(44.47)	(63.2)
	Option 5 - Slurrying Gypsum and Pumping to a Site Up or Down the Mississippi River 1/							
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	41.23	30.5	31.24	9.3	34.77	29.6	33.32	46.3
Net profits (loss)	(30.28)	(24.7)	(23.10)	(7.8)	(24.52)	(21.7)	(23.07)	(33.5)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table A.

I. INTRODUCTION

This report is an economic analysis of various point source control alternatives for the Phosphate Subcategory of the Fertilizer Manufacturing Industry. The report focuses on the impacts resulting from the remedial control options currently under consideration for four phosphoric acid plants located in Louisiana. The four companies and their plant locations are:

Company	Plant location
Agrico Chemical Company	Donaldsonville, LA
Allied Corporation	Geismar, LA
Beker Industries	Taft, LA
Freeport Minerals	Uncle Sam, LA

A. Background

In April 1974, the BPT and BAT limitations for wet process phosphoric acid manufacturing plants issued by EPA essentially required, with minor limitations, "no discharge" of process water pollutants. The effluent guidelines were based on prevailing industry practices which involved recycle of the water and land disposal (stacking) of the gypsum byproduct.

Over the past several years, the phosphoric acid plants located in Louisiana have experienced greater difficulties than originally anticipated by the representatives EPA and the Companies in achieving the "no discharge" status as promulgated. These difficulties occurred because of certain site characteristics which prevent safe stacking of the gypsum to heights originally anticipated and utilized in Florida. Also, the high net positive water balance experienced in the area over the past several years further aggravated the problems. Knowledge of the compressibility and bearing strength of the Louisiana soils has greatly increased since the time of promulgation.

Several gypsum stack failures have occurred in the past few years. The most recent failure occurred following a 6.5 inch rainfall in 16 hours during August of this year. The occurrence of these failures, in spite of conscientious management of the stacks by soil experts and use of modern monitoring and management techniques, suggests that the issue of zero discharge and gypsum stack management should be reexamined for these four plants.

As a result, EPA has initiated action to evaluate the problems and proposed remedial options. Presently various alternatives as described in Chapter V are being studied to determine an appropriate course of action.

B. Scope of the Report

The purpose of this report is to provide an economic analysis of the various remedial regulatory options for the four phosphoric acid plants. The analysis investigated the direct firm level impacts as well as the overall impacts on the industry and their customers.

C. General Approach

Because of the time and information constraints involved in the preparation of this report, the major emphasis has been to present an overview of the present state of the fertilizer industry focusing, of course, on the phosphate sector. This includes the industry structure, financial characteristics of the industry and pricing and pricing considerations. Financial profiles were developed for the four Louisiana plants under study using known production rates and secondary data.

The control options used in the report were developed by the Effluent Guidelines Division in association with the Technical Contractor, Frontier Technical Associates, Inc. (Technical Memorandums" August 1982 and November 1983) 1/ Also, FTA developed cost estimates of the alternatives that were deemed to be technically feasible. The costs of the remedial options were applied to the financial profits of the individual plants and the resulting impacts studied.

It is well to note that in a report of this nature, a number of simplifying assumptions must be made that would not be necessary with the availability of more detailed primary information. However, we believe the assumptions are realistic and the accuracy of the impacts as developed are within reasonable limits.

1/ P. Michael and Terlecky, "Technical Memorandum: Surface and Subsurface Site Characteristics at Louisiana Phosphoric Acid Plants" 11 August 1982, and Technical Memorandum: Remedial Options - Louisiana Phosphoric Acid Plants," 18 November 1983. Prepared for Thomas Fielding, Environmental Protection Agency, Effluent Guidelines Division, Frontier Technical Associates, Inc. (FTA).

II. INDUSTRY DESCRIPTION

The fertilizer industry is comprised of establishments primarily engaged in manufacturing nitrogen, phosphorus, and potassium fertilizer. The focus of this report is on the production of an intermediate chemical, phosphoric acid, which is used in the manufacture of phosphate (phosphorus) fertilizer. The phosphate fertilizer industry and the facilities making up the industry are examined in this chapter.

Raw materials used in the production of phosphate fertilizer are phosphate rock and sulfuric acid. Intermediate and final products, for purposes of this study, are divided into three segments, each of which have minor variations. These segments are phosphoric acid and superphosphoric acid, normal and triple superphosphate, and ammonium phosphates. A schematic diagram of the production of phosphate fertilizer products is presented in Figure II-1.

In this chapter we will describe the raw materials, industrial processes, and final products of the industry, industry structure, and finally present an overview of the financial performance of the industry.

A. Industrial Process Description, Raw Materials, and Final Products

The phosphate fertilizer industry uses phosphate rock as the major raw material, which is principally mined in Florida and North Carolina, and to a limited extent in Tennessee, and the Western States. The major minerals of most phosphate rock are in the apatite group and can be represented by the generalized formula $Ca_5(F,Cl,OH)(PO_4)_3$. Small quantities of calcium may be replaced by many elements such as magnesium, manganese, strontium, lead, sodium, uranium, cerium, and yttrium. The major impurities include iron as limonite, clay, aluminum, fluorine, and silica as quartz sand.

After mining, the rock is processed in order to transform the rock into soluble P_2O_5, a form readily available to plants. The first of these processes is beneficiation. In this process the rock is ground by using various mills which reduce the material to very small particles.

The most common method of transforming the particles of phosphate rock into P_2O_5 is by treatment with a mineral acid such as sulfuric, nitric, or hydrochloric acid to make phosphoric acid. Sulfuric acid is used predominantly in the U.S., hence we will limit the process description to the use of sulfuric acid.

The acidulation process involves mixing the particles of phosphate rock with sulfuric acid after the acid has been diluted with water to a 55 to 70

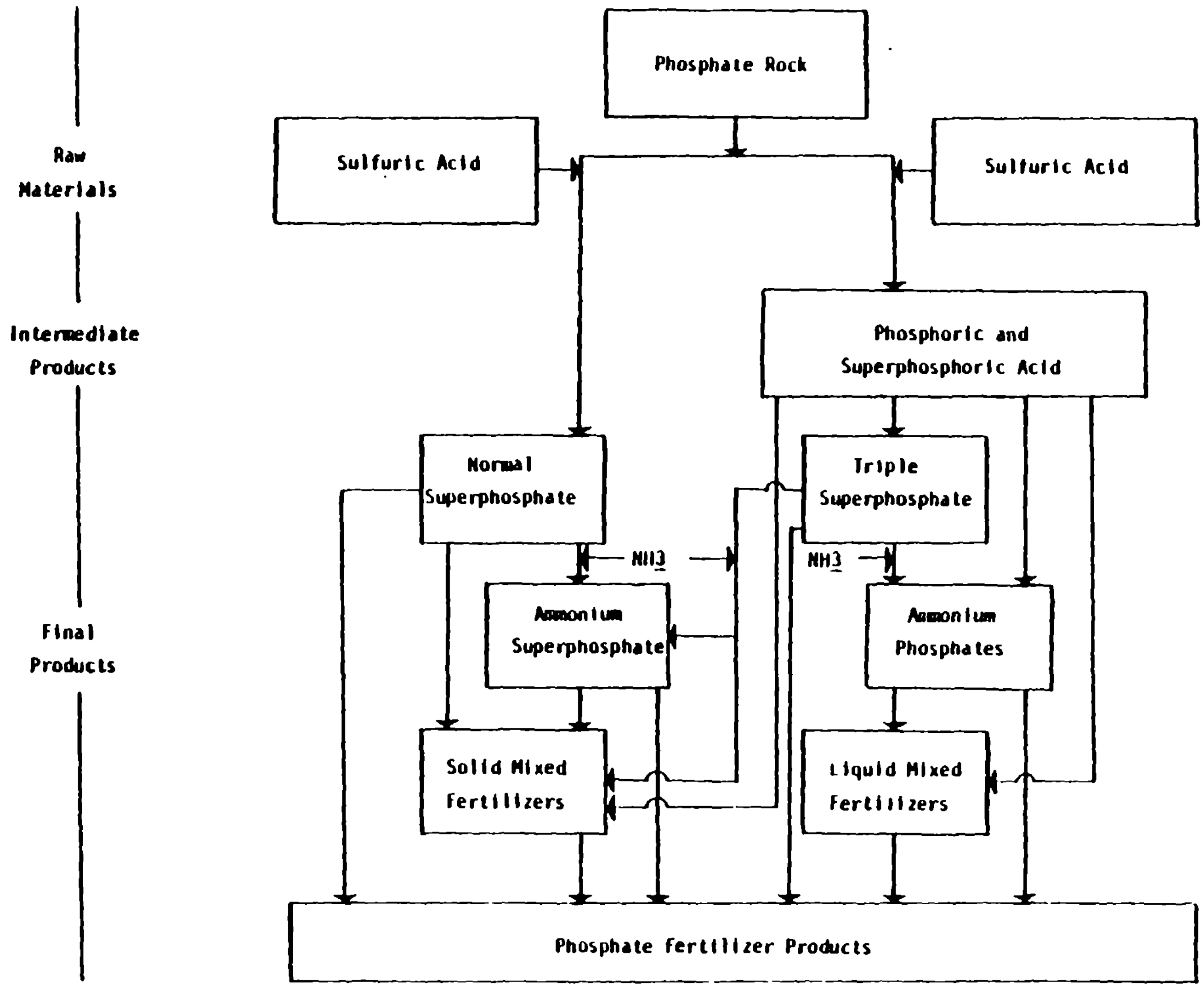


Figure II-1. Schematic diagram of the phosphate fertilizer production process.

percent H_2SO_4 concentration. This mixing takes place in a vessel (sometimes called a digestor) where it is held for several hours. The chemical reactions which occur produce gypsum, phosphoric acid and water. (Additional minor amounts of various elements present in the phosphate rock are also present, such as aluminum, lead, strontium, uranium and fluorine.)

Following the reaction in the digestor, the watery mixture of phosphoric acid and gypsum is pumped through a filter which separates the particulate gypsum and many impurities present from the phosphoric acid. The volume of the by-product gypsum is approximately five kilograms per kilogram of phosphoric acid. This gypsum is then sluiced with the contaminated water from the plant to a disposal area where the gypsum is settled out of the water and stored in stacks while the water is recirculated back to the acidulation process.

The phosphoric acid produced in this process, which is approximately 32 percent P_2O_5 is further concentrated to approximately 54 percent P_2O_5 by vacuum evaporation of water. Additional impurities are also removed from the phosphoric acid in this process.

Superphosphoric acid which is approximately 68 to 72 percent P_2O_5, is manufactured at numerous phosphoric acid plants. Superphosphoric acid is basically phosphoric acid (54 percent P_2O_5) which is further concentrated by a molecular dehydration process.

Normal superphosphate is a fertilizer material containing from 16 to 21 percent P_2O_5 which is made by reacting ground phosphate rock with a sulfuric acid and water solution. This product has declined in importance in recent years.

Triple superphosphate is manufactured in much the same way as normal superphosphate except that phosphoric acid is used instead of sulfuric acid in the acidulation process. Triple superphosphate typically accounts for over half of all phosphate fertilizer products.

Ammonium phosphates are produced by reacting phosphoric acid with anhydrous ammonia. Both solid and liquid ammonium phosphate fertilizers are produced in the United States with solid being of greatest importance and accordingly emphasized here. Ammoniated superphosphates are also produced by adding normal or triple superphosphate to the mixture.

Ammonium phosphate fertilizers have product nutrients ranging from 10 to 21 percent nitrogen and from 20 to 55 percent P_2O_5. Important ammonium phosphate fertilizer grades in the U.S. are:

Monoammonium phosphates (MAP)

11-48-0 11-55-0
13-52-0 16-20-0

Diammonium phosphates (DAP)

16-48-0 18-46-0

where N-P-K analysis represents

N = percentage of available nitrogen
P = percentage of available P_2O_5
K = percentage of soluble potassium oxide (K_2O)

These ammonium phosphate grades can be used directly or blended with other fertilizers, in both liquid and solid forms, to produce mixed fertilizers.

B. Industry Structure

The phosphate fertilizer industry, dependant on phosphate rock formations as its principle raw material, is concentrated in areas where the rock is mined. In this section we will present an analysis on the plant locations and capacities, with particular emphasis on capacity utilization and the role of the four affected plants located in Louisiana.

1. Location and Size of Plants

For purposes of this analysis we will consider only phosphoric acid plants, concentrated (triple) superphosphate plants and ammonium phosphate plants. The manufacture of other products, such as super phosphoric acid for example is usually done at plants producing phosphoric acid.

Table II-1 lists the plants who can produce phosphoric acid in the U.S. Thirty-two plants are able to produce, though several plants are idle at this time. These plants have a total capacity of over 11.5 million tons of P_2O_5 in 1983 (not counting the three idle plants which have a total capacity of 408,000 tons of P_2O_5). An analysis of the capacity size distribution of operating plants is presented below:

Capacity range (1000 tons P_2O_5)	Number of plants
<200	8
200-500	12
>500	8
Idle or insufficient information	4

Fifteen plants are located in Florida. These plants represent 63 percent of total production capacity. Only four plants are located in Louisiana, representing nearly 1.8 million tons P_2O_5, or 15 percent of total capacity. The remaining plants are located in the south and western area of the country.

Total phosphoric acid plant capacity has been increasing steadily during the past ten years. In 1973 total capacity was just over 6.4 million tons of P_2O_5 or only 56 percent of current capacity. This capacity increase resulted in spite of the closure of numerous plants which could not remain competitive, at least rock resources. A list of plants closing since 1976 is presented in Appendix A.

Table II-1. Wet-process phosphoric acid plant location and capacity, 1983. 1/

Company	Location	Capacity 2/ (1000 tons P_2O_5)
Agrico Chemical-Williams	Pierce, FL	420
	Donaldsonville, LA	400
Allied Corp.	Geismar, LA	160
Amax Corp.	Piney Point, FL 3/	-
Bartow Chemical Products	Bartow, FL	414
Beker Industries	Conda, ID	273
	Taft, LA	460
CF Industries, Inc.	Bonnie, FL	690
	Plant City, FL	650
Chevron Chemical Co.	Garfield, UT	100
	Rock Springs, WY 4/	-
Conserv Inc. (Phibro)	Nichols, FL	200
Farmland Industries	Pierce, FL	574
Fertilizer Co. of Texas	Pasadena, TX	50
First Mississippi Corp.	Fort Madison IA 3/	-
Freeport Minerals	Uncle Sam, LA	750
Ft. Meade Chemical Products	Ft. Meade, FL	440
Gardinier	Tampa, FL	720
W. R. Grace & Co.	Bartow, FL	310
International Minerals	Bonnie (N Wales), FL	975
	5/	500
Mississippi Chemical Corp.	Pascagoula, MS	243
Mobil (Pasadena Chemical)	Pasadena, TX	240
Mobil Chemical Co.	Depue, IL	125
Occidental Ag. Chemical	White Springs, FL	1,066
	Lathrop CA 3/	-
Olin Corp.	Joliet, IL	127
Royster Co.	Mulberry, FL	168
J.R. Simplot Co.	Pocatello, ID	240
	Helm, CA	125
Texasgulf (Aquitaine)	Lee Creek, NC	1,020
USS Agri-Chemicals	Bartow, FL	90
Total United States		11,530

1/ Capacity data for the Louisiana plants, estimated by TVA are not the same as estimates made more recently by representatives of EPA. The more recent EPA capacity estimates for the Louisiana facilities are used in Chapter 4.
2/ Capacity estimates are based on an operating year of 340 days.
3/ Idle.
4/ Insufficient information.
5/ Under construction.

Source: Fertilizer Trends, 1982, National Fertilizer Development Center, TVA, Muscle Shoals, Alabama.

The Tennessee Valley Authority (TVA) does not project any changes in capacity through 1985.

Concentrated superphosphate plants and plant capacities are presented in Table II-2. Only twelve plants manufacture concentrated superphosphate in the U.S., nine of which are in Florida. Total capacity of operating plants is just over 1.9 million tons of P_2O_5.

Unlike phosphoric acid production capacity, concentrated superphosphate capacity has been declining during the past ten years. Capacity in 1973 was nearly 2.6 million metric tons, 36 percent higher than 1983.

Ammonium phosphate plant location and capacity data are presented in Table II-3. There are currently twenty-four companies owning forty plants, thirty-five of which are operating. An analysis of plant capacity is presented below for operating plants.

Capacity range (1000 tons P_2O_5)	Number of plants
<50	11
50-100	5
101-300	9
301-500	5
>500	3
Idle	5
Insufficient information	2
Total Plants	40

Although still concentrated in Florida where twelve plants are located, ammonium phosphate plants are much more widely dispersed than phosphoric acid and concentrated superphosphate. Ammonium phosphate plants are located in seventeen states.

Ammonium phosphate plant capacity has generally been increasing during the past ten years, though capacity in 1983 was down slightly from 1982. Capacity in 1973 was 4.7 million tons of P_2O_5, only 76 percent of 1983 capacity.

2. Level of Utilization

Utilization rates have declined in the phosphoric acid industry since 1981, after being very high during the period from 1978-1980. While utilization rates must be interpreted with caution because of difficulty in estimating plant capacities, rates presented on Table II-4 indicate that utilization rates from 1973-1982 have averaged nearly 90 percent. 1/

More recently industry's utilization has declined. Phosphoric acid producers have felt the impact of depressed farm prices and federal crop

1/ Capacity estimates do not include idle or closed facilities.

Table II-2. Concentrated superphosphate plant location and capacity, 1983.

Company	Location	Capacity 1/
		(1000 tons P_2O_5)
Agrico Chemical-Williams	Pierce, FL	276
Amax Corp.	Piney Point, FL 2/	-
CF Industries, Inc.	Plant City, FL	375
Chevron Chemical Co.	Garfiled, UT	41
Gardinier	Tampa, FL	250
W.R. Grace & Co.	Bartow, FL	330
International Minerals	Bonnie (N Wales), FL	138
Occidental Ag. Chemical	White Springs, FL	78
Royster Co.	Mulberry, FL	97
J. R. Simplot Co.	Pocatello, ID	79
Texasgulf (Aquitaine)	Lee Creek, NC	255
USS Agri-Chemicals	Fort Meade, FL 2/	-
Total United States		1,919

1/ Capacity estimates are based on an operating year of 340 days.

2/ Idle.

Source: Fertilizer Trends, 1982, National Fertilizer Devlopment Center, TVA, Muscle Shoals, Alabama.

Table II-3. Ammonium phosphate plant location and capacity, 1983

Company	Location	Capacity 1/
		(1000 tons P_2O_5)
Agrico Chemical-Williams	Pierce, FL	83
	Donaldsonville, LA	756
Allied Corp.	Helena, AR	50
Amax Corp.	Piney Point, FL 2/	-
Beker Industries	Conda, ID	209
	Taft, LA	370
Brewster Phosphates	Luling, LA 2/	-
	Geismar, LA 2/	-
CF Industries, Inc.	Bonnie, FL	635
	Plant City, FL 2/	-
Chevron Chemical Co.	Richmond, CA	20
	Fort Madison, IA	58
	Kennewick, WA	36
	Garfield, UT	56
	Rock Springs, WY 3/	-
Conserv Inc. (Phibro)	Nichols, FL	184
Farmland Industries	Pierce, FL	336
Fertilizer Co. of Texas	Pasadena, TX 3/	-
	Kerens, TX	33
First Mississippi Corp.	Fort Madison IA 2/	-
Ford Motor Co.	Dearborn, MI	10
Gardinier	Tampa, FL	438
W. R. Grace & Co.	Bartow, FL	370
	Joplin, MO	10
	Columbus, OH	15
	New Albany, IN	25
	Wilmington, NC	25
	Henry, IL	25
International Minerals	Bonnie (N Wales), FL	750
Kaiser Steel Corp.	Fontana, CA	15
Mobil (Pasadena Chemical)	Pasadena, TX	230
Mobil Chemical Co.	Depue, IL	125
Occidental Ag. Chemical	White Springs, FL	188
Royster Co.	Mulberry, FL	80
J.R. Simplot Co.	Pocatello, ID	158
	Helm, CA	126
Tennessee Valley Authority	Muscle Shoals, AL	20
Texasgulf (Aquitaine)	Lee Creek, NC	343
USS Agri-Chemicals	Cherokee, AL	115
	Bartow, FL	242
Total United States		6,136

1/ Capacity estimates are based on an operating year of 340 days.
2/ Idle.
3/ Insufficient information.
4/ Under construction.

Source: Fertilizer Trends, 1982, National Fertilizer Development Center, TVA, Muscle Shoals, Alabama.

Table II-4. Indicative utilization rates for the phosphoric acid industry, 1973-1982.

Year	Estimated capacity	Production	Indicative utilization rate
	---------1000 tons	P_2O_5---------	percent
1982	10,714	8,523 1/	72
1981	10,663	9,228	87
1980	10,354	10,240	99
1979	9,729	9,554	98
1978	9,561	8,892	93
1977	9,296	8,038	86
1976	8,951	7,226	81
1975	8,753	6,921	79
1974	6,488	6,186	95
1973	6,233	5,919	95

1/ 1982 Production data from Bureau of Census, USDC.

Source: Capacity from Fertilizer Trends, Tennessee Valley Authority, Muscle Shoals, Alabama, various years.

set-aside programs (such as the payment-in-kind program) both of which have diminished the demand for phosphate fertilizer. Phosphoric acid producers have been reportedly operating at 60 to 70 percent capacity in 1983. (Chemical Marketing Reporter, July 18, 1983.)

The current industry slump has caused the delay and possible curtailment of expansion plans by numerous companies in all aspects of the production of phosphate fertilizer. (Chemical Marketing Reporter, 1983.) We anticipate that increased domestic demand brought about by increased acreage in crops (especially corn which is the most important crop in terms of phosphate use) and higher crop prices will cause utilization rates to increase. The industry may subsequently resume expansion investments, which appeared to be needed in the late 1970s because of the fast growing market at that time.

C. Financial Characterization of the Industry

Financial data specific to the phosphoric acid segment of the phosphate fertilizer industry or even the phosphate fertilizer industry itself are not available. However, reasonably detailed profitability data are available for the fertilizer industry as a whole. (Cost data are not as plentiful.) Two data sources are used in this report to provide a picture of the financial characteristics of the industry. The Fertilizer Institute publishes an annual report entitled "Fertilizer Financial Facts" (Fertilizer Institute). Data are provided for three segments of the industry:

1. basic potash producer, 6 companies reporting in 1980,
2. integrated company, basic producer, 32 companies reporting in 1982, and
3. integrated company, nonbasic producer, 8 companies reporting in 1982.

Data from the second group are used in this report.

The second data series is Robert Morris' Annual Statement Studies (Robert Morris, 1983). The Annual Statement Studies are developed from raw data the Robert Morris Associates (RMA) member bank's voluntary submit to RMA. These data are acquired from lending applications and do not constitute a random or statistical sample.

Both of the data series used include financial characteristics of nitrogen and potash producers as well as phosphate producers. Because producing segments of the fertilizer industry are related and the demand for one nutrient is related to the demand for other fertilizer nutrients, we believe that financial data representing the entire industry are representative of phosphate fertilizer and phosphoric acid producers. Hence, although much of the data used in this analysis is for the entire industry, we assume it represents the phosphate segment of the industry.

1. Revenues and Costs

Phosphoric acid, which is an intermediate product used in the production of phosphate fertilizer, is frequently used by the company manufacturing it and therefore not actually sold. However, other companies produce only phosphoric acid which is sold to other companies to manufacture the actual phosphate fertilizer. Currently, (November 1983) published prices for phosphoric acid are 167.50 per ton for 54 percent P_2O_5. (Chemical Marketing Reporter, 1983.) (Phosphoric acid will generally be considered to be 54 percent P_2O_5 in this report unless otherwise specified.)

The variable costs associated with the production of phosphoric acid typically range from 75 to 80 percent of sales. (David, et al., 1973.) The major available costs are for the raw materials, phosphate rock and sulfur. These inputs generally account for 75 percent of variable costs and nearly 60 percent of the total costs associated with the manufacture of phosphoric acid. Other significant variable costs include labor, chemicals, power and in some cases transportation.

Fixed costs generally range from 15 to 25 percent of sales. These costs are the most difficult to estimate because of wide variations from facility to facility. Depreciation for example varies widely because many plants are relatively old and the value of depreciable assets is accordingly low while other newer multi-million dollar plants have much higher depreciation rates. In addition to depreciation, major fixed costs include taxes (excluding income), insurance, interest, and overhead.

A more detailed analysis of revenues and costs is presented in Chapter IV.

2. Industry Profitability

The fertilizer industry has experienced significant fluctuations in profitability in the past, with some years being very profitable while other years the industry suffers substantial losses. The last year for which data are available (1982) indicates a poor year with the industry losing money.

Return on net worth experienced by integrated companies, basic producers, in the industry (principally phosphate and nitrogen manufactures) has ranged from 27.4 percent in 1980 to -2.9 percent just two years later. Return on net worth, as compiled by the Fertilizer Institute for integrated companies, basic producers are presented below.

Year	Before tax profit on sales (percent)	Before tax profit on net worth (percent)
1982	-1.05	-2.9
1981	8.79	12.2
1980	14.72	27.4
1979	11.73	20.6
1978		11.1
1977		15.7
1976		19.1

Generally profitability has been high enough to attract additional capital into the phosphate industry, which is exemplified by the increased capacities, particularly in the phosphoric acid and ammonium phosphate segments of the industry.

A slightly different situation is presented in the Annual Statement Studies (median quartile of 84 different firms).

Year ending March 31	Before tax profit on sales (percent)	Before tax profit on net worth (percent)
1983	1.4	10.1
1982	3.4	16.4
1981	2.6	13.6
1980	1.4	10.7
1979	1.8	14.1

Clearly the second data series represents a more uniform profitability over the past 5 years. This is because the Annual Statement Studies covers a broad segment of the industry and includes 84 companies; whereas, the Fertilizer Institute series is concentrated on integrated companies, basic producers (32 companies). The additional companies and segments tend to average the high and low characteristics of the basic producers. Also, the basic producers are more highly capitalized with total net sales reported at 81 percent of total assets. This is in contrast to sales at 220 percent of total assets as represented by the Annual Statement Studies. This is the reason for the seeming disparity in the return on sales data.

3. Financial Structure of the Industry

The fertilizer industry's assets can be classified as current and fixed. Current assets consist of cash, accounts receivable and inventory. Current assets generally comprise about 30 to 35 percent of total assets. Fixed assets, comprised mainly of property plant and equipment, account for 60 to 65 percent of total assets (The Fertilizer Institute, 1983). The proportion of fixed assets to total assets has been increasing in recent years, as a result of increased investment in the industry.

Total liabilities generally account for 60 to 70 percent of assets. Long term debt accounts for 15 to 20 percent of total assets and has been rising in recent years. Net worth ranges from 30 to 40 percent of total assets.

III. PRODUCTION, CONSUMPTION, AND PRICING OF PHOSPHATE PRODUCTS

In this chapter we will discuss the production, consumption, international trade, and prices for phosphate fertilizer products. These discussions will review the historical trends as well as our outlook for the future.

This discussion will generally focus on all aspects of the industry from phosphate rock and phosphoric acid to the final fertilizer products.

A. Production of Phosphate Fertilizer Products

The production of most phosphate fertilizer products increased from 1970 through 1980 according to data on Table III-1. Phosphate rock production grew from 38.7 million tons of rock to 60.0 million tons in 1980. Wet process phosphoric acid production grew at an average annual rate of 7.5 percent while the production of finished fertilizers increased at an average annual rate of 5.5 percent from 1970 through 1980. (The mix of production of finished fertilizers also changed with ammonium phosphates becoming more important while the production of normal superphosphate decreased substantially.)

After 1980, production of all products declined. The decline in production of phosphate products in 1981, 1982, and into 1983 corresponded in part to decreased domestic demand because of low agricultural prices and federal crops set-aside programs, a softening in the export market and a general recession which affected both the U.S. and world economy. Additional production capacities of some foreign countries also hurt the U.S. phosphate industry.

The current situation has led to an excess in capacity in the industry with major uncertainties as to future capacity and production levels. In response to large increases in export shipments that occurred in the late 1970s, many producers began capacity expansion programs. Some of the plants were built; however the net gain was reduced due to the closing of small noncompetitive plants (Section II-B1). Plans for new plants have been temporarily put on hold because of the extent of idle capacity now prevalent in the industry (Section II-B2). Future production levels are likely to increase but major uncertainties due to the international market and the domestic farm situation make forecasts difficult (Harre, 1983). In generally, we believe the production rate will increase in 1984, but the overall rate of growth over the foreseeable future will not be as great as the rate experienced in the 1970s.

Table III-1. U.S. production of phosphate rock, phosphoric acid, and phosphate fertilizer materials, 1970-1982.

Year	Phosphate rock 1/	Wet process phosphoric acid 2/	Fertilizer 2/ Superphosphate Normal	Fertilizer 2/ Superphosphate Concentrated	Fertilizer 2/ Ammonium phosphates	Fertilizer 2/ Other	Fertilizer 2/ Total
	million tons of material	million tons of P_2O_5	1000 tons of P_2O_5				
1970	38.7	4.6	670	1,474	2,092	361	4,597
1971	38.9	5.0	626	1,513	2,395	468	4,992
1972	40.8	5.8	677	1,659	2,577	570	5,483
1973	42.1	5.9	620	1,693	2,919	347	5,578
1974	45.7	6.2	698	1,719	2,654	296	5,367
1975	48.8	6.9	484	1,678	3,193	218	5,573
1976	49.2	7.2	383	1,595	3,614	232	5,824
1977	52.1	8.0	340	1,791	4,325	243	6,699
1978	55.2	8.9	291	1,820	4,875	190	7,176
1979	56.9	9.6	353	1,842	5,271	197	7,663
1980	60.0	10.2	425	1,693	6,125	66	8,309
1981	59.1	9.2	227	1,558	5,172	33	6,981
1982	NA	7.9	120	1,017	4,534	3/	5,671

1/ Source: "Phosphate Rock," Minerals Yearbook, U.S. Bureau of Mines.

2/ Source: "Inorganic Fertilizer Materials and Related Products," USDC Current Industrial Reports, Series M28A and M28B.

3/ Included in Ammonium Phosphates.

B. Consumption of Phosphate Fertilizer Products

The domestic consumption of phosphate fertilizer, unlike production, increased steadily through the seventies from 4.5 million tons of P_2O_5 in 1970 to a peak in 1979 of 5.6 million tons. This represents an increase of slightly over 2 percent per year (Table III-2). Consumption since that time has declined to 4.8 million tons in 1982. The major growth in this area has been the use of P_2O_5 in mixtures, which increased from 3.7 million tons to 4.8 million tons over the same period. Demand for direct application material has been flat.

There are two major reasons for the above trends. First, the average fertilizer application rate per unit of production steadily increased during the 70s but fertilizer experts generally believe there will be a general leveling of application rates (Harre, 1983 and Murphy, 1983). A second major determinate of domestic consumption is the total acreage planted. Beginning in 1972, total acreage planted in the U.S. increased steadily from 283 million acres in 1972 to 356 million in 1981. At that point the USDA began various acreage set-aside programs to bring production under control. Although production over the next 2 to 3 years is uncertain, it is certain that the rate of increase in acres harvested will not increase at the same rate as in the seventies.

Use of phosphate fertilizer, by state, in 1981 is shown in Figure III-1. It is well to note that approximately 70 percent of the phosphate fertilizer consumed in the United States would travel up the Mississippi River and supply the states in the Central United States. This is significant because it indicates that the Central United States is supplied by phosphate products produced both in the Louisiana plants and the competing plants in Florida.

C. International Trade and Competition

The U.S. is a major exporter of phosphate materials, annually exporting about 40 percent of production in recent years. These exports include a mix of materials, including phosphate rock, phosphoric acid, concentrated superphosphates, and ammonium phosphates. While exports of phosphate materials in all forms have increased, the higher valued products, particularly ammonium phosphates have become an increasingly important part of total exports.

Data on exports and imports of phosphate fertilizer materials are presented on Table III-3 (excluding phosphate rock). These data show a steady increase in total phosphate fertilizer materials until 1981 when total exports fell. Imports of phosphates have been steady since 1970, generally ranging from 200,000 to 300,000 tons of P_2O_5.

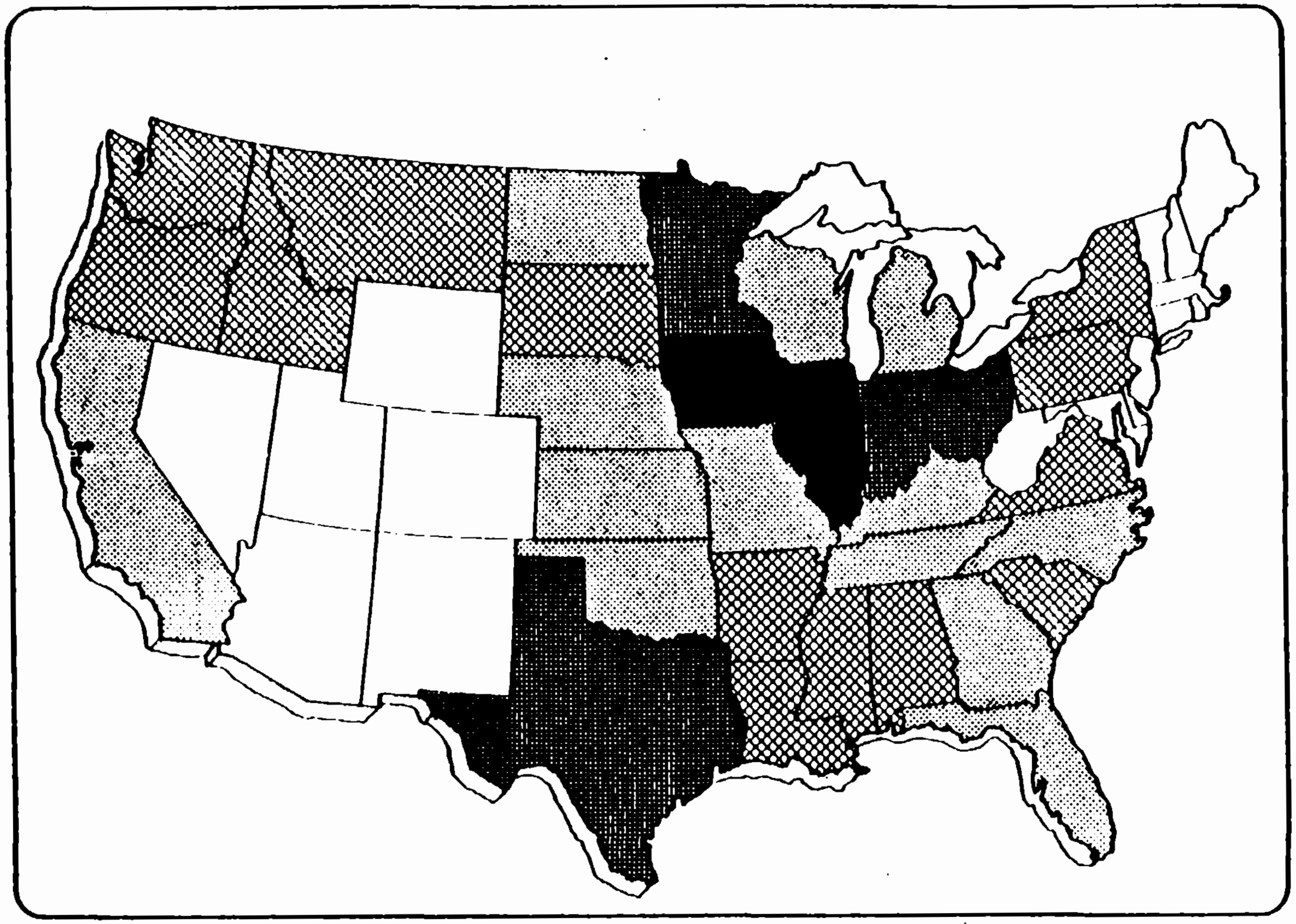
During the period 1970-1981 phosphate rock exports have ranged from 10 to 15 million tons of material. No significant trends in rock exports are in evidence.

Table III-2. U.S. consumption of phosphate fertilizer materials, 1970-1982

Year	P_2O_5 in Mixtures	Direct Application Materials: Superphosphate Normal	Superphosphate Triple	Ammonium Phosphates[a]	Total P_2O_5 Consumption
		(1000 tons of P_2O_5)			
1970	3,709	62	546	184	4,574
1971	3,943	55	556	179	4,803
1972	3,997	44	577	174	4,864
1973	4,237	35	569	201	5,085
1974	4,271	39	538	193	5,099
1975	3,718	36	531	176	4,511
1976	4,428	28	548	161	5,227
1977	4,790	26	559	185	5,630
1978	4,341	21	488	179	5,096
1979	4,769	17	555	150	5,606
1980	4,564	24	527	183	5,431
1981	4,735	22	472	134	5,434
1982	4,243	14	375	111	4,818

[a]Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0, and 27-14-0.

Source: USDA, Commercial Fertilizers, Statistical Reporting Service, annual reports.



KEY

(1,000 tons P_2O_5)

- 0 – 50
- 51 – 100
- 101 – 200
- 201 – 400
- >401

Figure III-1. Use of phosphate fertilizer by state, 1981.

Table III-3. Exports and imports of phosphate fertilizer materials, 1970-1981

Year	Exports				Imports
	Superphosphate	Ammonium phosphate	Phosphoric acid	Total	All materials
	(1000 tons P_2O_5)				
1970	333	470	36	839	280
1971	323	624	105	1,052	282
1972	405	835	41	1,281	340
1973	412	1,028	74	1,514	295
1974	494	916	220	1,630	293
1975	500	1,240	313	2,053	245
1976	591	1,307	442	2,340	226
1977	565	1,553	469	2,587	240
1978	748	2,237	527	3,512	224
1979	738	2,243	804	3,785	263
1980	790	2,781	818	4,389	220
1981	693	1,994	832	3,519	227

Source: "U.S. Exports," USDC Report FT410 and "U.S. Imports," USDC Report FT135, various annual reports.

The export market is expected to continue to grow at a higher rate than the domestic market, which the Bureau of Mines has projected at only one percent through 1987. However, because the U.S. dollar has been so strong on international monetary markets, U.S. phosphate has not been as attractive to foreign countries and the demand for phosphates has softened. Meanwhile other countries have been moving to increase phosphate productive capacities. These countries include Morocco, Senegal, Brazil, and Tunisia.

Major importers of U.S. phosphate products include Canada, Mexico, Japan, India, and China. Once a major importer, Brazil has decreased its dependency on U.S. phosphate, largely because of the inability to secure needed foreign capital. Subsequently Brazil has begun exploiting its somewhat lower quality resources.

We believe that the export market will continue to be very important to the phosphate fertilizer industry. However, the high valued dollar could continue to be a detriment to the growth of phosphate exports and an inducement to countries with phosphate rock to develop their resources.

D. Phosphate Product Prices

Prices for phosphate rock have increased steadily in nominal terms since 1973. However, in constant dollar terms (1982 dollars) prices have remained reasonably steady, varying between $25 and $28 per ton since 1977. Average annual prices in both nominal and constant (1982 dollars) are presented on Table III-4.

Phosphoric acid prices are not widely published, partially because much of the phosphoric acid produced in the U.S. is used by the producing companies, hence no actual sales are made. Quoted prices, which may not accurately represent transaction prices because of price discounting practices, are presented on Table III-4 for 1981 to October 1983. These prices are year-end quotes (except for 1983).

Quoted phosphoric acid prices in October 1983 declined in both real and nominal terms, reflecting the overall decrease in demand for phosphate fertilizers. We expect this price to return to higher levels as the phosphate fertilizer industry recovers.

Phosphate fertilizer prices are also presented on Table III-4 for two common types of fertilizer, superphosphate and an ammonium phosphate, 18-46-0. These prices, which are retail, reached all time highs in 1974 and 1975 when there was a significant fertilizer shortage (David, et al., 1976). Prices subsequently fell in 1977 and 1978 in both real and nominal terms. In 1979 real prices began to rise until 1981 when the phosphate fertilizer market weakened due to low agricultural prices and federal crop set-aside programs.

Table III-4. Nominal and real phosphate rock, phosphoric acid, and select phosphate fertilizer prices 1/

Year	Phosphate rock 2/		Phosphoric acid (54 percent P2O5) 3/		Fertilizer 4/			
					Superphosphate (46 percent P2O5)		18-46-0 5/	
	dollars per ton of material							
	Nominal	Real (1982)	Nominal	Real (1982)	Nominal	Real (1982)	Nominal	Real (1982)
1970	NA	-	NA	-	75.70	172.05	94.80	215.45
1971	NA	-	NA	-	76.60	166.52	95.20	206.96
1972	NA	-	NA	-	78.50	163.54	98.10	204.38
1973	5.66	11.10	NA	-	90.80	178.04	114.00	223.53
1974	10.98	19.61	NA	-	169.00	301.79	204.50	365.18
1975	22.99	37.69	NA	-	NA	-	239.50	392.62
1976	19.28	30.13	NA	-	NA	-	183.00	285.94
1977	17.48	25.71	NA	-	NA	-	183.70	270.15
1978	18.48	25.32	NA	-	153.00	209.59	186.00	254.79
1979	20.04	25.37	172.80	218.73	189.00	239.24	230.50	291.77
1980	22.78	26.49	172.80	200.93	246.00	286.05	288.00	334.88
1981	26.63	28.33	172.80	183.83	239.00	254.26	272.50	289.89
1982	NA	-	172.80	172.80	-	-	-	-
Oct.1983	28.00 6/	-	167.40	-	205.00	-	238.00	-

1/ Real prices are 1982 prices converted by using the GNP implicit price deflator.
2/ Prices are average prices received for both domestic and export sales.
3/ Prices are year end quotes. These prices may not actually represent transaction prices as acid may be sold at a discount or premium to quoted prices.
4/ Fertilizer prices are prices paid by farmers.
5/ 18-46-0 is a mixed or ammonium phosphate fertilizer which is 18 percent nitrogen, 46 percent phosphorus and 0 percent potassium. This is the most common type of phosphate fertilizer. The prices for this fertilizer also reflect the price of nitrogen.
6/ From Chemical Marketing Reporter. FOB Tampa.
NA-Not available.
Source: Phosphate rock prices from Minerals Yearbook, various years. Phosphoric acid prices are from "Chemical Marketing Reporter," various issues.

IV. THE LOUISIANA PLANTS

In this chapter we will discuss the characteristics of the four phosphoric acid plants located in Louisiana which would be affected by the alternative regulatory options. Topics to be addressed include the product mix and rated capacity for each product, important operational characteristics, and sales and cost characteristics. We will also discuss the importance of these facilities to the industry as a whole.

The emphasis of this discussion, especially the sales, cost, and income characteristics will be found on the manufacture of the phosphoric acid. The related activities of the plants will not be considered in detail.

The four companies and their plant locations are listed below.

Company	Plant location
Agrico Chemical Company	Donaldsonville, LA
Allied Corporation	Geismar, LA
Beker Industries	Taft, LA
Freeport Minerals	Uncle Sam, LA

A. Product Lines and Capacities

Numerous products are manufactured at each facility. All of the facilities produce sulfuric acid and phosphoric acid. Three of the four plants also produce some form of final product fertilizer, including nitrogen based fertilizers as well as phosphoric. None of the plants manufacture superphosphate.

Production and capacity information is presented below by product line.

1. Phosphoric Acid

The Tennessee Valley Authority (TVA) traditionally develops estimates of plant capacity, follows plant closings and forecasts new capacity for the entire fertilizer industry. We have used these estimates as an indicator of industry capacity for the Phosphate subcategory. The relationship between the four Louisiana phosphoric acid plants and total industry capacity is shown below:

Plant	Phosphoric acid capacity estimates 1/ --(1000 tons P_2O_5)--	Percent of industry capacity
Agrico Chemical Co.	400	3.5
Allied Corp.	160	1.4
Beker Industries	460	4.0
Freeport Chemicals	750	6.5
Total 4 Plants	1,770	100.0
Industry Total 2/	11,530	100.0

1/ From Fertilizer Trends 1982, TVA.
2/ Does not include idle capacity.

These four plants represent 12.5 percent of the total number of plants in the industry. They are, on average, slightly larger than the typical plant and comprise 15.4 percent of industry capacity.

The Allied Chemical Company plant also produces super phosphoric acid. The capacity for this product is unknown.

2. Sulfuric Acid

Sulfuric acid is manufactured by all four plants to be used in the production of phosphoric acid. Production data are only available on two plants, Agrico Chemical Company which manufactures approximately 1.2 million tons annually and Freeport Chemical which manufactures 2.3 million tons annually.

Because sulfuric acid is produced and used by a multitude of industries, a discussion of industry capacity is not appropriate.

3. Ammonium Phosphates

Ammonium phosphates are manufactured by two of the plants. These plants are listed below with their respective capacity estimates.

Plant	Ammonium phosphate capacity (1000 tons P_2O_5)	Percent of industry capacity
Agrico Chemical Company	756	12.3
Beker Industries	370	6.0
2 Plant Total	1,126	18.3
Industry Total	6,136	100.0

Source: Fertilizer Trends 1982, TVA

These two plants represent a significant portion of total ammonium phosphate capacity, 18.3 percent. It is unknown whether these facilities would continue to produce ammonium phosphates in the event that their phosphoric acid plants are unable to remain in operation.

4. Other Products

Ammonia is produced at Agrico Chemical with a productive capacity of 468,000 tons (3.0 percent of the industry total) and Allied Corporation with a capacity of 340,000 tons (2.2 percent of the industry total). Both of these plants use the ammonia in the production of ammonium phosphate (the Beker Industries plant purchase ammonia to manufacture ammonium phosphate.)

Both the Agrico Chemical plant and the Allied Corporation plant produce urea. Combined capacity is approximately 440,000 tons of urea or 7.1 percent of industry capacity.

Numerous other products are also manufactured at the Allied Chemical plant. These products are nitric acid, ammonium nitrate and hydrofluoric acid.

B. Phosphoric Acid Operational Characteristics

The critical factor in the continued operation of these four plants is the ability to store on land the gypsum by-product generated with the production of phosphoric acid. If environmentally acceptable and economically feasible alternatives are not available these four plants will have to discontinue the manufacture of phosphoric acid. The data below show the remaining life of the gypsum stacks under normal operating rates if all of the gypsum is stored in these stacks.

Plant	Remaining stack capacity
Agrico Chemical Company	2.5 to 3 years
Allied Corporation	13 years
Beker Industries	2 months
Freeport Chemical	6 years

Source: "Technical Memorandum," August 1983.

All of the plants are currently stacking the gypsum except the Beker Industries plant which discharges into the Mississippi River.

C. Sales, Cost, and Income Characteristics

For purposes of this analysis, sales, and costs are examined for the production of phosphoric acid only. We implicitly assume that all four plants produce and sell their phosphoric acid at market prices, even though three of the plants use phosphoric acid internally to make ammonium phosphate.

All of the estimates regarding both sales and costs were made from general knowledge of the industry and not necessarily from specific information provided by the four plants. Rather, the estimates were made with consideration toward the size, age, and other plant specific characteristics. However, we believe that the analysis presents an accurate picture of the relationship between sales and costs for the four plants involved.

Two cost and sales scenarios are presented. Initially we depict the industry's current situation (November 1983) when phosphate prices are depressed and the plants are operating at 70 percent of capacity. Secondly a market situation more in line with experiences from 1980 and 1981 when the industry was operating at near capacity with phosphate prices somewhat higher is depicted.

Table IV-1 depicts general sales and cost levels which have prevailed in 1982/1983 for the Louisiana phosphoric acid plants. During this period the entire industry cut back on production to approximately 70 percent of capacity. Net income (margins) were negative as indicated by a negative return on investment, which in 1982 was -2.9 percent.

Sales of phosphoric acid (54 percent P2O5) were estimated at $167.40 per ton for all facilities. We estimated total costs to range from $167.25 per ton to $168.75. (These costs do not include a return on investment.) Major components of production costs were variable costs which ranged from approximately $137 to $140 per ton. The major components of variable cost were for the raw materials used in the production of phosphoric acid, namely phosphate rock and sulfur. Fixed costs were estimated to range from $28 to $32 per ton.

During this time margins on a per ton basis were negative, subsequently total income was also negative for most of the facilities. We expect that this situation will not persist and income levels will rise to levels more equivalent to those experienced during the period from 1979 to 1981.

Table IV-2 depicts sales, cost, and income characteristics which we believe more accurately represent the long-run experience in the industry. These costs are estimates of the situation in the industry during the years from 1979-1981 when the industry was operating near capacity. Sales were estimated at $172.80 per ton of phosphoric acid (54 percent P2O5). Variable costs were slightly below those experienced in 1982/1983 because of lower phosphate rock prices, labor and power costs although sulfur costs were somewhat higher during this time period. Fixed costs were lower, primarily because higher capacity utilization rates spread these costs over a larger output.

Net margins on the production and sale of one ton of phosphoric acid (54 percent P2O5) ranged from approximately $7.50 to $11.00 before taxes and $5.00 to $7.00 after taxes.

Table IV-1. Estimates of average sales and cost experiences of four Louisiana phosphoric acid plants in 1982/1983. 1/

Item	Unit	$/Unit	Plant: Agrico Chemical Per ton (dollars)	Agrico Chemical Annual 2/ (million $)	Allied Corporation Per ton (dollars)	Allied Corporation Annual 2/ (million $)	Beker Industries Per ton (dollars)	Beker Industries Annual 2/ (million $)	Freeport Minerals Per ton (dollars)	Freeport Minerals Annual 2/ (million $)
Sales	1 ton (54% P_2O_5)	167.40	167.40	86.8	167.40	34.7	167.40	99.8	167.40	162.8
Variable Costs										
Phosphate Rock	1.75 tons	28.00 3/	49.00	25.4	49.00	10.2	49.00	29.2	49.00	47.6
Transportation	1.75 tons	5.00	8.75	4.5	8.75	1.8	8.75	5.2	8.75	8.5
Sulfur	.50 tons	100.00	50.00	25.9	50.00	10.4	50.00	29.8	50.00	48.6
Power	120 kwh	0.05	6.00	3.1	6.00	1.2	6.00	3.6	6.00	5.8
Chemicals	-	-	2.00	1.0	2.00	.4	2.00	1.2	2.00	1.9
Labor	-	-	14.00	7.3	16.00	3.3	13.00	7.8	14.00	13.6
Other	-	-	8.00	4.1	8.00	1.7	8.00	4.8	8.00	7.8
Total Variable Cost			137.75	71.3	139.75	29.0	136.75	81.6	137.75	133.8
Fixed Costs										
Depreciation			5.00	2.6	3.50	0.7	6.00	3.6	3.50	3.4
Taxes, Interest, Insurance			6.00	3.1	4.00	0.8	7.00	4.2	4.00	3.9
Maintenance			4.00	2.1	6.00	1.2	4.00	2.4	7.00	6.8
Overhead			15.00	7.8	15.00	3.1	15.00	8.9	15.00	14.6
Total Fixed Costs			30.00	15.6	28.50	5.8	32.00	19.1	29.50	28.7
Income (Loss) Before Taxes			(.35)	(0.1)	(.85)	(0.1)	(1.35)	(0.9)	.15	.3
Income Taxes 4/			-		-		-		.05	.1
Net Margins (Losses)			(.35)	(0.1)	(.85)	(0.1)	(1.35)	(0.9)	.10	.2

1/ Assumes the phosphoric acid produced is sold at quoted market rates.

2/ Annual production is calculated at 70 percent of capacity. Capacity ratings are as follows, expressed in thousand tons P_2O_5: Agrico 400, Allied 160, Beker 460, and Freeport 750. This converts to the following production capacity expressed as phosphoric acid, 54 percent P_2O_5: Agrico 741, Allied 296, Beker 852, and Freeport 1389.

3/ FOB Tampa.

4/ Average income tax rate estimated at 35 percent.

Table IV-2. Estimates of average sales and cost experiences of four Louisiana phosphoric acid plants in 1979 to 1981. 1/

Item	Unit	$/Unit	Plant: Agrico Chemical Per ton (dollars)	Agrico Chemical Annual 2/ (million $)	Allied Corporation Per ton (dollars)	Allied Corporation Annual 2/ (million $)	Beker Industries Per ton (dollars)	Beker Industries Annual 2/ (million $)	Freeport Minerals Per ton (dollars)	Freeport Minerals Annual 2/ (million $)
Sales	1 ton (54% P_2O_5)	172.80	172.80	115.2	172.80	46.0	172.80	132.5	172.80	216.0
Variable Costs										
Phosphate Rock	1.75 tons	24.00 3/	42.00	28.0	42.00	11.2	42.00	32.2	42.00	52.5
Transportation	1.75 tons	5.00	8.75	5.8	8.75	2.3	8.75	6.7	8.75	10.9
Sulfur	.50 tons	115.00	57.50	38.3	57.50	15.3	57.50	44.1	57.50	71.9
Power	120 kwh	0.04	4.80	3.2	4.80	1.3	4.80	3.7	4.80	6.0
Chemicals	-	-	2.00	1.3	2.00	0.5	2.00	1.5	2.00	2.5
Labor	-	-	13.00	8.7	15.00	4.0	12.00	9.2	13.00	16.3
Other	-	-	8.00	5.3	8.00	2.1	8.00	6.1	8.00	10.0
Total Variable Cost			136.05	90.6	138.05	36.7	135.05	103.5	136.05	170.1
Fixed Costs										
Depreciation			3.80	2.5	2.75	0.7	4.50	3.4	2.50	3.1
Taxes, Interest, Insurance			5.00	3.3	3.50	0.9	6.00	4.6	3.00	3.7
Maintenance			4.00	2.7	7.00	1.9	4.00	3.1	7.00	8.8
Overhead			13.00	8.7	14.00	3.7	13.00	10.0	14.00	17.5
Total Fixed Costs			25.80	17.2	27.25	7.2	27.50	21.1	26.50	33.1
Income (Loss) Before Taxes			10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Income Taxes 4/			3.80	2.6	2.60	0.7	3.60	2.8	3.60	4.5
Net Margins (losses)			7.15	4.8	4.90	1.4	6.65	5.1	6.65	8.3

1/ Assumes the phosphoric acid produced is sold at quoted market rates.

2/ Annual production is calculated at 90 percent of capacity. Capacity ratings are as follows, expressed in thousand tons P_2O_5: Agrico 400, Allied 160, Beker 460, and Freeport 750. This converts to the following production capacity expressed as phosphoric acid, 54 percent P_2O_5: Agrico 741, Allied 296, Beker 852, and Freeport 1389.

3/ FOB Tampa.

4/ Average income tax rate estimated at 35 percent.

estimated at $172.80 per ton of phosphoric acid (54 percent P_2O_5). Variable costs were slightly below those experienced in 1982/1983 because of lower phosphate rock prices, labor and power costs although sulfur costs were somewhat higher during this time period. Fixed costs were lower, primarily because higher capacity utilization rates spread these costs over a larger output.

Net margins on the production and sale of one ton of phosphoric acid (54 percent P_2O_5) ranged from approximately $7.50 to $11.00 before taxes and $5.00 to $7.00 after taxes.

V. THE REMEDIAL CONTROL OPTIONS

The Effluent Guidelines Division of EPA has considered ten different options for control of the gypsum slurry and other wastes from the four Louisiana phosphoric acid plants. These options are:

1. discharge effluent and solids to the Mississippi River (raise pH from ∿1.5 to 6.5 prior to discharge),

2. ocean disposal of gypsum solids by barge,

3. barging the solids up or down the river to an alternate disposal site,

4. transporting dried solids to a disposal site (sanitary landfill) by truck,

5. use of a slurry pipeline to transport solids to an alternate disposal site,

6. reuse waste material,

7. use wetlands as disposal sites,

8. stabilization alternatives,

9. underground injection alternatives, and

10. discontinue operations.

Options 1 through 5 are considered technically feasible by the Effluent Guidelines Division, and the associated costs developed by EGD are presented in the following section. Options 6 through 9 were judged to be not feasible for technical reasons and associated costs were not developed. For a more complete discussion of the options see: "Technical Memorandums", 11 August 1983 and 18 November 1983. The costs associated with discontinuing operations and closing the phosphoric acid plants and monitoring the stacks have not been considered. (Option 10)

A. Summary of Remedial Option Costs

The investment and operating costs for each of the options that were considered technically feasible are summarized by plant in Tables V-1-5. The costs presented here are taken from technical memorandum mentioned above and are only summarized in terms of investment and operating costs. For further technical detail and estimate of costs by component the reader is referred to the "Technical Memorandums."

Table V-1. Investment and annual operating costs for Option 1: Discharge Effluent and Gypsum Solids to River (raise pH) $1983

Plant	Daily flow	Capital investment	Operating and maintenance
	(MGD)	---------------($1000)---------------	
Allied	1.76	$ 2,258	5,849
Agrico	5.78	5,539	18,226
Beker	5.63	5,389	17,774
Freeport	8.80	$ 7,595	27,462
TOTAL	22.0	$20,781	$69,311

Source: Technical Memorandum

Table V-2. Investment and annual operating costs for Option 2: Ocean Disposal of Gypsum Solids $1983.

Plant	Waste gypsum produced annually	Capital investment	Operating and maintenance
	(1000 tons)	-------------($1000)-------------	
Allied	830	$ 6,635	$ 16,437
Agrico	2,560	21,896	55,939
Beker	2,640	21,233	52,600
Freeport	4,000	33,176	82,187
Four Plants	10,030	$82,942	$207,160

Source: Technical Memorandum

Table V-3. Investment and annual operating costs for Option 3: Barging of Gypsum to site up or down the river (20% solids slurry) $1983

Plant	Waste gypsum produced annually	Capital investment	Operating and maintenance
	(1000 tons)	------------($1000)	------------
Allied	830	$ 23,937	$ 15,300
Agrico	2,560	78,994	50,491
Beker	2,640	76,600	48,961
Freeport	4,000	119,687	76,502
Four Plants	10,030	$299,218	$191,254

Source: Technical Memorandum

Table V-4. Investment and annual operating costs for Option 4: Transportation by Truck to Alternative Disposal Sites (gypsum solids) $1983

Plant	Daily wt of gypsum	Annual landfill cost	Annual transportation cost	Total annual cost
	(tons)	($1000)		
Allied	8,000	$ 6,000	$ 5,800	11,800
Agrico	8,500	20,300	27,500	47,800
Beker	2,500	19,100	51,700	70,800
Freeport	12,500	29,800	$ 46,200	76,000
Four Plants	31,500	$75,200	$131,200	$206,400

Source: Technical Memorandum

Table V-5. Investment and annual operating costs for Option 5: Slurrying Gypsum and Pumping to a Site up or Down River $1983.

Plant	Waste gypsum produced annually	Capital investment	Operating and maintenance
	(1000 tons)	-------------($1000)-------------	
Allied	830	$26,064	$ 5,502
Agrico	2,560	86,011	18,156
Beker	2,640	83,404	17,605
Freeport	4,000	130,319	27,508
Four Plants	10,030	$325,798	$68,771

Source: Technical Memorandum

VI. PROJECTED ECONOMIC IMPACTS

The imposition of remedial options to control the current problems related to wastewater and waste gypsum management at the Louisiana Phosphoric Acid plants will result in economic impacts for the four plants. The expenditures for the remedial options will not improve operating efficiency but will result in increased costs to produce a unit of product. The extent of these impacts are analyzed in this chapter as well as the projected profitability of the plants before and after controls.

The economic impacts of the various remedial alternatives were projected using the methodology as described below in each of the respective sections. Basically, we first examined the increase in revenue required to maintain the profitability of the plants at baseline level (no control options) and the possibility of the plants passing these costs on to the end user. Second, we looked at the profit and loss situation for each of the plants under the various alternatives.

Production effects are also examined in this chapter. Production effects may result from two sources--plant closures resulting from the economic impact of the proposed remedial options, and/or production decreases or shifts in the regulated plants resulting from regulatory action.

In this case, we have examined the effects of an orderly shutdown of the four plants based upon the estimated life of their stacking capacity.

Since we do not have detailed financial performance data on the plants, a basic assumption was made that the plants are as profitable as the industry average in the integrated company, basic producer category of the fertilizer industry. This may or may not be true. Nevertheless, it does allow a realistic look at the economic and financial impacts of the remedial options.

A. Price Effects

1. The Price Increase Required by the Remedial Options to Maintain Profitability at the Baseline Conditions

One economic indicator that is extremely useful is the estimated price increase that is required to offset the added cost of the remedial alternatives. To estimate the required revenue increase we use an annualized costing formula. This analysis also has a second part. Once the price increase required is determined then the second question must be answered. This question addresses whether the price increase can be passed along to consumers in the form of higher profits, backward to raw material suppliers, absorbed in the profit margins of the plants or a combination of the above. This question will be addressed in the following section.

To determine the required revenue increase, capital (investment) costs, operating and maintenance costs, investment tax credits, depreciation, investment life, interest rates (cost of capital), and inflation need to be taken into account. The methodology developed herewith will incorporate all of these factors into one formula.

The derivation of the basic formula for the price impact analysis requires the following assumptions:

- there is no replacement investment for remedial control options.
- remedial control investments have zero salvage value.
- no differential inflation occurs among the cost or revenue items.
- the weighted average cost of capital and the marginal income tax rate remain constant during the life of the investment.
- depreciation is based on the 1981 Economic Recovery Act, Accelerated Cost Recovery System (ACRS) five-year rates.
- a 10 percent investment tax credit is applicable on remedial control investment and is realized in the year following the investment.

The resulting annual revenue increase will not affect the net present value of the phosphoric acid plants which we are unable to calculate due to a lack of data on book values, salvage values, depreciation and other variables needed to make such calculations.

The simplified formula for calculating the required revenue increase can be expressed as:

$$R_y = OM_y + \frac{I_o \ TAXF}{(1-t) \displaystyle\sum_{y=1}^{n} \frac{(1+inf)^y}{(1+d)^y}}$$

where

R_y = annual required revenue increase

y = time period (year)

OM_y = operation and maintenance costs in year y (for this analysis $OM_1 = OM_2 = OM_3$ etc.)

I_o = capital investment occurring at the beginning of the project.

t = marginal tax rate (for this analysis $t = .46$)

n = the expected life of the pollution control investment (for this analysis $n = 10$)

inf = inflation rate (for this analysis $inf = .06$)

d = cost of capital (for this analysis d = .12)

TAXF = constant which accounts for investment tax credit (assumed to equal .10) and the accelerated depreciation rate, depreciating the investment over five years as allowed by the 1981 Economic Recovery Act. Specifically

$$TAXF = 1 - \frac{.1 + .15t}{1+d} - \frac{.22t}{(1+d)^2} - \frac{.21t}{(1+d)^3} - \frac{.21t}{(1+d)^4} - \frac{.21t}{(1+d)^5}$$

Solving this equation for TAXF and substituting the result and the values for "inf," "d" and "t" into the original equation produces the required revenue formula as follows:

$$R_y = OM_y + .144\ I_o$$

This provides an annualized cost with allowances for depreciation and investment tax credit.

The results of the analysis are shown for each option and plant on Tables VI-1 through VI-5 and summarized below:

Option	Price increase required 1/ $ Per ton	Percent
1	20.56 to 25.68	12.3 to 15.3
2	58.70 to 79.77	35.1 to 47.7
3	63.27 to 83.52	37.8 to 49.9
4	39.83 to 83.11	23.8 to 49.6
5	31.24 to 41.23	18.7 to 24.6

In summary, the various control options result in an increase in production cost from $20.56 to $83.52 per ton of phosphoric acid (54 percent P_2O_5). This translates to a pretax increase of 12.3 to 49.9 percent depending on the alternatives considered. 1/

1/ The increases in cost from the remedial option alternatives presented here differ from those calculated by the technical contractor because of differences in cost of capital, tax considerations, also the increases in cost presented in this report are in terms of tons of 54% P_2O_5 phosphoric acid in contrast to reporting by the technical contractor which was based on annual operating cost on a per ton basis for P_2O_5 and labeled cost/ton WPA. In effect, it was the annualized cost divided by the capacity of total P_2O_5. Our analysis is based on 54 percent P_2O_5 phosphoric acid at the basic price of $167.40 versus the price per ton of phosphate P_2O_5 (100% equivalent) of $310 per ton.

Table VI-1. Annual and per ton cost increases resulting from the pollution control costs for Remedial Control Option 1: Raise pH and Discharge Effluent and Gypsum Solids into the Mississippi River

Plant	Annualized cost	Cost per ton of phosphoric acid 1/ (54 percent P_2O_5)	Percent price increase required 2/
	($1000)	(dollars)	
Agrico Chemical Company	19,024	25.68	15.3
Allied Corporation	6,174	20.84	12.4
Beker Industries	18,550	21.78	13.0
Freeport Minerals	28,556	20.56	12.3

1/. Per ton costs are estimated assuming the plants in question operate at 100 percent of capacity. Capacity estimates are as follows:

	Tons P_2O_5 (100 percent P_2O_5)	Tons phosphoric acid (54 percent P_2O_5)
Agrico Chemical Company	400,000	740,740
Allied Corporation	160,000	296,300
Beker Industries	460,000	851,850
Freeport Minerals	750,000	1,388,890

2/ Assuming a base price of $167.40 for phosphoric acid.

Table VI-2. Annual and per ton cost increases resulting from the pollution control costs for Remedial Control Option 2: Ocean Disposal of Gypsum Solids

Plant	Annualized cost	Cost per ton of phosphoric acid 1/ (54 percent P_2O_5)	Percent price increase required 2/
	($1000)	(dollars)	
Agrico Chemical Company	59,092	79.77	47.7
Allied Corporation	17,392	58.70	35.1
Beker Industries	55,658	65.34	39.0
Freeport Minerals	86,964	62.61	37.4

1/ Per ton costs are estimated assuming the plants in question operate at 100 percent of capacity. Capacity estimates are as follows:

	Tons P_2O_5 (100 percent P_2O_5)	Tons phosphoric acid (54 percent P_2O_5)
Agrico Chemical Company	400,000	740,740
Allied Corporation	160,000	296,300
Beker Industries	460,000	851,850
Freeport Minerals	750,000	1,388,890

2/ Assuming a base price of $167.40 for phosphoric acid.

Table VI-3. Annual and per ton cost increases resulting from the pollution control costs for Remedial Control Option 3: Barging the Gypsum to a Site up or Down the Mississippi River

Plant	Annualized cost	Cost per ton of phosphoric acid 1/ (54 percent P_2O_5)	Percent price increase required 2/
	($1000)	(dollars)	
Agrico Chemical Company	61,866	83.52	49.9
Allied Corporation	18,747	63.27	37.8
Beker Industries	59,991	70.42	42.1
Freeport Minerals	93,737	67.49	40.3

1/ Per ton costs are estimated assuming the plants in question operate at 100 percent of capacity. Capacity estimates are as follows:

	Tons P_2O_5 (100 percent P_2O_5)	Tons phosphoric acid (54 percent P_2O_5)
Agrico Chemical Company	400,000	740,740
Allied Corporation	160,000	296,300
Beker Industries	460,000	851,850
Freeport Minerals	750,000	1,388,890

2/ Assuming a base price of $167.40 for phosphoric acid.

Table VI-4. Annual and per ton cost increases resulting from the pollution control costs for Remedial Control Option 4: Transportation of Gypsum by Truck to Alternative Disposal Sites

Plant	Annualized cost	Cost per ton of phosphoric acid 1/ (54 percent P_2O_5)	Percent price increase required 2/
	($1000)	(dollars)	
Agrico Chemical Company	47,800	64.53	38.5
Allied Corporation	11,800	39.83	23.8
Beker Industries	70,800	83.11	49.6
Freeport Minerals	76,000	54.72	32.7

1/ Per ton costs are estimated assuming the plants in question operate at 100 percent of capacity. Capacity estimates are as follows:

	Tons P_2O_5 (100 percent P_2O_5)	Tons phosphoric acid (54 percent P_2O_5)
Agrico Chemical Company	400,000	740,740
Allied Corporation	160,000	296,300
Beker Industries	460,000	851,850
Freeport Minerals	750,000	1,388,890

2/ Assuming a base price of $167.40 for phosphoric acid.

Table VI-5. Annual and per ton cost increases resulting from the pollution control costs for Remedial Control Option 5: Slurrying Gypsum and Pumping to a Site Up or Down River

Plant	Annualized cost	Cost per ton of phosphoric acid 1/ (54 percent P_2O_5)	Percent price increase required 2/
	($1000)	(dollars)	
Agrico Chemical Company	30,542	41.23	24.6
Allied Corporation	9,255	31.24	18.7
Beker Industries	29,615	34.77	20.8
Freeport Minerals	46,274	33.32	19.9

1/ Per ton costs are estimated assuming the plants in question operate at 100 percent of capacity. Capacity estimates are as follows:

	Tons P_2O_5 (100 percent P_2O_5)	Tons phosphoric acid (54 percent P_2O_5)
Agrico Chemical Company	400,000	740,740
Allied Corporation	160,000	296,300
Beker Industries	460,000	851,850
Freeport Minerals	750,000	1,388,890

2/ Assuming a base price of $167.40 for phosphoric acid.

2. Expected Price Increases

The fertilizer industry is a competitive industry subject to various supply and demand characteristics and making basically a commodity type product. Little, if any, product differentiation is recognized among end users except the nutrient content, form--liquid or granular-- and mix of the product. The resulting effect is that the phosphoric acid production under question can easily be substituted for by phosphoric acid from other plants or other phosphate fertilizers. The orderly closing of numerous small plants (Section II-B and Appendix A) is cited as evidence of the extreme cost pressure in the industry. While we do not know the cost structure for those plants closed, we can only speculate that many of the closings occurred because of the narrow margins and homogeneity of the end products involved.

Second, there is currently over-capacity in the industry due to a number of factors described in the proceeding sections. The industry operated at a reported 72 percent of capacity in 1982 and was projected to decline another 5-6 percent in 1983, down from the 90 percent experienced in the 1970s (see II-B-2). In addition, approximately 25-30 percent of this capacity is used for export. Because of the over-capacity problems, proposed plants that were scheduled to be built have been postponed (II-B).

Third, it is clear from an examination of the geographical markets involved that the four plants in question do not have a unique position in any of the markets. Basically all of the phosphate that is used in the midwest originates from the mines in Florida. It is a matter of transporting the phosphate rock to Louisiana and using local supplies of sulphur and anhydrous ammonia, or transporting the sulphur and anhydrous ammonia to Florida to manufacture the phosphoric acid and disposing of the gypsum in that area. Obviously it would take a detailed examination to determine the least cost option, but our judgement at this point would suggest that the costs would be roughly equivalent. Further, the four plants do not enjoy a unique market in the midwest, as approximately 70 percent of the nations fertilizers is consumed in the midwest but only 15.4 is produced in the four plants in question. In other words, the phosphate products produced in Florida are presently competing in the midwest markets.

Economic theory suggests that when increased costs are incurred throughout an industry (or among all producers), price increases will result over the long run. However, in this situation only 15.4 percent of the industry capacity is affected. Given the present situation it is doubtful if the increased cost from remedial options could be passed forward to intermediate or end users in other than token amounts. Given the required price increase of 12 to 50 percent under the various options, and if a plant would price their product at that percent above the market price, buyers most likely would choose alternative suppliers. For integrated producers who require the phosphoric acid to manufacture the end products, it would simply be cheaper to buy the phosphoric acid from an alternative supplier although their internal cost structure may be such that a higher percentage of the control costs could be absorbed.

B. Financial Effects

The profit and loss situation for each of the plants under the various remedial options is presented in this Section. Only the optimistic scenario was used as the short-term (operating at a loss) scenario would only show more negative results. Pretax profitability was taken from Chapter V and combined with the annualized cost developed in Section VI-A. The net results, on an aftertax basis is shown on Tables VI-6-10.

Based on the assumptions used in the development of this report, the results indicate that if the plants are required to implement remedial options they will be placed in a net operating loss situation. As a result, the firms will be forced to cease operations and close their plants. This is true for the least cost alternative -- which is Option 1 -- and, of course, for the remaining options under study.

C. Production Effects

The current production capacity of the industry is 11.5 million tons of P_2O_5.

Assuming that the Louisiana phosphoric acid plants cannot remain competitive under the conditions of the remedial control options, we make the worst case assumption that they will close when they have no more room to store the waste gypsum. This will mean that if these plants operate at near capacity levels the Beker Chemical plant will close in 1984, and the Agrico Chemical plant will close in 1986 or 1987. (The other plants can remain in operation until 1990, hence we will not consider the effects of their closure).

1. Direct Effects -- Employment

In addition to the financial loss associated with the potential plant closures the closures would result in the loss of a substantial number of jobs. According to EGD the plants employ the following approximate number of people:

Plant	Approximate number of employees
Beker	400
Agrico	400
Allied	200
Freeport	500

Obviously if a plant closes, the jobs associated with that plant will be lost. Since each of these plants are located in small communities, opportunities for immediate reemployment are slim.

Table VI-6. Effects on profit resulting from Remedial Control Option 1: Discharge Effluent and Gypsum Solids Into the Mississippi River 1/

Item	Agrico Chemical per ton (dollars)	Agrico Chemical annual (million $)	Allied Corporation per ton dollars	Allied Corporation annual (million $)	Beker Industries per ton dollars	Beker Industries annual (million $)	Freeport Minerals per ton dollars	Freeport Minerals annual (million $)
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	25.68	19.0	20.84	6.2	21.78	18.6	20.56	28.6
Pretax profits (losses) after controls	(14.73)	(11.6)	(13.34)	(4.1)	(11.53)	(10.7)	(10.31)	(15.8)
Income taxes	--	--	--	--	--	--	--	--
Net profits (loss)	(14.73)	(11.6)	(13.34)	(4.1)	(11.53)	(10.7)	(10.31)	(15.8)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table IV-2.

Table VI-7. Effects on profit resulting from Remedial Control Option 2: Ocean Disposal of Gypsum Solids 1/

Item	Plant							
	Agrico Chemical		Allied Corporation		Beker Industries		Freeport Minerals	
	per ton (dollars)	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	79.77	59.9	58.70	17.4	65.34	55.7	62.61	87.0
Pretax profits (losses) after controls	(68.82)	(52.5)	(51.20)	(15.3)	(55.09)	(47.8)	(52.36)	(74.2)
Income taxes	--	--	--	--	--	--	--	--
Net profits (loss)	(68.82)	(52.5)	(51.20)	(15.3)	(55.09)	(47.8)	(52.36)	(74.2)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table IV-2.

Table VI-8. Effects on profit resulting from Remedial Control Option 3: Barging the Gypsum to a Site Up or Down the Mississippi River 1/

Item	Plant: Agrico Chemical		Allied Corporation		Beker Industries		Freeport Minerals	
	per ton (dollars)	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	83.52	61.9	63.27	18.7	70.42	60.0	67.49	93.7
Pretax profits (losses) after controls	(72.57)	(54.5)	(55.77)	(16.6)	(60.17)	(52.1)	(57.24)	(80.9)
Income taxes	--	--	--	--	--	--	--	--
Net profits (loss)	(72.57)	(54.5)	(55.77)	(16.6)	(60.17)	(52.1)	(57.24)	(80.9)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table IV-2.

Table VI-9. Effects on profit resulting from Remedial Control Option 4: Transportation of Gypsum by Truck to Alternative Disposal Sites 1/

Item	Plant							
	Agrico Chemical		Allied Corporation		Beker Industries		Freeport Minerals	
	per ton (dollars)	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	64.53	47.8	39.83	11.8	83.11	70.8	54.72	76.0
Pretax profits (losses) after controls	(53.58)	(40.4)	(32.33)	(9.7)	(72.86)	(72.9)	(44.47)	(63.2)
Income taxes	--	--	--	--	--	--	--	--
Net profits (loss)	(53.58)	(40.4)	(32.33)	(9.7)	(72.86)	(72.9)	(44.47)	(63.2)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table IV-2.

Table VI-10. Effects on profit resulting from Remedial Control Option 5: Slurrying Gypsum and Pumping to a Site Up or Down the Mississippi River 1/

Item	Plant							
	Agrico Chemical		Allied Corporation		Beker Industries		Freeport Minerals	
	per ton (dollars)	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)	per ton dollars	annual (million $)
Pretax profits before controls 2/	10.95	7.4	7.50	2.1	10.25	7.9	10.25	12.8
Annual cost of controls	41.23	30.5	31.24	9.3	34.77	29.6	33.32	46.3
Pretax profits (losses) after controls	(30.28)	(24.7)	(23.10)	(7.8)	(24.52)	(21.7)	(23.07)	(33.5)
Income taxes	--	--	--	--	--	--	--	--
Net profits (loss)	(30.28)	(24.7)	(23.10)	(7.8)	(24.52)	(21.7)	(23.07)	(33.5)

1/ Assumes remedial control costs cannot be passed on in the form of higher prices.

2/ Profitability estimates taken from Table IV-2.

2. Industry Effects

The recent decline in production of phosphate materials was precipitated by a corresponding decline in the demand for phosphate fertilizer in both domestic and export markets. Domestic markets have been hurt by low crop prices, farm income, and federal crop acreage reduction programs. The export market has been depressed because of a recession worldwide, the development by other countries of their phosphate resources and especially the hign value of the dollar relative to other foreign currencies.

Projections of future production levels, which must be made in view of demand are complicated by all of these factors. For this reason, projections of domestic use are normally only made for the upcoming crop year by the Tennessee Valley Authority. Projections of capacity and domestic demand are made for five years by the Food and Agriculture Organization of the United Nations (FAO), but these projections are made for North America as a whole and are largely outdated because of changing conditions in demand since they were made in February 1983. (Changes in market conditions since February stem from increased crop prices, reduced inventories, and the outlook for reduced federal crop acreage reduction programs, especially for corn, which will increase the demand for phosphate fertilizer, at least domestically.) Also FAO projections do not include any analysis of export markets.

Domestic demand for phosphate fertilizer in 1984 is expected to total approximately 5.1 million tons of P_2O_5 (Harre, personal communication, 1983). Export demand while expected to increase over the 1983 crop year, continues to be hurt by unfavorable exchange rates. The most current estimates are for a total export demand of approximately 4.1 million tons of P_2O_5 (Andrilenas, 1983).

Production of phosphoric acid will have to total approximately 9.2 million tons of P_2O_5 to meet demand requirements, assuming no changes in inventories. Given TVA's estimates of capacity of 11.5 million tons of P_2O_5 in the form of phosphoric acid, capacity utilization rates under baseline conditions will equal approximately 80 percent.

The implications of plant closures against this background are as follows:

The Beker Chemical plant, located in Taft, Louisiana would probably be forced to discontinue operations if not allowed to continue discharging its gypsum slurry into the Mississippi River. (We assume the other plants would continue to use remaining capacity to stack the gypsum by-product.) This loss in industry capacity would mean that utilization rates in the industry would probably increase to 83-84 percent. We do not believe that there would be any industry wide production effects resulting from the remedial control options in 1984.

It is difficult to forecast the impact of an additional closure in 1986 or 1987 because of the uncertainties on the demand side. If demand remains at the projected 1984 rate of 9.2 million tons, the industry utilization rate will be increased to 87 to 88 percent. In other words, the loss of the Beker and Agrico plants will reduce total capacity, according to TVA estimates to approximately 10.6 million tons of P_2O_5.

In order for there to be any production effects resulting from the remedial control options, we believe that domestic and export demand would have to reach a level near the maximum industry capacity of 10.6 million tons of P_2O_5. The likelihood of this happening by 1986 or 1987 is hard to assess because of the difficulty in making demand projections this far into the future. However, domestic demand is not expected to increase significantly. We are doubtful that the export market will increase enough to cause serious production effects during this time period.

Capacity can be added to the industry according to industry sources in approximately two to three years (Harre, Personal Communication, 1983). If industry utilization rates increase to maximum levels in the late 1980s, we believe investment in additional capacity would result.

Should the four plants be allowed to discharge directly, the question of the related cost savings is then appropriate. According to preliminary estimates, the costs for maintaining an active gypsum stack amounts to roughly $1.00 per ton of P_2O_5 (54 percent produced). Approximately one-half of that cost would be necessary for continued stack maintenance even though new additions of gypsum would not be added.

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APPENDIX A

Phosphoric Acid Plants Closing Since 1976

Company	Location	Approximate closing date
Arkla Chemical	Helena, AR	1976
Beker Industries	Marseilles, IL	1976
Bordon Chemical	Streator, IL	?
Collier Carbon	Pittsburg, CA	?
Duval Corp.	Hanford, CA	1977
First Mississippi	Fort Madison, IA	1982
Gulf Resources	Kellogg, ID	1982
Occidental Chemical	Lathrop, CA	1983
Olin Corp.	Pasadena, TX	1980
Stauffer	Pasadena, TX	1976
Stauffer	Garfield, UT	1982
Valley Nitrogen	Helm, CA	1981