

Report To The Congress

OF THE UNITED STATES

Phosphates: A Case Study Of A Valuable, Depleting Mineral In America

This report discusses the many problems and long leadtimes involved in phosphate development in the United States, world's largest producer of phosphates. Phosphate rock is the only known practical source of phosphorus, crucial to fertilizer used in agriculture.

Over the next two decades the richest U.S. phosphate deposits are likely to be depleted. There is cause for concern as to how new sources may be developed to meet the Nation's growing agricultural needs.

GAO recommends that the highest levels of Government begin promptly an assessment of access impediments to phosphate minerals and review of the Nation's long-range phosphate position regarding future availability, including legislative changes as may be needed to ensure supply.



007947



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-114812

The President of the Senate and the
Speaker of the House of Representatives

Ensuring an adequate supply of essential minerals such as phosphate rock is a problem facing this country now and will be of greater significance in the future as domestic sources are depleted. This report summarizes our analysis of the phosphate situation and recommends that the highest levels of Government begin promptly an assessment of access impediments to phosphate minerals and review of the Nation's long-range phosphates availability position including legislative changes as may be needed to ensure supply.

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretaries of Agriculture, Commerce, and Interior, and State; the Administrator, Environmental Protection Agency; the President, Export-Import Bank of the United States; and the Director, Office of Science and Technology.

A handwritten signature in black ink, appearing to read "James A. Sticks".

Comptroller General
of the United States

AWC 32

D I G E S T

The United States produces three-fourths of its annual 50-million-ton production of phosphate from central Florida. Sizable quantities of high-grade ore in this area are expected to become scarce over the next 20 years.

Over half of all phosphate production in the United States occurred in the last 12 years. The Nation is faced with the task of developing sizable new sources of phosphate within that time in order to continue meeting agricultural needs.

Phosphorus is one of three primary plant nutrients, along with nitrogen and potassium, used in chemical fertilizer. As such, it is absolutely vital to sustaining the Nation's agricultural output. Phosphate rock is the only practical source of phosphorus on a commercial scale.

As presently-mined, high-grade phosphate deposits are being depleted, there is a pressing public need that long-term availability be assured in order to maintain adequate food production.

The best data available now showing phosphate reserves--2.2 billion metric tons--indicate that these reserves probably will be adequate for the next 20 years. Production is projected to peak within 10 years and begin declining thereafter. In face of steadily rising demand, it is far from certain that the Nation's reserves will be adequate beyond the year 2000.

This does not mean that we will run out of phosphates, but over the next 30 years

we will be in a period of transition from cheap, convenient, readily-available supplies to higher-cost, harder-to-get-at sources.

Earlier GAO work has shown the need for anticipatory governmental action to ameliorate or preclude serious problems of materials availability. ^{1/} This present case study of phosphate minerals is a specific illustration of the general point. Failure to appreciate changing supply conditions for phosphates could have grave future consequences.

ELEMENTS OF A NATIONAL
MATERIALS PLANNING SYSTEM

GAO has identified elements necessary for planning for the availability of phosphates. They include the following four factors:

1. A reliable information system--
Bureau of Mines reserve figures on phosphates have fluctuated. Within a period of about a year its domestic reserve estimate was revised from 3.5 billion to 2.9 billion metric tons to 2.2 billion metric tons, the current figure. These estimates were based on visits and telephone calls by individual commodity specialists to companies who voluntarily supplied unverified information. In most cases, these specialists were required to use their own judgment and experience in determining what modifications to make in compiling data for national estimates.

Since then, the Bureau of Mines has made a more thorough analysis of phosphate reserves: its first study conducted in Florida is impressive. Other parts of the

^{1/}See GAO report "Learning to Look Ahead: The Need for a National Materials Policy and Planning Process," (EMD-79-30).

country, however, where most potential reserves lie, have yet to be inventoried. The Bureau of Mines relies too heavily on unverified, proprietary data without judging its reliability, a practice requiring further attention.

World-reserve estimates have fluctuated wildly from year to year and are considered far less reliable than the domestic estimates. As the availability of phosphates in the United States decreases, the need for accurate data will become more pressing.

2. Environmental and land-use concerns--
Past availability of phosphates depended only on whether or not it was profitable to produce them. Increasingly, availability is being subordinated to environmental impact and competing desires for nonmining uses of public lands. Government policies that seek to minimize environmental damage, as well as the Government's withdrawals of public land from any commercial development, diminish potential phosphate reserves significantly.

A typical company in northern Florida obtained land in 1973 and began applying for development permits but its operations are now scheduled to start in 1980, 7 years after acquiring the land.

Over fifteen years ago, four companies initially applied for permits to explore and lease areas within the Osceola National Forest in northern Florida. Osceola contains an estimated 120 million metric tons of phosphate rock. No leases have been issued yet, and a bill is now before the Congress that would prohibit phosphate mining entirely there for environmental reasons. Most decisions permitting use of public lands are made by balancing the immediate environmental impact and protection of endangered species of wild life with the economic importance of a single deposit. There is no known assessment that measures cumulative effects of environmental regulations and

related policies on the Nation's ability to produce such minerals as phosphates.

3. Assessment of world market outlook-- Global resources and consumption require a much clearer understanding of world phosphate conditions. Trends indicate that the United States, now a large exporter of phosphate, may have to reduce exports toward the end of the century. The Soviet Union, second largest producer, is expected to increase its phosphate imports.

Morocco probably will become the dominant world supplier by 2000 A.D. Morocco is estimated to have over two-thirds of the world reserves, some 18 billion metric tons, representing six times that of any other country.

These trends are bound to have economic and probably strategic implications for the United States and its allies. The changing phosphate supply conditions call for a review of Government activities affecting possible new sources of development, potential reduction in national consumption, and export policy.

4. A planning system for mineral availability-- A large number of separate Government agencies influence phosphate development but, at times, in counterproductive ways. The Government conducts no long-range planning for the availability of vital mineral resources. The country traditionally has relied on market forces to deal with shortages that develop and generally has expected private industry to meet the new demands.

Recognition is growing of the need for Government to plan for the long-term requirements of the country. The National Commission on Supplies and Shortages has called for fundamental changes in the way

this country considers the availability of materials.

As recommended in a previous report, the Government should establish an institutionalized planning process to insure materials availability. Periodic presidential assessments of materials' problems should be carefully considered. Currently, GAO is working with the Congress and other informed parties to define explicitly the content of a materials' policy planning process.

RECOMMENDATIONS TO THE
EXECUTIVE AGENCIES

The Secretary of the Interior should make a thorough review of the Nation's long-range phosphate position and report to the Congress on the future availability of phosphates. This phosphate assessment should be completed no later than December 31, 1981. Such a review should include:

- A comprehensive assessment of the phosphate reserves of the Nation and the world. To the extent that this is based on unverified data, the Secretary should judge the need, if any, for Government verification of proprietary (source) records.
- A determination of the extent that environmental concerns and land-use decisions are likely to restrict phosphate development.
- A review and evaluation of alternatives to dependency on imports and assessment of their costs.
- A Department of Agriculture estimate of future needs for phosphates in agriculture and possible food production alternatives to depending on foreign fertilizer sources.

Currently, Government phosphate research and development is conducted by the Bureau of Mines, the Tennessee Valley Authority, and several other organizations. The Office of Science and Technology Policy in the Executive Office

of the President should coordinate and make sure that an integrated research and development program for phosphates is begun and that the Office of Science and Technology Policy contribute as appropriate to the comprehensive review and report.

MATTERS FOR CONSIDERATION
BY THE CONGRESS

At the request of the Congress, GAO is monitoring the activities of the presidential task force on Nonfuel Minerals Policy Review. Our work to date indicates that the task force review has not addressed the phosphate issue in a coherent manner. This official inattention underscores, we believe, the need for Congressional mandating of the review called for in our report.

The Congress should require immediate work to start on the recommended review and be particularly alert to Interior's response to this report, as required by the Legislative Reorganization Act of 1970.

In the same fashion, the Congress should also carefully monitor the actions of the Office of Science and Technology Policy in assisting formulation of a comprehensive research and development program for phosphates. If the Office of Science and Technology Policy persists in its negative attitude and abdication of responsibility, the Congress should consider an alternative placement of responsibility for coordination of materials R&D issues of national concern.

AGENCY COMMENTS

Responses to this report from the Departments of Agriculture, Commerce, Interior, and State; the Environmental Protection Agency; the Export-Import Bank of the United States; and the Office of Science and Technology Policy are included as appendixes I through VII.

The responses from Agriculture, the Environmental Protection Agency, and Eximbank support GAO's conclusions and recommendations. They share GAO's concern for the implications of future phosphate availability and price. Furthermore, they are greatly interested in participating in the recommended Interior-led review.

The responses from Interior and Commerce and the Office of Science and Technology Policy show disagreement with some conclusions and recommendations. A principal reason given is that the issues raised are being considered by the Nonfuel Minerals Policy Review task force.

GAO strongly disagrees. As mentioned earlier, GAO has been monitoring the Nonfuel Minerals Policy Review at the request of the Congress.

To date, no serious attention has been paid to the phosphate problems identified here. Further, the latest draft report by the Nonfuel Minerals Policy Review task force does not consider the problems surrounding phosphates per se. Consequently, there is no basis for relying on the Nonfuel Minerals Policy Review.

Interior also thinks GAO's suggestion for a comprehensive review is not necessary because assessments by the Bureau of Mines are scheduled for completion by the end of 1982. However, with funds neither having been budgeted nor appropriated, the estimated completion date appears unrealistic.

Both Interior and Commerce state that problems of future phosphate development and production should be set forth in a globally broad context. The scope of analysis favored by Interior and Commerce coincides exactly with that envisioned and recommended by GAO.

Interior's belief that the great deal of variation in the estimates of national phosphates reserves is "the product of the methods employed to define resources and recoverable reserves" does not seem realistic. GAO repeats its recommendation that a new review include examination of the reliability of available data, and the need for appropriate Government verification of proprietary (source) records.

Of final note, the Office of Science and Technology Policy appears unwilling to

accept responsibility for coordinating an integrated national research-and-development program. An effective Federal R&D strategy for phosphates cannot be implemented merely through existing arrangements involving partial interagency coordination. Neither can extension of the status quo resolve deficiencies of concern to the private industrial sector. GAO urges the Office of Science and Technology Policy to reconsider its position and take the lead in assisting formulation of a comprehensive, national R&D program for phosphates.

C o n t e n t s

		<u>Page</u>
DIGEST		i
CHAPTER		
1	INTRODUCTION	1
	Scope	2
2	THE IMPORTANCE OF PHOSPHATES	3
	Sources of phosphate	3
	Phosphate usage	5
	The phosphate market	7
	Effects of phosphate prices and industry trends	8
3	THE FUTURE AVAILABILITY OF PHOSPHATES	11
	Phosphate demand	11
	Phosphate resources	14
	Available data on phosphate supply	17
	Identified reserves	18
	Economic reserves	21
	Need for more reliable data	23
	Need for planning	23
	Conclusions	23
4	ENVIRONMENTAL AND LAND-USE TRADE-OFFS	25
	Environmental impact of phosphate mining	25
	Environmental restrictions on mining	26
	Land use: Access to phosphates on public land	29
	Conclusions	31
5	WORLD OUTLOOK FOR PHOSPHATES	32
	Outlook for continued exports	32
	World reserves and resources	33
	Soviet Union	35
	Morocco	37
	Changing trade patterns	38
	Conclusions	39

	<u>Page</u>	
6	A MATERIALS' POLICY AND PLANNING PROCESS TO ENSURE THE AVAILABILITY OF ESSENTIAL RESOURCES	41
	Government's current involvement with phosphates	41
	Need for improved information about future phosphate supplies	41
	Need for research and development	43
	Need for more involvement	44
	Current efforts toward a materials' policy and planning process	46
	The President's nonfuel minerals' policy study	47
	Recent legislation and related activity	47
7	CONCLUSIONS AND RECOMMENDATIONS	49
	Conclusions	49
	Recommendations to the agencies	49
	Matters for consideration by the Congress	50
	Agency comments	51
 APPENDIX		
I	Letter dated May 21, 1979, from the Depart- ment of the Interior's Assistant Secretary, Policy, Budget and Adminis- tration	53
II	Letter dated May 21, 1979, from the Department of Agriculture's Forest Service Chief	55
III	Letter dated May 22, 1979, from the De- partment of State's Deputy Assistant Secretary for Budget and Finance	56
IV	Letter dated May 14, 1979, from the Export-Import Bank of the United States' President and Chairman	59
V	Letter dated June 29, 1979, from the Environmental Protection Agency's Assistant Administrator for Planning and Management	61

		<u>Page</u>
VI	Letter dated June 12, 1979, from the Department of Commerce's Assistant Secretary for Administration	64
VII	Letter dated May 21, 1979, from the Executive Office of the President, Office of Science and Technology Policy's Associate Director, Natural Resource and Commercial Services	69

ABBREVIATIONS

BLM	Bureau of Land Management
EPA	Environmental Protection Agency
GAO	General Accounting Office
MAS	Materials Availability System
NCSS	National Commission on Supplies and Shortages
NFMPR	Nonfuel Minerals Policy Review
OSTP	Office of Science and Technology Policy
TVA	Tennessee Valley Authority
U.S.S.R.	Union of Soviet Socialist Republics

CHAPTER 1

INTRODUCTION

Phosphorus is one of the three primary plant nutrients, along with nitrogen and potassium, contained in chemical fertilizer and, as such, is essential to modern agricultural production. The only practical source of phosphate on a commercial scale is phosphate rock. ^{1/} The United States has long been the world's leading producer, user, and one of the leading exporters of phosphate rock and processed phosphates. The large U.S. production has come largely from the Bone Valley formation of central Florida, one of the richest phosphate deposits in the world. But this source of low-cost, easy-to-process ore is now being depleted. United States' phosphate production from these deposits is projected to peak in 1985, and to steadily decline thereafter. Current domestic high grade reserves, in fact, probably will be exhausted over the next 30 to 40 years.

This does not mean that we will run out of phosphates. Because they are such an absolute necessity, phosphates will most likely continue to be produced--somewhere, at some price. Over the next 30 years, however, we will be in a period of transition from cheap, convenient, readily-available supplies to higher-cost, harder-to-get-at sources. We will probably move from assured self-sufficiency and a dominant exporter position to one of increasing dependency on possibly unreliable foreign sources of supply. Since phosphates are a fundamental necessity to agriculture, there may also be strategic implications to this transition. The situation, in short, is somewhat analogous to that now being experienced with oil.

It is the purpose of this report to examine the degree of Government planning for the transition period, to raise those questions of public policy we think need to be addressed, and to examine the extent to which the Government is dealing with them now. In many ways, phosphate depletion serves as a case study of the Government's role generally in planning for the continued availability of essential natural resources. The energy supply lessons of the early 1970s taught us that

^{1/}A rock that consists of calcium phosphate together with other minerals, and is a source of phosphorus used in fertilizer production.

the continued availability of resources cannot be taken for granted. We expect materials' availability to be of even greater concern in the years ahead. Phosphates is a case in point.

SCOPE

We interviewed officials of the Departments of Interior, Agriculture, State, Commerce, and the Environmental Protection Agency to obtain their views on phosphates. Within the Department of the Interior, we contacted officials at the Bureau of Mines, the Geological Survey, Fish and Wildlife Service, and the Bureau of Land Management.

State officials in Florida, Idaho, and North Carolina were also interviewed to learn about their programs concerning mining--especially phosphate mining. We also visited mines in those States to discuss phosphate-mining techniques, the effects of environmental regulation on the industry, and methods being used to estimate the quantity of domestic phosphate reserves and resources. Further, we researched appropriate literature, interviewed several expert consultants on phosphates, and asked Chase Econometric Associates to prepare certain phosphate projections for this report.

CHAPTER 2

THE IMPORTANCE OF PHOSPHATES

As presently-mined, high-grade phosphate deposits are being depleted, there is a pressing public need that long-term availability be assured in order to maintain adequate food production.

The development of new phosphate sources, however, even more than most other minerals, raises a whole host of public issues. There is first controversy over the reliability of official phosphate statistics and what they mean. There is opposition to strip mining, and the necessarily slow land reclamation that phosphate mining entails. There is competition for scarce water resources, of which phosphate processing is a prodigious consumer, and worry over possible water pollution, eutrophication (overenrichment of plant life in the water), and salt water intrusion. There is also concern over the destruction of wildlife. Because many of the potential sources of additional reserves are on Federal land, the future of phosphates awaits resolution of the complex federal land-use issues.

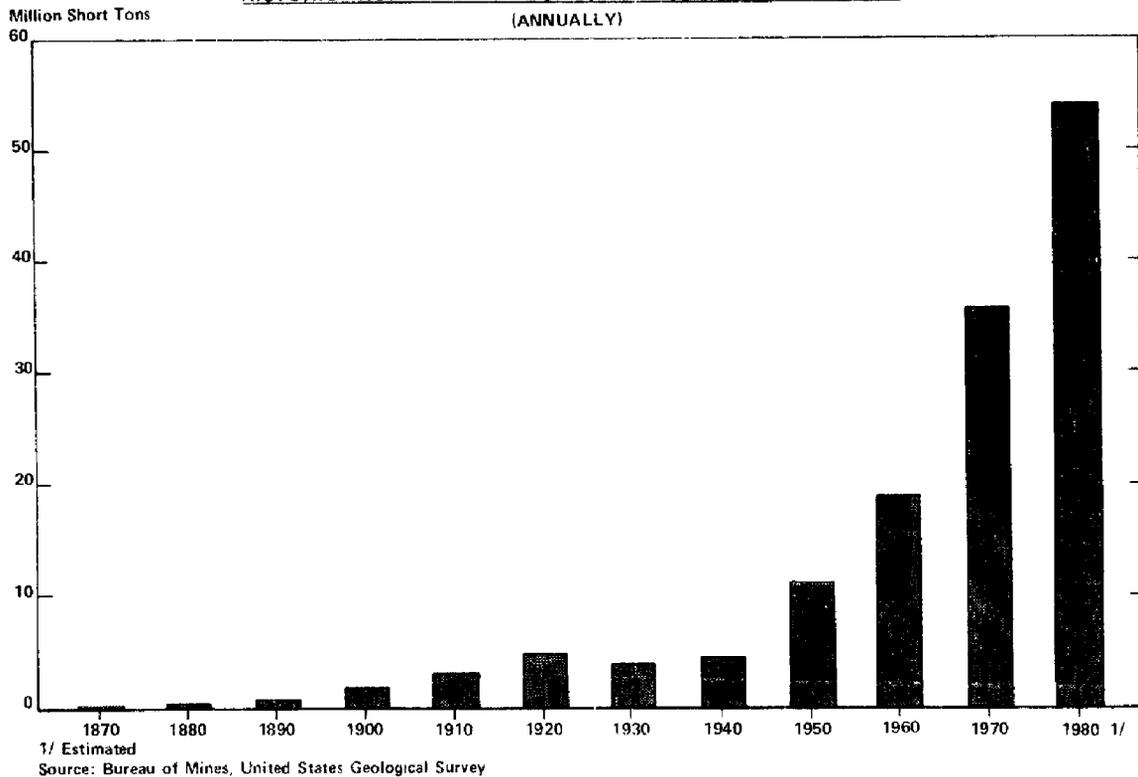
All of these questions are discussed in some detail in the chapters that follow. This chapter is intended to outline the general importance of phosphate--where it comes from, how it is used, and its general economic effect, particularly on agriculture.

SOURCES OF PHOSPHATE

Phosphorus is believed to have been used as a fertilizer since prehistoric times, probably in the form of bone, guano, or fish meal. It was first isolated by Hennig Brand in 1669, but not identified as the source of a plant nutrient until 1800. Justus Von Liebig dissolved bone in sulfuric acid, demonstrating that it could be rendered into soluble phosphoric acid that was more readily available to plants as fertilizer. Following that discovery, the demand for bones was so great that European battlefields were dug up and the bones shipped to England. It was soon discovered that phosphoric acid could also be derived from phosphate rock, and in 1847, the first few tons were dug up in Suffolk, England. Phosphate production in North America began in Canada in 1863, and in South Carolina in 1867. By 1870 production of phosphate rock

in the United States had reached 66,000 metric 1/ tons; today it is close to 50 million metric tons a year.

Figure 1
HISTORIC PRODUCTION OF DOMESTIC PHOSPHATE PRODUCTION
(ANNUALLY)



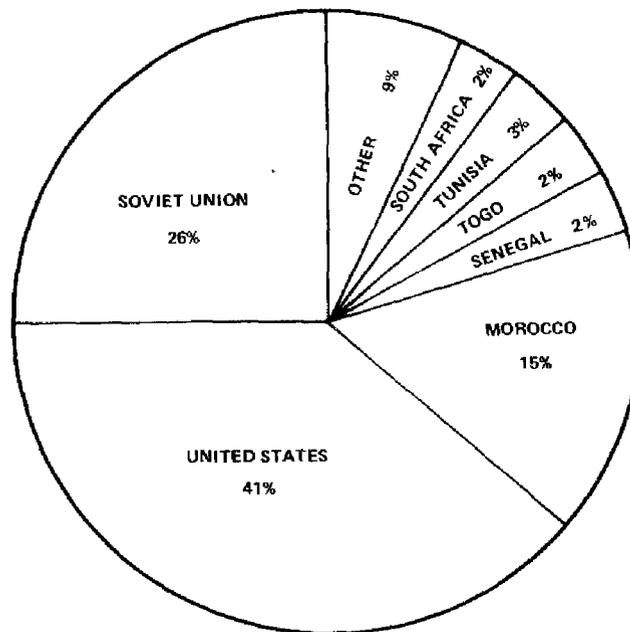
The estimated current world phosphate rock production is 120 million metric tons, of which about 80 percent is from sedimentary marine deposits. They are believed to have been formed by the upwelling of sea water or the disposition of phosphorus from warm currents on the continental shelves or interiors. The richest of these deposits, such as those in Florida and Morocco, were formed by submarine reworking of a phosphate-rich residuum. These were then refined by weathering and leaching over millions of years.

Another 17 percent of world production is from igneous rock formations, notably those of the Kola Peninsula in Russia and Phalaborwa in South Africa. The remaining 3 percent of

1/Reserves and production are expressed in metric tons (2204.6 lb.) except in those cases where short tons (2000.0 lb.) are specifically noted (Chase Econometrics' and Zellars-Williams' studies).

production is from the guano-derived deposits in Peru. The United States, the Soviet Union, and Morocco are by far the largest producers of phosphate rock.

Figure 2
SOURCES OF WORLD PHOSPHATE PRODUCTION 1978



Source: Bureau of Mines

PHOSPHATE USAGE

Phosphate rock in upgraded form is important to both agriculture and industry. Most of this upgrading is now carried out by chemical means, largely through the reaction of a strong inorganic acid (primarily sulfuric acid) with the phosphate rock to remove major impurities and to produce soluble phosphate.

About 90 percent of the world's phosphate production is used for agriculture, mostly fertilizer, but with some (about 2 percent) used as animal feed. The other 10 percent is used in the production of elemental phosphorus to make a wide variety of industrial chemicals.

In the United States, phosphate rock is usually strip-mined ^{1/}, and processed into fertilizer or exported directly as rock. Lesser quantities are used for industrial chemicals. The main source of rock is Florida (81 percent), the Western States, mostly Idaho (10 percent), North Carolina (5 percent), and Tennessee (4 percent). About half of Idaho's production and all of Tennessee's is for industrial phosphorus. About 28 percent of total rock production is exported, most of it from Florida and North Carolina.

These phosphate fertilizers stimulate root growth and expedite plant maturity, thereby increasing yields and shortening the crop cycle. Although soils often contain some natural phosphate, it is not normally in a form that can be readily assimilated by plants; hence the increasing use of phosphatic along with the other chemical fertilizers.

Fertilizer use in the United States has doubled since 1960. During that period yield per acre rose over 30 percent while growing time was more than cut in half. It is fair to say, we think, that the continuing series of record U.S. crops in recent years would not have been possible without this increased fertilizer usage. Six crops in particular account for over 80 percent of phosphatic fertilizer use: corn (40 percent), hay and pasture (13.6 percent), wheat (11.3 percent), cotton (6.7 percent), oats and barley (5.4 percent), and soybeans (5 percent). These crops are not only basic to domestic agriculture, but contribute importantly to world food needs and our own balance of trade. Half of our wheat, cotton, and soybean production is now exported along with one-fourth of all feed grains.

On a world scale, phosphatic fertilizer usage has shown similar increases in the other industrialized countries, but relatively little use thus far in the lesser developed

^{1/}There are a few relatively small underground mines in Montana.

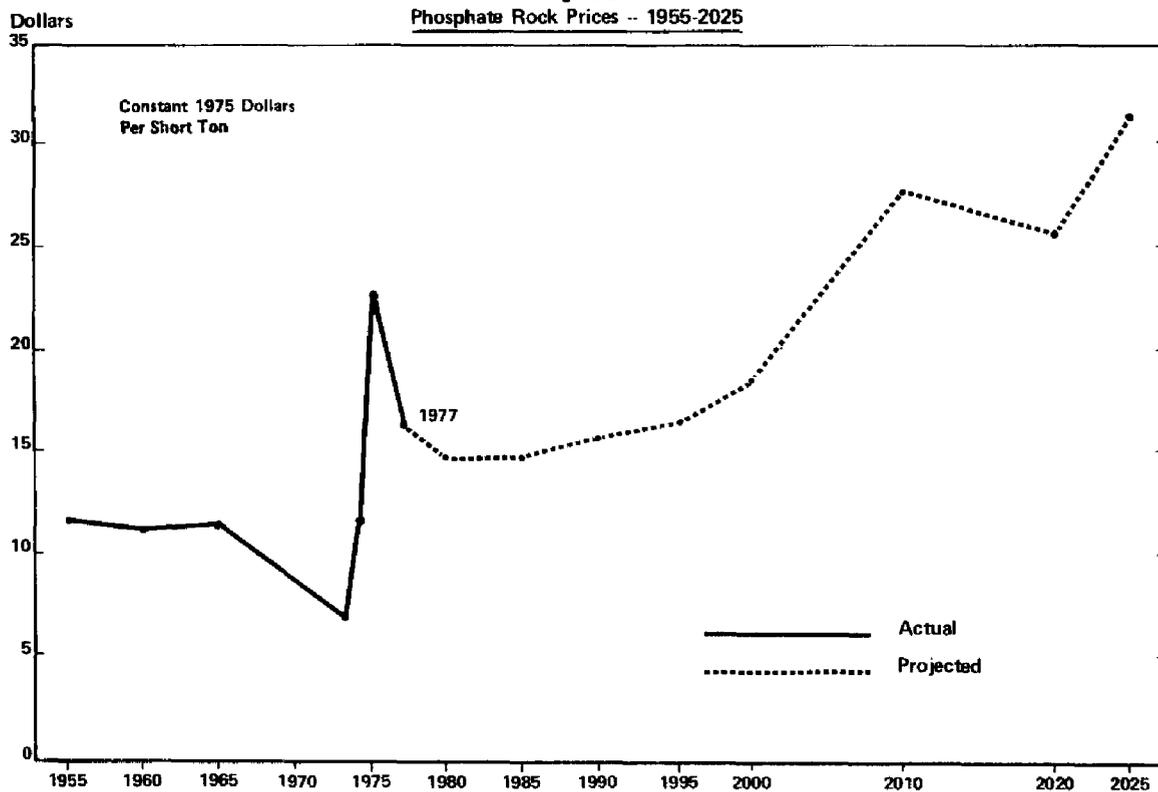
countries where the most urgent population pressures are occurring. It is pertinent to note that the high yield varieties of grain, which are being counted on to solve world food problems, are generally dependent on the heavy use of chemical fertilizer.

THE PHOSPHATE MARKET

Fertilizer demand obviously stems from the demand for the products fertilizers help to produce. Thus, fertilizer usage depends heavily on anticipated crop prices and the ratio of those prices to that of fertilizer. The rapid growth of fertilizer use during the 1960s was due to declining fertilizer prices during a period of stable crop prices. Fertilizer prices declined during this period because of technical innovations and a favorable investment climate that greatly increased productive capacity and production. By the early 1970s, demand had caught up with production, but price controls prevented price rises and demand continued to grow and accelerate until 1974. This was, in fact, a time of tremendous demand on the world grain markets, when acreage controls were lifted in the United States and farmers encouraged to maximize production. Dollar devaluation also stimulated U.S. farm exports at the same time.

With price controls imposed by former President Nixon in 1971, however, there was no incentive to increase fertilizer capacity, and fertilizer shortages were widespread by 1974. With the lifting of price controls, fertilizer and phosphate rock prices, in particular, skyrocketed increasing more than 400 percent on the world market. This, in turn, stimulated another rapid expansion of fertilizer productive capacity at a time when growers were rapidly cutting back usage, and resulted in a consequent supply glut that has continued to depress prices to the present time. Phosphates, though, have been somewhat buoyed recently by a strong export demand both for rock and processed fertilizer. Phosphate prices are expected to rise steadily over the next two decades, and continue to rise substantially through 2025. (See fig. 3.)

Figure 3
Phosphate Rock Prices -- 1955-2025



Source: Chase Econometric Associates, Inc.

In the short run, phosphate demand is thought to have an elasticity of about -0.5 , meaning that a rise in fertilizer prices of 10 percent relative to crop prices would reduce fertilizer demand by 5 percent. Over a longer period, however, elasticity is about -1 , so a 10-percent relative price rise will cut demand by the same percentage.

Historically, in the United States, 10 to 15 companies have accounted for 80 to 90 percent of total phosphate production. It is a capital-intensive industry with considerable vertical integration. The phosphate industry in the past has been competitive and, as indicated below, responsive to the market forces of supply and demand.

EFFECTS OF PHOSPHATE PRICES

The direct effect of phosphate prices on the ultimate consumer at the grocery store is probably minimal since they are greatly diluted as they pass along the food chain. Thus, it has been estimated that a 100-percent increase in phosphate rock prices results in only a 0.2 percent increase in grocery prices. Even to the farmer, the effect

is somewhat dampened because fertilizer costs make up only about 7 percent of total farm costs with phosphate fertilizers accounting for about one percent of the total farm costs.

On the other hand, fertilizers do account for a significant percentage of the variable cost of producing crops (50 percent of wheat, 35 percent of corn, and 20 percent of soybeans), and thereby can have a decided influence on what crops and acreages are planted. As fertilizer prices increase without compensating increases in crop prices, application rates generally decline and so do crop yields; other factors unchanged. Crop yields, in turn, affect crop production which naturally affects crop prices directly. Thus, higher crop prices directly affect cereal and bakery product prices and indirectly affect meat, milk, eggs, and livestock products through higher feed grain costs. These actions, in turn, may have a greater effect ultimately on food prices than the direct passthrough of increased costs would indicate.

Further, if phosphate scarcities were to cause reduced applications rather than cost passthroughs, the effects could be even more telling. As shown in 1974, the immediate effects of reducing application were negligible since phosphate depletion from the soil is slower than, say that of nitrogen. After a year, however, the reduced yield would be noticeable and after 3 years, very noticeable. Corn and cotton are particularly heavy users of phosphate and their respective yields would be significantly and adversely affected once the phosphate level in the soil was depleted. It is estimated, for example, that a modest 10-percent reduction in phosphate application could reduce corn yields by 3 percent in the second year and 4 percent in the third, and for wheat, 1 and 7 percent respectively. Cotton and soybeans would suffer even greater reduction of 8-9 percent in the third year. Increased grain prices further would result in higher feed prices and eventually raise food prices more than a direct passthrough of higher phosphate prices.

Phosphate prices, of course, have an even more direct effect on producers. Higher prices, as in 1974, can be expected to increase investment, capacity, and production. Such price increases would probably also increase the rate of technical innovation in processing presently subeconomic reserves. Recent trends in the industry, however, may cause a slowing of the industry's response to demand signals from what it was in the past. Energy costs have increased

substantially, and inflation has greatly increased the capital costs of new plants. Further, changing regulatory requirements have made investment considerably more risky, and increased the leadtimes required to bring it to fruition.

Sustained phosphate scarcities and their associated increased prices can have a number of adverse effects both domestically and on a world scale. On the one hand, they can prove costly to farmers and eventually reduce food supplies. Depressed phosphate prices, on the other hand, can discourage the development of needed new sources and thereby eventually cause even more disruptive supply shortages. Any sustained period of depressed world prices, particularly, could discourage domestic development and lead to greater import dependence.

It should, therefore, be an objective of national planning to encourage increased supplies and stable prices. If the increased costs of new production were to require higher prices, it would be in the national interest, we believe, that they rise gradually to allow such development. Further, it is probably not in the national interest to allow reduced world prices over a period of time to discourage domestic development.

The general problem of ensuring future phosphate supplies, however, will probably require more than just a reliance on stable market conditions. The following two chapters present information on market factors which have the potential for seriously limiting future domestic supplies of phosphate.

CHAPTER 3

THE FUTURE AVAILABILITY OF PHOSPHATES

Questions concerning the availability of phosphates--are we running out, or do we have enough?--inevitably lead to controversy. Some knowledgeable sources maintain that there are enough phosphates to last several centuries while others point to imminent scarcities. The argument often centers on the reliability of reported data, and the assumptions made in projecting that data into the future.

There is no doubt that the total known deposits of phosphates in the world, disregarding their grade or accessibility, would be more than sufficient to meet all foreseeable needs, if they could be used. Unfortunately, figures concerning total phosphate resources are not very helpful in determining the amount that could be brought to market, at a price the consumer would be willing to pay, and in fact, these figures can confuse the issue if not carefully qualified.

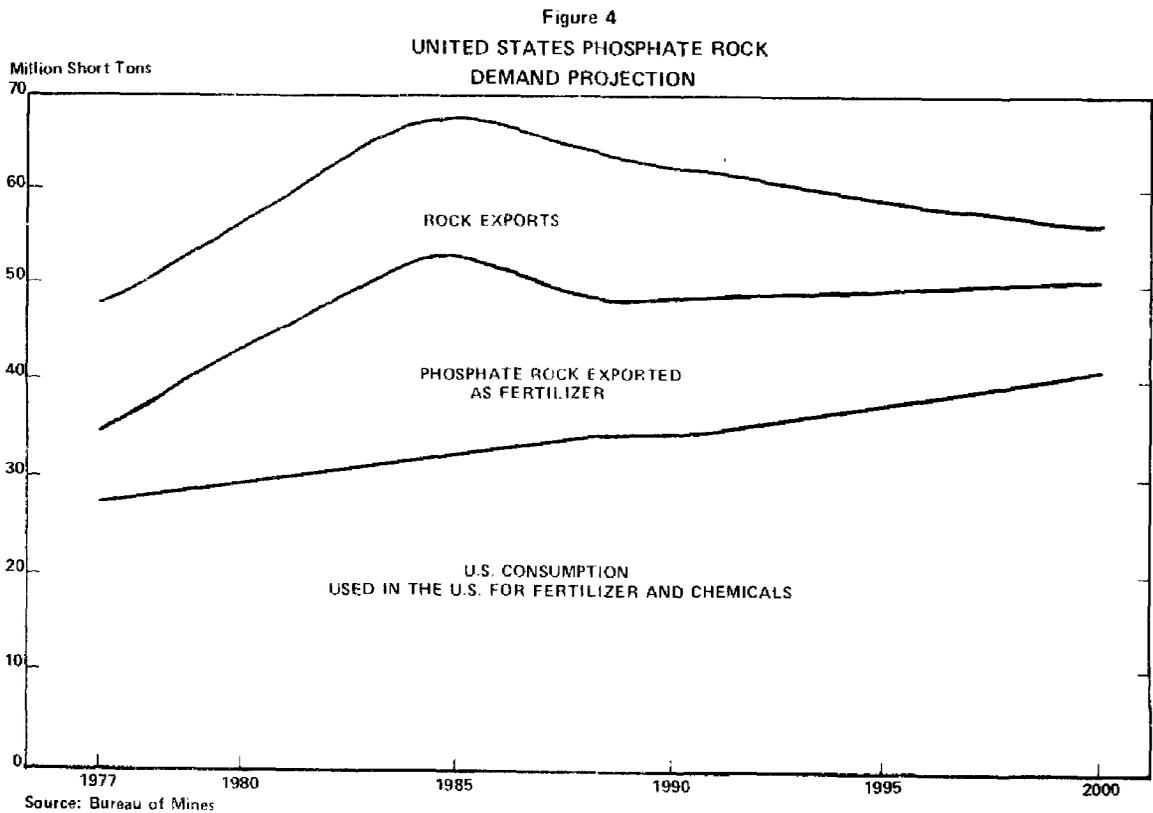
The widely quoted figures of known economic reserves are equally misleading if taken as finite quantities that will be exhausted at some definite point in time. These statistics refer specifically to the quantities that can be produced at current prices, using known technology. As prices rise or new technologies lower costs, reserves increase correspondingly. Also as currently mined deposits are exhausted, there are incentives to explore and develop new sources. This has been the historical trend. Conversely, however, rising costs, lower prices, or land withdrawals can lower economic reserves.

For purposes of public policymaking, then, it is necessary not only to have reliable data, but also an understanding of just what that data represents. It is in this context that phosphate supplies are discussed here.

PHOSPHATE DEMAND

As shown in figure 1 (p. 4), U.S. phosphate production has risen dramatically in the last few decades, and in 1978, approached 50 million metric tons. Of all the phosphate production in the United States since 1870, about 51 percent occurred in the last 12 years.

The official projections for future phosphate demand made by the Bureau of Mines (see fig. 4) are for a 2.3 percent annual growth in agricultural demand through the end of the century, no growth in industrial use, and a 6-percent annual growth in exports through 1985, before they start to decline.

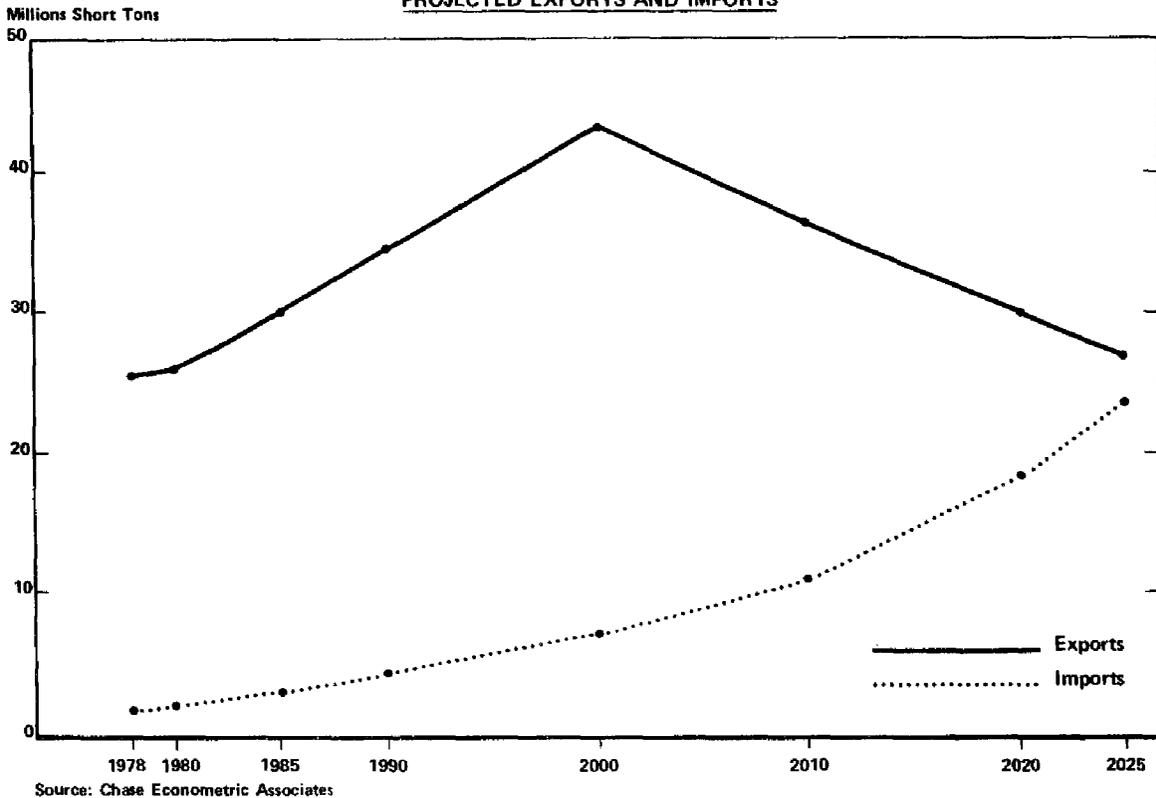


An independent forecast made for us by Chase Econometric Associates calls for a 3-percent annual increase in agricultural demand (including exports), and a 3.5-percent annual increase in industrial use. Since industrial phosphates currently account for only about 9 percent of total production, this category is not of great significance. Both Bureau of Mines' and Chase Econometric's forecasts recognize a reduced use of phosphates in detergents because of environmental

reasons, but Chase expects other industrial uses to account for continued growth about in line with the expected rise in GNP. Both forecasts predict an initial increase in exports followed by an eventual decline. The current trend in exports is toward more processed fertilizers than phosphate rock. This includes the equivalent of 3.5 million metric tons of rock a year scheduled to be shipped from north Florida to the Soviet Union in a 20-year period beginning in 1978. The eventual decline in exports is expected, not because of any drop in world demand, but rather because of the exhaustion of high-grade deposits.

The Chase projections (shown in figs. 5 and 7) are, however, more relevant to the subject of this report since they are carried beyond the year 2000 into the period of potential scarcities. Chase projects exports declining after 2000, with the level of imports steadily increasing.

Figure 5
PROJECTED EXPORTS AND IMPORTS



Long-range forecasting of this type is, of course, at best uncertain, but the general expectation that phosphate demand will gradually rise in line with agricultural growth seems reasonable. The Chase projection, in particular, forecasts a substantial increase in the exports of U.S. cereals and feed grains in line with a need to supply food for the steadily growing world population.

Given this demand, it then becomes necessary to consider the potential sources of supply to meet it.

PHOSPHATE RESOURCES

How large are our phosphate resources? From the best available data, phosphate reserves are currently estimated by the Bureau of Mines to be 2.2 billion metric tons. Principal supply sources are in four areas of the country: Florida, North Carolina, the Western States, primarily Idaho, and Tennessee.

The official projections for future phosphate production made by the Bureau of Mines (see fig. 6) are for increases in production until 1985, and then a decline from that peak.

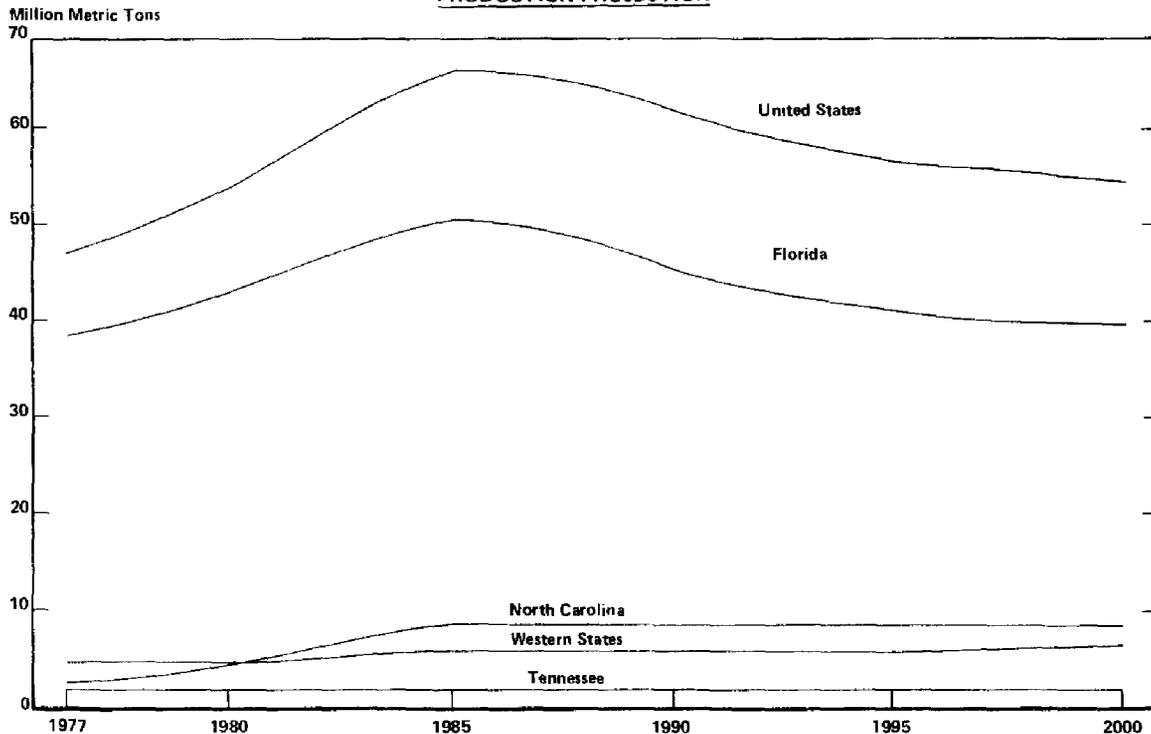
Since the Bone Valley formation in Central Florida is the principal U.S. production center for phosphate rock (accounting for 75 percent of total production), Central-Florida production projections correspond closely to total U.S. production projections. Central Florida production is expected to increase from 35 million metric tons in 1977 to 46 in 1985, and then decline to 35 by the year 2000. Furthermore, within the following 10 years, these currently minable, high-grade reserves are expected to be virtually exhausted.

North Florida production is forecasted to increase from 2.7 to 4.5 million metric tons by 2000. In North Carolina, production is expected to increase from 2.3 million in 1977 to 8.6 million metric tons by the end of the century. Production in Tennessee should continue at the present level of 1.7 million metric tons to the year 2000, after which high-grade reserves are expected to be near exhaustion. Production in the Western States is forecasted to increase from 4.9 million in 1977 to about 6.2 million metric tons in 2000.

Estimates of phosphate production from each region were prepared from available planned capacity and future

demand. The following figure shows the expected production from each region of the United States to the end of the century.

Figure 6
UNITED STATES PHOSPHATE ROCK
PRODUCTION PROJECTION



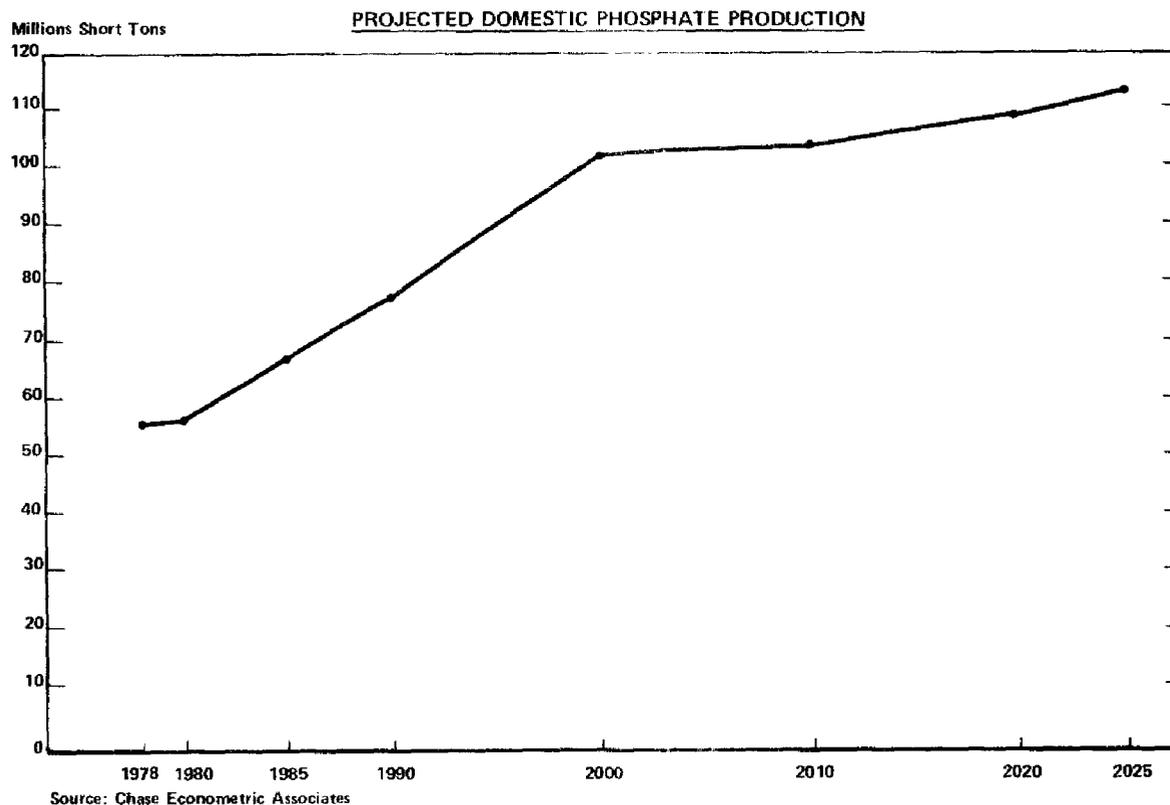
Source: Bureau of Mines

More production, particularly in the Western States, is not likely to take place unless there is an increase in regional demand for phosphorus that is not obvious today. It was assumed that if a company decided to open a new mine, even with adverse markets and supporting economics, the total capacity of the region would adjust by closing older existing mines that had lost contracts or markets for products. Future mining capacity will influence new mine investment and operating costs. This will be particularly evident in North Carolina and Florida. New mines in these areas will probably be limited by current and future costs. New capacity will be added only if the market prices will support the costs or if a company has a captive demand that justifies future costs of phosphate-rock processing.

Given the projected demand and supply for the next 20 years, there is no projected phosphate shortage. Beyond that, however, the Bureau of Mines predicts, and we agree, that availability of high-grade reserves will become a serious consideration.

Chase Econometric Associates' forecast (see fig. 7) shows projected domestic (supply) production increasing from 56 million short tons in 1978 to 112 million by 2025. This projection shows that our production will continue to increase; however, it doesn't show the source of the phosphate rock. Chase assumes phosphate rock will be available from other domestic or foreign sources at increasingly higher costs. The Chase assumption could be accurate. The Bureau of Mines is silent on forecasting production beyond 2000, because they haven't identified future potential reserves.

Figure 7



For national planning purposes, however, it is critical to consider whether the sources will be domestic or foreign, and at what price. In addition, domestic production is being governed by questions of environmental and land-use tradeoffs. Available data doesn't answer these questions.

AVAILABLE DATA ON PHOSPHATE SUPPLY

A consideration of new phosphate sources--those that might replace the depleting deposits in Tennessee and especially central Florida--should probably begin with a consideration of identified phosphate sources, those for which the Geological Survey considers extraction to be currently or potentially feasible and economic.

The U.S. Geological Survey identified U.S. resources as follows:

U.S. Phosphate Rock Resources

(billion metric tons)

Western States (Idaho, Utah, Wyoming, Montana)	6.0
Florida	2.4
North Carolina	2.0
Coastal Georgia	1.1
Other	<u>.2</u>
Total	<u>11.7</u>

Only a fraction of these resources, however, are recoverable reserves at current or near-future returns. Some of the more promising resources lie in Government-controlled national forests (discussed on p. 30) and their access is questionable.

Large resources of phosphate rock in south Georgia are unminable at present because of low grades or because mining would result in unacceptable damage to the environment. The Hawthorn Formation primarily in Florida contains a vast, low-grade, low-tonnage-per-unit-volume resource, much of which is covered by very thick overburden. This resource has been estimated from several billion up to hundreds

of billion of tons. However, a new mining processing method will have to be worked out before these resources can be considered even potentially economic.

According to Geological Survey's estimate, about half of the identified resources in the United States are located in the Western States, primarily Idaho, Montana, Utah, and Wyoming. The Western States' production, however, is now only about 5 million metric tons per year which is less than 10 percent of the total produced. Western capacity is low because the ores are difficult to mine and process, their location is far from markets, and the weather is unfavorable to year-round operation.

IDENTIFIED RESERVES

Techniques are available to assess adequately reserves (those deposits which are economic at prevailing prices). Modern procedures include three-dimensional sampling by core drilling, laboratory tests of ore concentration and recovery, economic appraisal, and evaluation of transportation, water, and energy requirements. Such analyses, however, require access to the land and the cost data on proposed operations.

Mining companies, of course, have reliable data on their own reserves. But the reliability of national statistics depends on the extent to which mining companies are willing to release accurate information. Data from drill samples must be reported to the Geological Survey if companies are mining public land, but reporting is voluntary on private land. In either case, the companies are not required to report cost information, which would also help determine reserves. Other sources of information used by Government specialists are professional publications, contacts with State geologists, and Survey mineral resource data.

Bureau of Mines' specialists have no single criterion or procedure for evaluating data received, or the authority to examine sources from which companies compile estimates. The specialists' personal judgment, knowledge, and experience determine, in most cases, what modifications should be made to the figures submitted. In past years, information on reserves was limited as most companies would not release it. Reserve data is still considered sensitive and difficult to obtain.

Reserve information can be misleading because of the misinterpretation of Bureau of Mines' published reports in

the press and also by trade associations anxious to support their own point of view. In addition, a Bureau of Mines' official suspects some corporate sources may inflate their reserves to convince shareholders of their secure position. These statements also confuse the public about potential reserves.

Until recently, Government estimates were made by contacting individual producers by telephone or by visits to summarize the results. Lately the Bureau of Mines has added completed and in-process "Materials Availability System" (MAS) studies to their information on phosphates in the Eastern United States. The primary function of MAS is to classify reserves through geologic, engineering, and economic evaluations of identified resources. None though has been made in the Western States.

The Bureau of Mines attempts to assess reserves objectively and does not feel restrained in changing estimates of reserves and resources, even significantly, if the new data justifies doing so. The Bureau makes changes as necessary to reflect the most current information.

In the past year, especially, phosphate reserve estimates have changed significantly. The 1978 Mineral Commodity Summary showed reserves to be 3.5 billion metric tons. In mid-1978, a second refinement of reserve information was made and the estimate of 2.9 billion metric tons was published in the Mineral Commodity Profile. At the end of 1978, an estimate of reserves in the United States was made for the 1979 Mineral Commodity Summary. At this time, several MAS studies were drafted or completed. These studies were the basis for again changing the reserve estimates. They were reduced to 2.2 billion metric tons a decrease of 700 million tons, or 25 percent. This decrease occurred because estimated reserves in Florida (site of the completed MAS studies) decreased from 1.1 billion to 400 million tons.

Individuals outside the Bureau also estimate phosphate reserves and their estimates vary, too. A comparison of domestic phosphate estimates from various sources as obtained from Bureau of Mines is shown on the following page.

Figure 8

Domestic Phosphate Reserve Estimates a/

(million short tons)

<u>Location</u>	<u>Wayne Thomas Corporation</u>	<u>Manderson Associates</u>	<u>Garrand Corporation</u>	<u>Bureau of Mines</u>
Central Florida	2,000	1,434	-	424
North Florida	200	115	d/	4
Florida subtotal	<u>2,200</u>	<u>1,549</u>	<u>1,300</u>	<u>428</u>
North Carolina	<u>1,000</u>	<u>500</u>	<u>250</u>	<u>1,000</u>
East Coast subtotal	3,200	2,049	1,550	1,428
Tennessee	b/	60	60	1
Eastern subtotal	-	<u>2,109</u>	<u>1,610</u>	<u>1,429</u>
Idaho	-	900	1,300	800
Utah	-	-	-	100
Wyoming	-	-	e/200	50
Montana	<u>b/</u>	<u>c/</u>	<u>-</u>	<u>50</u>
Western subtotal	-	900	1,500	1,000
Grand total	b/	<u>3,009</u>	<u>3,110</u>	<u>2,429</u> f/

a/Selection of consultants' estimates included in this table was arbitrary. Due to the proprietary nature of company data, we were unable to reconcile the differences between estimates.

b/Wayne Thomas Corporation did not estimate reserves for this area.

c/Manderson Associates' estimate does not show figures for individual Western States.

d/Garrand Corporation's estimate shows Florida reserves in total, not by selection.

e/This amount includes estimated reserves in Utah, Wyoming, and Montana.

f/This amount converts to 2.2 billion metric tons used elsewhere in the report.

Source: Bureau of Mines

ECONOMIC RESERVES

The Bureau's data has been criticized by some industry sources as being overly conservative. The real limitation of resource and reserve data for purposes of national planning is that it does not show what supplies are likely to be developed at future prices.

The mere presence of phosphates in the ground does not mean the minerals will necessarily be extracted. That depends on selling prices, transportation facilities, grade of the ore, types of impurities, depth and thickness of deposits, and availability of water among others.

Recognizing the need for better supply data, the Bureau of Mines sought to develop detailed information on deposits in Florida so they could calculate reserve estimates under various price levels and changes in technology.

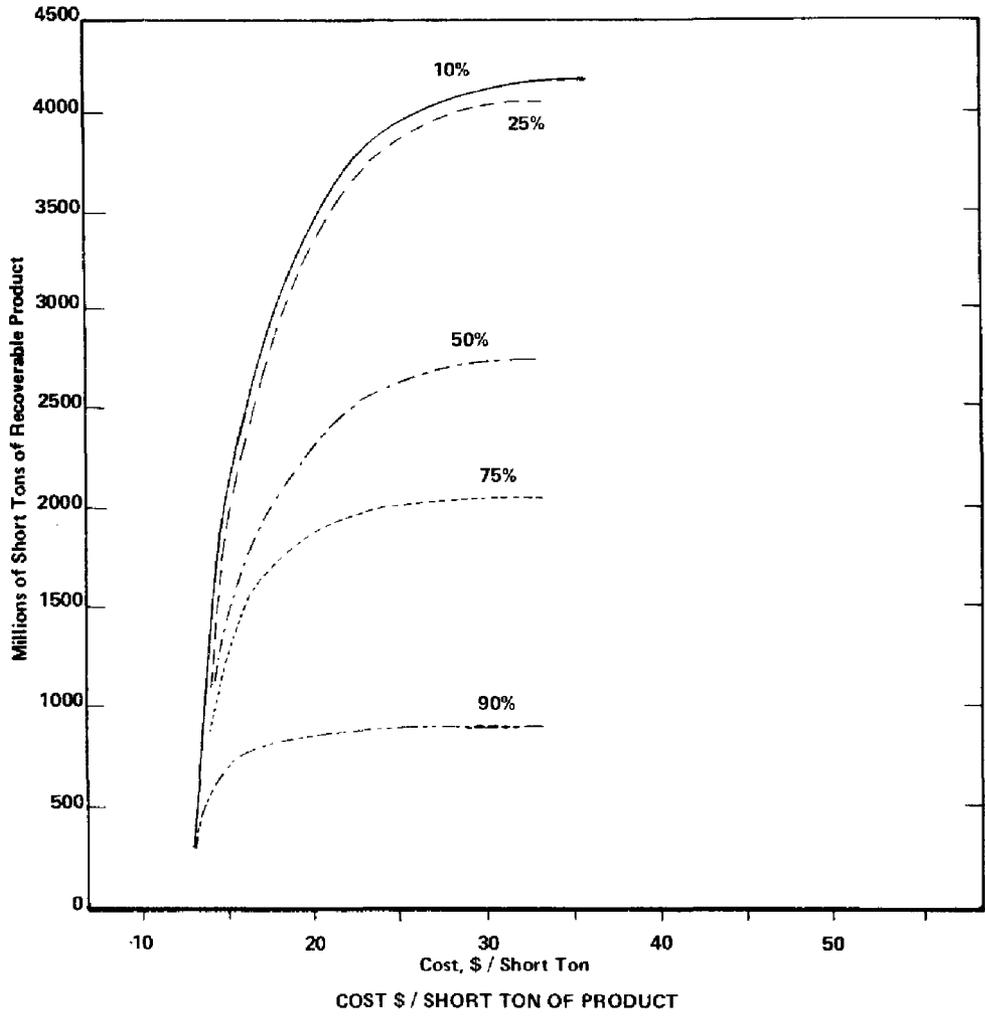
In June 1977, through its contractor, Zellars-Williams, Inc., the Bureau initiated an evaluation of the phosphate deposits in Florida as part of its MAS. The objective of the study was "to accumulate available information on the occurrence of phosphate in land pebble areas of Northern and Central Florida and make this information available to the MAS." The Zellars-Williams study area identified resources within the boundaries of the State. The study identified that Florida has additional phosphate resources that are potentially identifiable through additional exploration and/or technology, however, the Bureau of Mines does not believe the total resources will be changed substantially.

The following table indicates the total identified resources in recoverable product tons by mining cost, available for mining extraction under acceptable conditions. The portion of the total resource to be identified as reserves is dependent on the current cost/price relationship. As of mid-1978, the average price of phosphate rock was near \$16 per short ton as compared to an average production cost of approximately \$13. Therefore, the current "reserve" portion of the table below is the identified reserves in the \leq \$15 tons column and some portion of the adjoining \leq \$20 tons column. The portion of identified resources eventually to be recovered is dependent on future economics and environmental constraints.

The following figure illustrates the probability of recovering identified resources in Florida.

Figure 9
TOTAL IDENTIFIED FLORIDA PHOSPHATE RESOURCES IN RECOVERABLE
PRODUCT TONS BY COST
 Million Short Tons

The following figure illustrates the probability of recovering identified resources in Florida.



COST \$ / SHORT TON OF PRODUCT							
≤ 15	15-20	20-25	25-30	30-35	35-40	≥ 40	TOTAL
428.35	1384.04	1077.47	765.89	286.32	116.73	91.00	4149.80

Source: Zellars-Williams Study, 1977.

We think it is important to note that reserves in the graph show a marked increase as prices rise to about \$30,

an approximate doubling of current prices. Under the Chase forecast (see fig. 3, p. 8), prices in constant dollars will reach that level by 2025. Beyond \$30, however, identified resources show little response to further price increases.

NEED FOR MORE RELIABLE DATA

In planning for the future supplies of phosphate, we must begin with the development of reliable data. The Zellars-Williams study appears to be an impressive effort in analyzing phosphate reserves in Florida. Its estimates of reserves at various prices expressed in terms of probability are especially valuable for material planning of the type discussed in this report. However, the best analysis is dependent on the source of data used, which in this case, is unverified by the Bureau of Mines. We think the Government should be in a position to make some judgment as to the validity of the data used in its official statistics.

Also to be of real value in national planning, an analysis of the type made in Florida should be conducted in other parts of the country, especially in the Western States.

NEED FOR PLANNING

Based on the outlook for a strong U.S. agricultural demand and continued exports of phosphate products, the 1977 Bureau of Mines' estimated, high-grade, readily accessible reserve of about 3.5 billion metric tons would be completely exhausted by 2020. Since the Chase Econometric analysis was made in June 1978, the Bureau of Mines estimated phosphate reserves were reduced to 2.2 billion metric tons. At their projected usage rate, this is only about 30 years' supply of high-grade reserves. There are no other known high-grade readily-accessible reserves. It is for this reason we think serious effort should be devoted to evaluating our alternative strategies for securing adequate future supplies, whether to import or further domestic development, both of which would have important trade-off implications. Chapter 4 will discuss domestic trade-offs further.

CONCLUSIONS

The best data now available indicates that domestic phosphate reserves will probably be adequate for the next

20 years. Bureau of Mines projections expect production to peak within ten years, however, and begin declining after that.

Therefore, given the vital nature of phosphates and the leadtimes required to develop new sources, we believe that this ten-year period be used to decide our future supply strategy. In the following chapters, we discuss some of the major considerations we think should be part of such planning.

We have found phosphate data used by the government to be deficient and inconsistent. In the past, figures on phosphate reserves have fluctuated inordinately, and they were presented with little explanation of the underlying assumptions necessary to use them for planning purposes. This is perhaps not surprising since, to this point, there has been no public planning for phosphate availability--reliance on market forces having been adequate to ensure supply.

Recently the Bureau of Mines commissioned an exhaustive study of phosphate resources in Florida with an impressive analysis of the probability of future supply. If similar studies are made of the Nation's other phosphate resources, we think it would provide a useful starting point from which to do some intelligent planning.

Even the best analysis, though, is no better than the data used. As pointed out in this chapter, most of the current official statistics on phosphate reserves are based on voluntary, unverified company submissions. These submissions may well be reliable enough, at least on a national scale, for purposes of public planning. Nevertheless, we think that the Bureau of Mines in publishing official statistics, should pass some judgment on the accuracy of the source data, and advise policymakers of any significant data limitations.

CHAPTER 4

ENVIRONMENTAL AND LAND-USE TRADE-OFFS

The future availability of phosphates thus far has been discussed largely in economic terms: the extent of the deposits, the cost of production, and market prices. Increasingly, though, phosphate production is being governed by questions of environmental impact and competing desires for use of public lands.

These areas are recognized as points of extreme controversy. Mining critics maintain that industry is grossly underregulated and extremely damaging to the environment. Industry replies that past mistakes have been corrected, that current damage is exaggerated, and that the industry is now, in fact, threatened by overregulation. Similarly, on the use of public lands for mining, industry critics maintain that phosphate production precludes its use for any other purpose. Industry answers that economic phosphate deposits are extremely limited and need to be developed wherever they occur.

In discussing these issues here, we are not implying criticism of either the regulatory process or industry practices. Phosphate production unquestionably involves major environmental impacts and these need to be considered. We merely wish to point out that it can no longer be assumed that because economic deposits exist, they will be developed. Rather, a national planning process must consider a whole array of noneconomic constraints on phosphate development. It is the purpose of this chapter to describe the impacts they can have on future availability and their implications for national planning.

ENVIRONMENTAL IMPACT OF PHOSPHATE MINING

Phosphate mining and processing have become unpopular for a number of reasons. Piles of overburden, open ditches, tailings, and deep excavations all contribute to an unattractive landscape during the period of mining that precedes reclamation, and add to the difficulty of opening new mines.

Another environmental consideration often raised concerning phosphate mining has to do with industry's sizable consumption, and potential pollution, of water. The large

quantities of water being used by the industry have aroused concern. In spite of considerable recycling, studies have shown that water requirements for several mines in central Florida to be 3,000 to 12,000 gallons per minute during normal processing. Further, leakage from holding ponds (slime ponds) for phosphate mining residues could cause contamination of water sources.

Another objection to the phosphate industry is destruction of wetlands. Environmental groups and some regulatory agencies are particularly concerned about wetlands, which represent a large part of the total land in some Florida phosphate areas. Marshes, both intermittent and permanent, as well as swamps and extensive parts of river flood plains fall into the wetland classification. These areas are of value for wildlife habitat and surface water retention. Florida contains over 20 percent of the total remaining wetlands in the United States, which have been reduced primarily by urbanization, highway construction, and agriculture.

ENVIRONMENTAL RESTRICTIONS ON MINING

Increased Federal, State, and local interest in restoring and preserving the environment and maintaining an ecological balance has led to the establishment of stringent procedures to regulate and, in effect, sometimes prevent phosphate mining. The Federal Government, for example, requires an extensive environmental study of any operation impacting on navigable waters (primary rivers, tributaries, etc.). On Federal land, the Bureau of Land Management (BLM) issues the leases and the Geological Survey approves mining and reclamation plans. Both agencies always consult with the Fish and Wildlife Service and the U.S. Forest Service when mining affects national forest lands.

In addition to Federal regulations, State governments also maintain stringent controls over phosphate mining. In North Carolina, the Department of Natural and Economic Resources, issues permits and governs water use, well construction, dam safety, waste discharge, mining, and land reclamation. In Idaho, numerous State agencies regulate phosphate mining. The Departments of Health and Welfare, Water Resources, Lands, Fish and Game, and the State Board of Land Commission have regulations that cover wildlife, air quality, mining, land reclamation, construction, and stream channel alteration. The environmental issues of greatest concern are water quality, protection of wildlife

and vegetation, all of which have made it difficult for mining to take place.

Regulatory requirements for initiating and operating phosphate mining development in Florida have become increasingly involved in recent years. The proliferation of regulations reflects the public's growing awareness and concern for the environment. Florida has a rapidly growing population including a large number of retirees not generally sympathetic to the industry's development. In the minds of many people, strip mining is not compatible with Florida's image or with its primary economic base--agriculture and tourism. Public concern over strip mining is reflected in regulatory actions of the Government agencies.

Public concern over environmental issues has made the acquisition of permits for a new mining development an intricate, timeconsuming, and expensive process. In addition, operating mines are being required to operate under increasingly stringent parameters at significantly higher costs, including those of land reclamation.

During the process of getting a permit, prospective mining developments must address environmental issues at all levels of Government. This is illustrated on the next page, a list of some major permit requirements and costs for new phosphate ventures in Florida.

Environmental permits are not only expensive to obtain, but timeconsuming. For example, one phosphate company obtained land in northern Florida in October 1973, and it took almost 4 years and some 20 permits, before final approval was given to begin construction and development of a processing plant and mine. The operation is now scheduled to start in 1980, 7 years after the acquisition of land. Permit acquisition is also costly. In Florida, it averages between \$1.5 and \$3.7 million for approval of new phosphate operations which includes the cost of permits, monitoring the environment, pollution abatement equipment, and managing the operation to comply with regulations.

Some Major Permits and Related Costs
in the State of Florida

I. County

\$ Zoning Change	\$ -
\$ Master Plan Approval	75,000
\$ Development Order	-
\$ Operating Permit	50,000
\$ Building Permit	5,000

II. State

\$ Division of State Planning	
Development of Regional Impact	250,000
\$ Department of Environmental Regulation	
Air Quality Permit	30,000
Industrial Waste Water Permit	25,000
Dredge and Fill Permit	50,000
Drainage Well Permit	-
Dam Construction Permit	75,000
Potable Water Supply Permit	-
Sanitary Waste Permit	500
\$ Water Management District	
Consumptive Water Use Permit	50,000
Water Well Construction Permit	-
Works of the District Permit	10,000
Management and Storage of Surface Waters Permit	-
\$ Department of Natural Resources	
Reclamation Standards	50,000

III. Federal

\$ Environmental Protection Agency	
NPDES (Water Quality) Permit	125,000
Air Quality Standards	15,000
\$ Army Corps of Engineers	
Dredge and Fill Permit	25,000
Dam Construction in Waters of the United States Permit	-

Source: Zellars-Williams Study, 1977.

New mining developments, particularly, in areas where there has been little previous mining, can be expected to come under increasing public scrutiny and regulatory constraint including delays, postponements, and even prohibition. Environmental considerations thus will play an important role in determining the overall future availability of phosphate in this country.

Strip mining naturally disrupts the environment and there has been further criticism that reclamation technologies have given insufficient consideration to providing suitable replacement habitat for native wildlife. Traditional methods of water body construction and methods of pasture plantings have received the greatest criticism.

Concern over the survival of the canvasback duck may delay or prevent construction of a \$250-million mining operation in North Carolina. A company plans to construct an open-pit mine and processing plant and ship its products by barge, using a nearby creek as an access channel for the barges. The creek, however, is one of the most important winter nesting areas of the canvasback duck and work on the channel and turning basin could well be harmful to its habitat.

Another environmental concern in North Carolina has centered on the withdrawal of large volumes of water from the State's natural underground fresh water supply. State and private studies to determine whether salt would enter the fresh water system as a result of withdrawals have been inconclusive. The conflicting opinions on the impact of the water withdrawals have enabled mining companies to maintain their water permits. However, existing permits will be withdrawn, if a significant deterioration in the water quality occurs.

LAND USE: ACCESS TO PHOSPHATES ON PUBLIC LAND

Public lands represent one-third of the country's total land surface, and include some of its best phosphate potential. As mining operations are being depleted on private lands, future supply increasingly appears to depend on the development of public resources.

The amount of phosphate deposits on public lands nationally is not known. However, there is an estimated one billion metric tons of minable phosphate rock located in the States of Idaho, Utah, Wyoming, and Montana, 80 percent of which is in Idaho. The richest and most easily recoverable of these deposits is within the boundaries of the Caribou National Forest, Idaho, and additional reserves are on Idaho State lands.

In southeast Idaho, there are 83 Federal phosphate leases covering some 43,000 acres. All were issued before 1969, and none has been issued since. Applications for three competitive leases covering 2,524 acres and 98 prospecting permits covering 121,037 acres are pending. Additionally, an Idaho State moratorium went into effect in January 1978 under which no more State leases will be issued until the adoption of new rules and regulations. Subsequently, in late 1978, the Governor of Idaho asked the Secretary of the Interior to approve construction of four phosphate mining plants located in southeast Idaho. The Governor said that the State review of plans for the mining operations has taken 4 years and that one company is running out of phosphate-bearing land under its present lease.

As we have indicated, governmental actions have, and will continue, to make it difficult and in many cases perhaps impossible, to lease public lands for mining. These actions are in response to concern over the environmental impact of phosphate mining and its possible conflict with competing land uses. In 1978, final environmental impact statements on the effect of phosphate mining in the Los Padres (California), Caribou (Idaho), and Osceola (Florida) National Forests were completed. However, the Government has not issued leases pending completion of additional studies. It now appears that the proposed leases in the Los Padres will remain unresolved for a decade or more.

The Osceola National Forest covers over 157,000 acres of Government-owned land. It is located in Northern Florida and the U.S. Geologic Survey has previously estimated that 120 million tons of phosphate rock underlies portions of the Forest. Between 1969 and 1972 four companies applied for leases to develop the phosphate resources but to date no leases have been issued.

Legislation was introduced in the 96th Congress aimed at prohibiting phosphate mining in the Forest, for reasons pertaining to both environmental matters and protection of endangered species of wild life. Subsequent evaluations have raised questions with respect to the magnitude and worth of the phosphate deposits. Two additional studies have been completed evaluating possible impacts on the Florida aquifer and on endangered species in the Forest. The later studies indicate phosphate mining would not appreciably impact on the aquifer and that of the five identified endangered species, three might in fact

benefit from mining development and adequate protection measures could be taken for the other two species. Notwithstanding these analyses, the basic land use issue in the Osceola Forest remains unresolved.

CONCLUSIONS

Environmental and land-use constraints have three main effects on phosphate development. They (1) increase costs, (2) lengthen the time it takes, and (3) add uncertainty that new developments will be allowed at all. The first effect is not too severe, and could probably be absorbed in the marketplace, but the other two definitely have implications for national planning.

The environmental process described in this chapter, and the examples given, clearly indicate that industry's response to any sudden shortages such as those that occurred in 1974 would be lengthened considerably. It appears that a company wishing to open a new phosphate venture must now plan on a leadtime of several years and perhaps much longer before beginning actual development. This means, we think, that Government planners analyzing capacity against projected demand must ensure that they allow for regulatory delay.

Of even greater importance is the uncertainty that certain potential new sources of phosphates will ever be made available. As indicated, some of the most promising, undeveloped phosphate deposits in the country are now being met with opposition to development. For planning purposes, of course, it will be necessary to assess the probability of their use in projecting future supply. Beyond that, we think it is of utmost importance that planners participate in deliberations on environmental impact and land use. At present most of these decisions are made on a site-specific basis, weighing the immediate environmental impact against the economic importance of a single deposit. We know of no assessment, however, to measure the cumulative effects of the individual decisions on the Nation's ultimate needs for an important mineral.

CHAPTER 5

WORLD OUTLOOK FOR PHOSPHATES

As discussed in chapter 3, U.S. exports of phosphates are forecasted by Bureau of Mines to peak in 1985 and decline gradually through the year 2000. Thus the United States, which now accounts for nearly one-third of total world exports, will probably become a far less influential exporter during the next 20 years, and will probably become a net importer sometime thereafter. These projections imply further phosphate production from newly developed reserves, a fact which is uncertain. With this in mind, it is important for national planners to have some understanding of world phosphate projections. This chapter discusses what is known about them and, perhaps more importantly, what is not known.

Currently, there are adequate reserves of phosphate rock to supply world needs in the immediate future. New discoveries undoubtedly will occur, but they are unlikely to change marketing trends significantly or to reduce the relative importance of the world's major-producing areas soon.

The United States is now the world's leading producer of phosphate rock with a total of 50 million metric tons in 1978. The United States' output along with the second and third leading producers--the Soviet Union and Morocco--accounted for 82 percent of world production in 1978. The United States is now a large net exporter of phosphate rock, obviously not dependent on foreign sources.

OUTLOOK FOR CONTINUED EXPORTS

Factors that are expected to have a major impact on the competitiveness of domestic rock and upgraded products in the future are

- the declining quality of phosphate ores in Florida;
- the rapidly increasing production and capital-related, per-ton costs of phosphate rock;
- the expanding global alternative sources of both rock and upgraded products; and

--growing environmental regulations regarding rock mining operations, both existing and planned.

As a result, it seems very likely that the costs of phosphate rock will continue to rise and, if other factors remain unchanged, the competitive advantage of U.S. phosphate rock producers and exporters will decline. Morocco is expected to expand its productive capacity at a rapid rate in the near future, thus not only becoming a strong competitor for U.S. exports, but also making inroads into the U.S. market.

Through 1985 it is probable that supplies will be more than adequate to meet world demands. Although the United States is currently a major exporter of phosphates, in about 30 years, it probably will become at least partially dependent on imported phosphate raw materials or fertilizers. The incentive to maintain a competitive and active phosphate industry to support the agriculture of the United States is clear since not only its food supplies but those of much of the world are dependent on crop production from a relatively few geographic areas.

WORLD RESERVES AND RESOURCES

World reserves of phosphate rock are currently estimated by the Bureau of Mines to be about 27 billion metric tons. According to the Geological Survey, there are many billions of tons of additional resources of phosphate rock, but much of it is deeply buried, low in grade, or contains gangue minerals (worthless minerals associated with valuable mineral deposits, which must be separated to upgrade the ore to a commercial product) so that they cannot be mined and processed with present technology.

The accuracy of world reserve estimates is even harder to judge than those for domestic reserves since far less is known about them. For example, in 1938, total world reserves were estimated to be 17.5 billion metric tons, and in 1953, 46.7 billion metric tons. In 1971, the British Sulphur Corp. estimated world reserves of all grades to be 130 billion metric tons. The Institute of Ecology (1971) stated that known reserves of phosphate might be exhausted in 90 to 130 years, being only about 25 billion tons.

Bureau of Mines also estimates world reserves as well as domestic. But its estimates have also fluctuated widely as shown by the following figures.

World Phosphate Reserves Estimates

(billion metric tons)

1972	104
1973	61
1974	5
1975	13
1976	16
1977	18
1978	26
1979	27

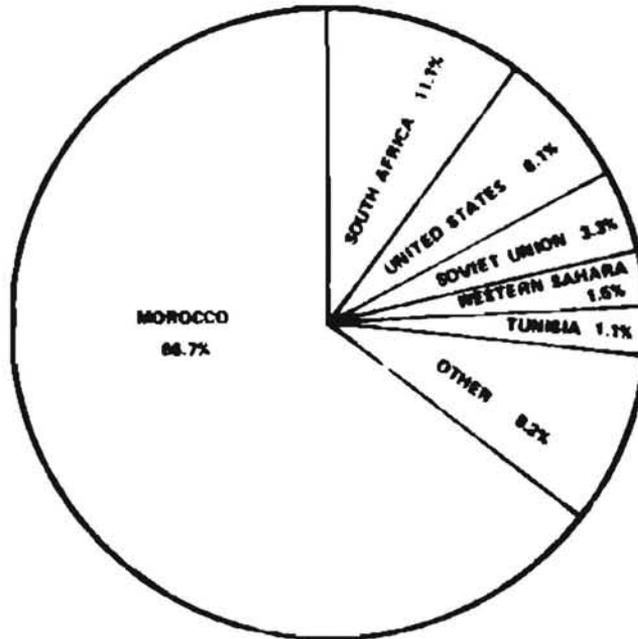
Source: Bureau of Mines

Prior to 1975, there is no explanation for the large fluctuations. Examples of recent reserve figures fluctuating in billions of metric tons are Morocco, 9 to 18; Australia, .9 to nil; and, the United States, 3.5 to 2.2. These recent fluctuations are explainable.

In estimating world reserves, the Bureau relies heavily on estimates supplied voluntarily by private mining companies. The estimates are modified based on the commodity specialists' judgment, knowledge, and experience, as well as professional publications, personal contacts with State and foreign geologists, and information available from Geological Survey. The most likely explanation for the unreliability of world reserve figures is simply that they are not based on any detailed analysis of the type we discussed in chapter 3 for domestic reserve data. As the United States moves towards more dependence on world markets, however, there will be an increasing need to develop more reliable data.

Relying for now, however, on the most recent official data concerning world reserves, shown in fig. 10, some conclusions can be drawn.

Figure 10
IDENTIFIED WORLD PHOSPHATE RESERVES (1978)



Source: Bureau of Mines

While these reserve estimates might continue to fluctuate, it appears that there are only a few countries able to supply the world with adequate phosphate rock. As indicated, Morocco has the largest reserves, and South Africa, United States, and the Soviet Union have substantial estimated reserves. Of the world phosphate producers, only the The United States and Morocco are major exporters and this trend is not expected to change in the future. While Mexico and South Africa are still expected to increase phosphate production in the next decade, their contribution to the world market is expected to remain small relative to that of the United States and Morocco. South African reserves, while large, are costly to export because of distance to markets. Other countries depend heavily at present on imports from the United States and Morocco to satisfy their phosphate requirements.

In 1978, the Soviet Union and Morocco produced an estimated 49 million metric tons, the equivalent of our domestic production and equal to 41 percent of the world production.

SOVIET UNION

In 1978, the Soviet Union produced an estimated 31 million metric tons of phosphate rock. In the past, it has exported both to Eastern and Western Europe, but in the early 1970s,

began phasing out these exports. The Eastern Bloc (Soviet Union and Eastern Europe) now is a net importer of phosphate materials and, by the year 2000, is expected to import the equivalent of 33 million tons of phosphate rock.

Use of fertilizer in the Soviet Union and Eastern Europe is receiving high priority in an attempt to improve agricultural output, and as a result, phosphate consumption is expected to increase at about 6 percent per year until 1980, and 5 percent after that. This growth will raise the demand for phosphate rock equivalents from the present level of 24 million to 86 million metric tons in the year 2000. Arthur D. Little, Inc., estimates that Soviet demand will exceed its supply by 1985.

Ever since the Soviets began operating mines in the Kola Peninsula in the 1930s, they have met the bulk of the phosphate demands from the Eastern Bloc phosphate manufacturers. The other important phosphate-producing area in the Soviet Union today is located in the Karatau region in Central Asia. Phosphate rock was discovered there in the mid-1930s, but there was little interest in exploiting the deposit at that time. The first Kola mine had just been developed and the Soviet Union has consequently become self-sufficient in rock supplies for its fertilizer plants, all of which are located in the eastern portion of the country. Recently, exploitation of the Karatau deposit has been increasing, rising from 4.5 million metric tons in 1971 to 10 million metric tons in 1975. However, the deposit is in a relatively remote region, which has complicated its development.

In 1977, the Soviet Union produced 24 million metric tons (over 80 percent) of its phosphate rock from deposits in the Kola Peninsula and Karatau region. The Kola Peninsula mines are targeted to produce 22 million metric tons of phosphate rock in 1980.

Another phosphate deposit recently discovered in Eastern Siberia is now under development. According to preliminary estimates, reserves amount to 3 billion metric tons of high-grade ore and could thus help to satisfy growing Soviet phosphate requirements after the mid-1980s.

The Soviets realized some years ago that they could not develop major new phosphate deposits rapidly enough to satisfy domestic requirements, and consequently, cut back on their exports.

The Soviet Union and Eastern Europe are now looking to North Africa and the United States to meet their needs and long-term arrangements have already been made. For example, Hungary has signed a 6-year agreement to import phosphate rock from Morocco starting with 135,000 metric tons in 1975 and increasing to 230,000 tons per year thereafter.

The Soviet Union signed an agreement with a U.S. company for 700,000 metric tons per year of phosphates of 100 percent equivalent phosphorus pentoxide in the form of superphosphoric acid, over a period of 20 years. This is the equivalent of about 3.5 million metric tons per year of phosphate rock. In exchange, the Soviet Union will supply ammonia, urea, and potash.

Another source of Soviet phosphate imports will be Morocco, most likely in the form of rock. An agreement signed with Morocco calls for the U.S.S.R. to supply Morocco with plant and equipment for a new phosphate complex to exploit its Meskala deposit. This deposit was initially expected to be mined at a rate of 3 million metric tons per year. The Soviets are asking for 3 to 5 million metric tons of phosphate rock annually in the 1980s, and 10 million tons per year after 1990. In return, Morocco will receive sulfur, potash, and other fertilizer materials, crude oil, mine timbers, and other products from the Soviet Union. Thus, of the estimated 33-million-metric-ton Soviet deficit in the year 2000, 13 million tons are already arranged for; 10 million tons coming from Morocco and 3 million tons from the United States as superphosphoric acid. The remaining 20-million-ton deficit will undoubtedly be a factor in world trade in future years.

MOROCCO

For many years, Morocco has been one of the world's largest rock exporters, and in 1977, Morocco was the largest, sending 15.7 million metric tons primarily to Europe, Latin America, and Asia. Moroccan exports are expected to increase to 18 million metric tons in 1978. Their phosphate reserves are thought to be far and away the largest in the world--and estimated at 18 billion metric tons in 1978. The highest grade of phosphate rock comes from the Khouribga deposits.

Maintenance and growth of its phosphate industry are important to Morocco. Phosphate production is a major part of total exports contributing close to half of Morocco's foreign exchange earnings. The production and export of phosphates have always been handled as a Government monopoly, under the Office Chérifien des Phosphates founded in 1920.

Currently, Moroccan phosphate rock output is well below capacity. The Khouribga and Youssoufia mines in central Morocco have a combined annual capacity of 22 million metric tons. In addition, Bu Craa in the Sahara can produce an additional 5.6 million tons. There are also two mines being developed; Ben Guerir, which will have an ultimate capacity of 10 million metric tons in the 1980s, and the second at Sidi Hajjaj. Both mines are due to come into production in the mid-1980s followed by mines in the Meskala area in 1990.

The terms of the agreement between Morocco and the Soviet Union provide for Soviet investment of \$2-3 billion for the Meskala mine and facilities. Also, a new railway will link these mines to a new harbor to be built on Morocco's Atlantic coast, some 50 miles to the west.

The agreement should help reinforce Morocco's dominance in world phosphates, and ensure the Soviet Union of needed supplies in what may become a tight international market.

CHANGING TRADE PATTERNS

Although it seems that patterns of world trade in phosphate rock will not change immediately or in the near future, the Soviet Union is encountering difficulty in developing its resources. Accordingly, U.S. and Moroccan exports will have to be accelerated to compensate for reduced exports from the Soviet Union. The Soviets are, in fact, fast becoming an importer, seeking additional supplies from the United States and Morocco. As U.S. phosphates decrease in grade and quantity, they may lose their competitive edge in the world market, unless we are able to convert our lower-grade resources to reserves at acceptable prices.

As the world's population continues to increase, greater demands will be placed on phosphate producers. Moroccan, especially, and also U.S. producers can be expected to increase their exports to meet that increased demand. For example, the People's Republic of China in late 1978 purchased 121,000 metric tons of bagged phosphatic fertilizers from Florida producers. Officials at the Bureau of Mines expect U.S. exports to increase at the same rate as world demand until the year 1985. By then, the Bureau contends that exports may have to be curbed due to increased domestic requirements and the decline in Florida production. Based on our analysis, we believe that such a decision should only be made after

considering alternative strategies, that is low-grade domestic ores versus imports.

Morocco is a major supplier to both Eastern and Western Europe. Western Europe is the world's largest importing region while Eastern Europe is second. In 1977 Morocco supplied 35 percent of the phosphate rock in international trade, the United States, 30 percent, and the U.S.S.R., 7 percent.

Future trade patterns indicate the potential for a strong trade bond between Eastern Europe and Morocco. The world trade patterns in 1980 are expected to emphasize the same basic trends. In both production and exports, the United States, U.S.S.R., and Morocco are expected to hold the same relative positions as previously. By the year 2000, Morocco will probably attain a dominant position in the world market which is forecasted to have a demand of 234 million metric tons annually, more than double that of today.

CONCLUSIONS

The general trends outlined in this chapter indicate that the United States, now a major exporter may reduce its exports toward the end of the century, and that the Soviet Union, now a major producer, will become a much larger importer. Morocco is expected to become the dominant world supplier in this period.

These trends, we believe, are bound to have important economic, and probably strategic, implications for the United States and its allies. They call for a review of current U.S. policies concerning the development, conservation, and export of phosphate resources. At the same time, they require a much better understanding of the world phosphate outlook. What new sources of phosphates will take up the slack from the declining output of the current major producers? Will most of the world become dependent on a single source of supply? If not, how can more expensive alternate sources be developed?

Presently, the best figures available on world production are obtainable through the International Phosphate Industry Association and are judged reasonably reliable. However, world phosphate rock reserves estimates must be considered extremely tenuous as they have not been subjected to serious verification.

Clearly an important part of a national planning system for phosphate availability, as well as most other minerals, is to develop reliable data on world resources and to assure its implications for purposes of making national policy concerning trade and domestic development.

CHAPTER 6

A MATERIALS POLICY AND PLANNING PROCESS TO ENSURE

THE AVAILABILITY OF ESSENTIAL RESOURCES

Given the possible depletion of high-grade phosphate ores coupled with such trade-off issues as accessibility and the environment, we believe the Government should focus on its responsibility to monitor reserves and to ensure the availability of this essential mineral. In this chapter, we discuss the Government's current role and responsibilities related to phosphates, and what additional measures we think are necessary to take.

GOVERNMENT'S CURRENT INVOLVEMENT WITH PHOSPHATES

There are now a large number of separate Government agencies that influence phosphate development, sometimes in conflicting ways. The principal one is the Department of the Interior with its varied and diverse roles. Interior's Geological Survey is charged with identifying phosphate resources and approving mining and reclamation plans on public lands. The Bureau of Mines has responsibilities for compiling reserve data and directing research and development of minerals. The Bureau of Land Management assesses the other resource impacts of all exploration and mining on Federal lands and issues leases. The Fish and Wildlife Service is responsible for administration of the Endangered Species Act. The Office of Minerals Policy and Research Analysis, under the Assistant Secretary, Energy and Minerals, acts as the focal point for minerals' policy development and coordination within the Department of the Interior.

NEED FOR IMPROVED INFORMATION ABOUT FUTURE PHOSPHATE SUPPLIES

We believe the first action to be taken in resolving the uncertainty over the future availability of phosphates should be to obtain adequate and reliable information on phosphate resources and reserves. In the case of phosphates, as with most other nonfuel minerals, the Secretary of Interior would be the logical person to designate for the task.

The Bureau of Mines has recently begun the type of assessment needed to estimate the Nation's potential phosphate reserves. No work has been done concerning foreign reserves.

Although the best data now available does not establish that we will run out of phosphates, neither does it give us the information needed to develop alternative strategies. Before settling on either complacency or drastic action, a great deal more needs to be learned about the probability of future supplies. At present, the Bureau of Mines relies on a single commodity specialist who, unaided and only with a limited travel budget, is charged with monitoring and analyzing the Nation's supply position on this vital mineral. Although the Geological Survey has the authority to drill on public land (and with permission on private land), no recent drillings have occurred. On those occasions when funds were requested, the requests were denied. The present system of passive management will have to be revised, we believe, in order to deal positively with phosphate problems discussed in this report.

Currently the Bureau of Mines' assessment indicates that phosphate supplies will be adequate until the end of this century. However, its projections do not go beyond that point. The turn of the century, though, is only 20 years away and, as we have pointed out, identifying phosphate deposits and developing them can take a long time.

The Department of Interior has been repeatedly criticized for inadequate attention to its leasing policy. However, in its budget justification for 1980, Interior stated that it will conduct a study to determine leasing goals for phosphate rock located on Federal lands. This would appear to be a good start, but reserve and resource data effort needs to be accelerated.

Planning for the future availability for phosphate should start with a thorough inventory of potential domestic phosphate reserves and an assessment of the probability of developing the remaining resources at likely future prices. What is needed for the entire country is an assessment similar to the Bureau of Mines' evaluation of phosphate deposits in Florida.

We must first determine the potential extent and severity of the future phosphate availability problem. If we are, indeed, faced with a future phosphate shortage, then the Government has a number of actions it could take. These include

--subsidization of subeconomic resources in the future,

- limitation on exports,
- greater emphasis on phosphate development in public land-use decisions and environmental trade-offs,
- increased level of phosphate research with more emphasis on increasing reserves, and
- increased emphasis on phosphate conservation in agricultural applications.

However, the appropriate combination of Government actions cannot be determined in the absence of reliable availability estimates as mentioned above.

NEED FOR RESEARCH AND DEVELOPMENT

It is important to note that research and development could provide a critical link between short- and long-range goals. For example, research and development should complement short-range materials' programs, and both of these should be designed to improve the Government's ability to anticipate, offset, and respond to foreseeable trends during the next 25 to 50 years. We believe the Office of Science and Technology Policy, in the Executive Office of the President, should be involved in this research and development effort, coordinating both the Federal effort with activities in private industry.

The Bureau of Mines and the Tennessee Valley Authority (TVA) have primary responsibility for conducting Government phosphate research. For the most part, their research efforts have focused on solving the immediate mining, processing, and environmental problems of phosphate production. Approximately \$10 million per year were expended in 1978 by nonindustrial organizations on phosphate research, with the Bureau and TVA each spending about \$3 million, and the remainder spent by such organizations as the Florida Phosphate Research Institute and the International Fertilizer Development Center.

Industry stated that although there is an ongoing research effort by Government agencies, there is neither a unified direction nor a very effective exchange of information.

Recently, a bill (H.R. 2743) was introduced in the 96th Congress to establish a national policy for materials research and development. The bill, if passed, would require the Administration to establish such a program and the means to coordinate the various Federal materials' research-and-

development activities. To be successful, however, research must focus on long-term availability, that is, on low-grade reserves.

NEED FOR MORE INVOLVEMENT

The Department of Agriculture's interest is obvious considering the importance of phosphates to the Nation's agricultural output, as highlighted in chapter 2. In the past, however, Agriculture has confined its interests to fertilizer end-products, not concerning itself with long-term phosphate availability. We think that Agriculture's broad responsibilities for the Nation's food supply, dictate an expanded role in future high-level policy discussions concerning the availability and use of phosphates. Actually, the importance of Agriculture's input is further emphasized by the fact that certain national forests, under the jurisdiction of the Forest Service, could be affected by future conditions of phosphate development.

The Department of State is involved with matters of worldwide phosphate availability. First, it supplies intelligence to the Bureau of Mines on foreign reserves through its embassies and mineral attachés abroad. Second, State has broader political and diplomatic responsibilities for assessing the strategic implications of supply interruptions of essential raw materials for the United States and its allies. The Agency for International Development has a corresponding responsibility to measure the effect of supply constraints on the lesser-developed countries. It has helped in the past by assisting in the development of a phosphate deposit in India which now contributes 730,000 metric tons a year towards that country's self-sufficiency.

The Department of Commerce also has broad responsibilities for the Nation's world trade position and specifically, to monitor commodities in short supply and devise appropriate export policies. To date, however, Commerce has not been concerned with longer-term management of phosphate supplies.

In addition to the major departmental responsibilities mentioned above, several independent agencies have specialized roles that can affect phosphate availability. The Environmental Protection Agency is responsible for major environmental abatement and control programs which involve assessing the impact the mining industry has on the environment. The Army

Corps of Engineers is responsible for determining the impact of mining on navigable rivers and their tributaries. The TVA in addition to sponsoring a phosphate research-and-development program, is also involved in introducing new fertilizer materials and improved fertilizer uses.

Finally, in 1974 the Export-Import Bank assisted in the export of approximately \$400 million of U.S. equipment and supplies to be used in the construction of ammonia plants, storage facilities, pumping stations, railroad tank cars and a 1,200-mile pipeline in the Soviet Union. This transaction was part of a program between the Soviet Union and American companies under which superphosphoric acid was to be shipped to the Soviet Union while ammonia, urea, and potash would be shipped to the United States. In approving that project, however, the Bank used corporate data showing domestic reserves at about 16 billion short tons, an estimate considerably in excess of the 3.8 billion short tons then estimated by the Bureau of Mines.

The picture that emerges from this discussion is that of a complex web of Government agencies, some with competing interests and responsibilities. The situation, in and of itself, is not inherently detrimental. But understanding the impacts and interactions that result from this complex policy network is not easy.

As the National Commission on Supplies and Shortages (NCSS) pointed out in its December 1976 report:

"Some means must be found to integrate the improved information produced by the agencies and departments into a comprehensive picture of how Government policies combine to affect basic industry, and, beyond that, the broad national interest. Means also must be found to alert high-level decisionmakers to the possible consequences of events which separately may be of little concern, but together can foreshadow major problems.

The wide viewpoint implied by both these requirements can be achieved only by someone with nationwide perspective. In the executive branch, this means a Presidential, as opposed to a Departmental, viewpoint. Consequently, the capabilities we seek must be lodged in the

Executive Office of the President. Our specific proposal is to create within an Executive Office agency a unit of specialists to monitor key industries and sectors, to develop a framework for analyzing the comprehensive effects of proposed major Federal policy actions, and to monitor the basic data collection, data analysis, and policy analysis activities of the line agencies and departments."

The sectoral analysis capability advocated by the NCSS was viewed as an important element in improving Federal materials policymaking, especially with respect to market and nonmarket transactions that can affect America's industrial infrastructure.

We believe it is the responsibility of Government to plan for the long-term needs of the Nation. That does not imply elimination of the important role played by the private sector. But industry, by necessity, concentrates on its own immediate well-being. Furthermore, it is the Government's prime responsibility to resolve the complex regulatory and associated problems that will heavily affect future materials availability.

CURRENT EFFORTS TOWARD A MATERIALS POLICY AND PLANNING PROCESS

The President's nonfuel minerals policy study

In December 1977, at President Carter's direction, a Cabinet-level committee was formed to review U.S. policies on nonfuel minerals and materials. That committee selected 12 mineral industries, 1 of which was phosphates.

The Administration's study had two basic objectives. The first was to identify current and anticipated problems with respect to nonfuel minerals, and to present appropriate policy options that could be used to deal with them. These were to include an assessment of how existing Government policies affect a nonfuel mineral, for example, phosphate.

The second objective of the President's study was of greater potential significance. That objective was to develop, test, and begin implementation of, a policy and planning process which could be used by Federal decisionmakers to assess minerals-related problems in the future. This objective seemed to indicate an acknowledgment that one-time

policy studies are no longer a sufficient response to the Nation's recurring materials problems.

Unfortunately, as of October 1979, this study had fallen far short of its original objectives. Although the entire study was supposed to have been completed -- with "action recommendations" sent to the President's desk -- by August 1978, the first phase of the study (problem identification) had not been concluded as of October 1979, and the Administration had abandoned a timeframe for completion of the final phases.

A "draft" report was released for review and comment in August of 1979, and was roundly criticized by a variety of interests at public hearings the following month. Most critics charged that both the analysis and the terms of reference used in the report -- such as "mitigating factors" and "alternative considerations" -- leave the impression that whatever problems exist in the nonfuel minerals area, they are not serious enough to warrant immediate attention. In the case of phosphates, for example, despite repeated promises that the situation would be analyzed in-depth, there is not even a reference to the issues cited in this report. For all practical purposes, this omission constitutes a lack of response to what could become, through inattention, a potentially serious national problem.

Recent legislation and related activity

In April 1979, we issued a report entitled, "Learning to Look Ahead: The Need for a National Materials Policy and Planning Process," (EMD-79-30). The report strongly supports the necessity for fundamental changes in the way this country addresses its materials' problems. We stated our belief that the Government must move to establish an institutionalized planning process for the materials area, especially in light of changed and changing conditions affecting established global systems of materials availability. The Nation has too often found itself in the position of reacting to changes in supplies of critical materials, rather than anticipating important circumstances and taking measures to avoid or offset their effects. In the case of some resources, such as phosphates, failure to anticipate changed future conditions could have grave consequences.

Recently, legislation has been introduced in the Congress to improve the Government's foresight capabilities with regard to materials-related problems. In commenting

upon some of those legislative proposals, we expressed support for the concept that the President should submit periodic reports to the Congress on materials problems that would likely face the United States within specified future time frames. Though uncertain when such legislation will be enacted, we believe, however, the phosphate situation provides an excellent illustration of materials availability problems. We also believe strategies for dealing with these problems should be presented in periodic Presidential reports.

Even in the absence of legislation establishing a general policy and planning process for materials, there are a number of actions which, can and should be, undertaken to improve the Nation's management capability for its vital phosphate resources.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The best data now available indicates that there will be adequate domestic phosphate reserves to last until the end of this century. Present Government forecasts, however, indicate that within 10 years, production will peak and then begin to decline. This is due to the imminent exhaustion of the Nation's richest reserves in the Bone Valley formation of Central Florida, now accounting for 75 percent of total production. There are other sizable, but currently subeconomic, deposits that could be developed to make up for a demise in Bone Valley production. Such developments, however, would probably encounter a number of economic and environmental problems. Furthermore, it is by no means certain that development will take place simply as a result of market forces. Instead, companies may turn to cheaper imports, which might eventually lead to an undesirable degree of import dependence. Because of the overwhelming importance of a reliable phosphate supply for the Nation's agriculture, we think it is desirable, while there is still time, to develop the alternative strategies for ensuring future availability of this critical mineral. Accordingly, we submit the following recommendations.

RECOMMENDATIONS TO THE AGENCIES

We recommend that the Secretary of the Interior make a thorough review of the Nation's long-range phosphate position, and report to the Congress on its future availability, and if appropriate, to suggest legislative actions needed to ensure supply. Such a review should be submitted to the Congress by December 1981 and include the following:

1. A comprehensive assessment of the phosphate reserves of the Nation and the world. To the extent that this is based on unverified data, the Secretary should judge the reliability of such data and the need, if any, for Government verification of proprietary (source) records.
2. A determination of the extent to which noneconomic trade-offs, such as environmental needs and other

land-use needs, are likely to limit future phosphate development.

3. A review and evaluation of alternatives to import dependency and assessment of their costs.
4. A submission from the Department of Agriculture contributing to the comprehensive phosphate assessment by estimating future needs and possible food production alternatives to being dependent on foreign fertilizer sources.

The Secretary of the Interior, in making these assessments, should consult and work closely with other departments and agencies of the Government as specified in chapter 6 of this report.

Currently, Government phosphate research and development is conducted by several organizations including the Bureau of Mines and the Tennessee Valley Authority. Therefore GAO recommends that the Office of Science and Technology Policy (OSTP), Executive Office of the President, coordinate and ensure implementation of an integrated research and development program for phosphates and that OSTP contribute as appropriate to the comprehensive Interior review and report.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The conclusions of this report, we believe, reinforce the need for an institutionalized planning process for materials. The executive branch now has a task force conducting a Nonfuel Minerals Policy Review (NFMPR). This effort was originally initiated to deal with the kinds of issues raised in this report.

At congressional request, GAO is monitoring the activities of the task force on nonfuel minerals policy review (NFMPR) and our work to date indicates that the NFMPR has not addressed the phosphate issue in a coherent manner. This official inattention underscores, we believe, the need for congressional mandating of the review called for in our report.

The Congress should require immediate work to start on recommended review and be particularly alert to Interior's response to this report, as required by the Legislative Reorganization Act of 1970.

In the same fashion, the Congress should also carefully monitor the actions of the Office of Science and Technology Policy in assisting formulation of a comprehensive research and development program for phosphates. If the OSTP persists in its negative attitude and abdication of responsibility, the Congress should consider an alternative placement of responsibility for coordination of materials R&D issues of national concern.

AGENCY COMMENTS AND OUR EVALUATION

We sent a draft of this report to the Department of Agriculture, Commerce, Interior, and State; the Environmental Protection Agency; the Export-Import Bank of the United States, the Office of Science and Technology Policy, and the Tennessee Valley Authority. Their responses are included as appendixes; some detailed comments, accompanying certain of the letters, were noted as appropriate but have not been reproduced. Only the Tennessee Valley Authority did not respond to our draft within the allotted time.

The responses from the Departments of the Interior and Commerce and the Office of Science and Technology Policy indicate disagreement with some of our conclusions and recommendations. A principal reason for these agencies' disagreeing with our conclusions is that the issues raised are being addressed by the ongoing Nonfuel Minerals Policy Review (NFMPR) task force.

We strongly disagree. As mentioned earlier, we have been monitoring the NFMPR at the request of the Congress. To date, no serious attention has been paid to the phosphate problems identified here. Further, the latest draft report by the NFMPR task force does not address the problems surrounding phosphates per se. Consequently, we believe there is no basis for relying on NFMPR.

Interior thinks our suggestion for a comprehensive review is not necessary because certain assessments by the Bureau of Mines are scheduled for completion by the end of 1982. However, funds have neither been budgeted nor appropriated for such assessments and so the estimated completion date appears completely unrealistic.

Both Interior and Commerce suggested problems of future phosphate development and production be set forth in a broader context than provided in our report. We concur and simply reiterate that the scope of analysis suggested by

Interior and Commerce is exactly what we envisioned in this review.

Two other comments warrant mention. First, Interior's response regarding the verifiability of phosphate reserve estimates does not come to grips with this critical issue. We therefore repeat our recommendation that a new review include examination of the means for appropriate Government verification of proprietary (source) records.

Finally, OSTP appears to have misinterpreted our report. OSTP concluded that

"* * * there seems no reason either to replace the market with massive government intervention or rush into a wholesale revision of environmental standards or land use policy to free up more U.S. phosphate reserves in the near term."

Our report suggests nothing resembling such courses of action. Of final note, the Office of Science and Technology Policy appears unwilling to accept responsibility for coordinating an integrated national research-and-development program. An effective Federal R&D strategy for phosphates cannot be implemented merely through existing arrangements involving partial interagency coordination. Neither can extension of the status quo resolve deficiencies of concern to the private industrial sector. GAO urges the Office of Science and Technology Policy to reconsider its position and take the lead in assisting formulation of a comprehensive, national R&D program for phosphates.



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAY 01 1979

Mr. J. Dexter Peach
Director
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This responds to your request for comments on the GAO draft report entitled "The Future of Phosphates: Case Study of a Valuable Depleting Mineral."

In general, we find this to be a timely, forward looking report on the advisability of taking steps now to assure the continuing supply of a critical mineral commodity in the future. We are encouraged that the report recognizes the complexity and long lead times required to perform credible resource studies. We are also pleased that GAO recognizes Department of Interior attempts to address the kinds of issues raised in this report, including the Department's efforts in the Nonfuel Minerals Policy Review, the Minerals Availability System (MAS) studies of the Bureau of Mines, and the planned Office of Minerals Policy and Research Analysis study to formulate a leasing policy for phosphate rock located on Federal lands. Further a comprehensive assessment of our domestic potential phosphate reserves is currently underway within the Bureau of Mines, and an assessment of world phosphate reserves will follow. Both studies are scheduled for completion by the end of 1982. In view of these ongoing and planned activities, we do not believe that the additional study called for in the draft report is necessary at this time.

Moreover we feel that the draft report, while acknowledging the complexity of resource studies, does not present the phosphate situation in a sufficiently broad context. The relationship of phosphate to other minerals in world trade, the impact of already formulated trading policies, domestic and foreign concerns about prices, GNP, employment, energy, and the dynamic economic and political state of world affairs do not receive adequate attention. In addition, environmental problems and constraints should be presented with more perspective and balance.

The report also highlights what is considered to be a great deal of variation in estimates of national phosphate reserves and asserts that much of this variation is associated with government reliance on unverified data provided by industry. We believe that much of the fluctuation in estimates can be accounted for when consideration is given to methods employed in defining "resources" versus "recoverable reserves." We have attempted to provide further explanations in the specific comments enclosed.

Sincerely,



Larry E. Meierotto
Assistant Secretary
Policy, Budget and Administration

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICEP.O. Box 2417
Washington, D.C. 200131420
MAY 21 1979

Mr. Henry Eschwege, Director
Community and Economic Development Division
U.S. General Accounting Office
441 G St. N.W.
Washington, D.C. 20548

Dear Mr. Eschwege:

In response to your letter of May 11, 1979, transmitting a draft of your proposed report to Congress entitled, "The Future of Phosphates: Case Study of a Valuable Depleting Mineral," GAO did a good analysis of the phosphate situation.

We concur with the proposed recommendations on a long-range phosphate position. There is a lack of, and a real need for Government long-range planning regarding the use and availability of vital mineral resources. The United States, through the appropriate agencies, must determine the future availability of mineral reserves (both national and world-wide supplies), project our needs, anticipate foreign needs, and plan accordingly.

It is hoped that the Secretary of Interior will institute the recommended review. The Department of Agriculture is interested in contributing to such a review and would like to be a full-fledged participant.

We appreciate the opportunity to review and comment on this draft report.

Sincerely,

JOHN R. MCGUIRE
Chief



DEPARTMENT OF STATE

Washington, D. C. 20520

May 22, 1979

Mr. J. Kenneth Fasick
Director
International Division
U. S. General Accounting Office
Washington, D. C.

Dear Mr. Fasick:

I am replying to your letter April 20, 1979, which forwarded copies of the draft report: "The Future of Phosphates: Case Study of a Valuable Depleting Mineral."

The enclosed comments on this report were prepared by the Acting Director, Office of International Commodities.

We appreciate having had the opportunity to review and comment on the draft report. If I may be of further assistance, I trust you will let me know.

Sincerely,

A handwritten signature in cursive script that reads "Roger B. Feldman".

Roger B. Feldman
Deputy Assistant Secretary
for Budget and Finance

Enclosure:
As stated

GAO DRAFT REPORT:
"THE FUTURE OF PHOSPHATES:
CASE STUDY OF A VALUABLE DEPLETING MINERAL"

The report correctly points out that phosphate is an essential and non-substitutable plant nutrient and that continued availability is vital for the nation's agriculture. It also emphasizes that a healthy agricultural sector is important not only for the domestic food supply, but also for food aid and as a source of foreign exchange.

The Department of State, however, believes that this study does not give adequate recognition to existing resource information. In particular, the recently completed "Minerals Availability Studies" on phosphates provide detailed information on phosphate deposits in three of the four supply areas--Florida, Tennessee, and the Carolinas/Georgia. While worldwide resource information could be improved, the data possessed by the Bureau of Mines is considered to be the best available anywhere. State also feels the report should give more attention to currently sub-economic deposits which could well be considered future resources under changing market conditions. In this context the role of known deposits in Australia, South Africa, and offshore Southeastern U.S. are worthy of more detailed consideration in the event of alternative world demand and price conditions.

Chapter 6 of the GAO Draft Report suggests a number of Government actions which might be pursued should further study reveal that we face a future phosphate shortage. Included in these actions was a limitation on exports. Here we would like to note that under current legislation the United States may only impose export controls to ameliorate inflation or for foreign policy or national security reasons. Consumers inevitably generalize their experiences with supply restrictions, assuming that a country which resorts to export controls for one product is inherently an unreliable supplier. Thus when considering the imposition of export controls, the cost of the general damage to our export efforts has to be calculated in addition to the merits of the specific case.

Two Preparatory Meetings on phosphates were held in connection with the UNCTAD Integrated Program for Commodities (December 1977 and June 1978). Here the U.S. took the position that the interests of all parties are best served in an environment which provides free access for producers, encourages investment in downstream processing in countries having a raw material base, and leads to a stable growth of both supply and demand. As a major agricultural producer and a country deeply concerned about the nutritional needs of developing countries, we opposed any arrangements intended to support phosphate rock prices at artificially high levels. To assist these developing countries with nutritional needs, the U.S. Agency for International Development has a substantial program for underwriting fertilizer supplies. The FAO's International Fertilizer Scheme also is active in procurement of fertilizers for developing countries. A move toward restriction of U.S. phosphate exports would run counter to these efforts.

The U.S. position for the UNCTAD meetings also emphasized the value of study of the long-term international supply situation. Although these discussions have come to a standstill because of deliberate non-participation by Morocco, our embassies and resource attachés are engaged in continuing efforts to improve knowledge of world mineral resources. The success of these efforts is, however, clearly dependent on cooperation from other producing countries. For example, last year the Department of State assisted the U.S. Bureau of Mines with an effort to sponsor and finance a systematic survey of Moroccan phosphate reserves. This offer was declined, however, and a subsequent commitment to furnish the findings of exploratory activity by the Government phosphate company has not been fulfilled to date.

The Department has an ongoing interest in the worldwide availability of phosphates, and will continue to work closely with Bureau of Mines and other interested agencies in improving our knowledge of future needs and resources.



John P. Ferriter
Acting Director
Office of International Commodities



PRESIDENT
AND
CHAIRMAN

EXPORT-IMPORT BANK OF THE UNITED STATES

WASHINGTON, D.C. 20571

May 14, 1979

CABLE ADDRESS "EXIMBANK"
TELEX 88-481

Mr. J. K. Fasick
Director, International Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Fasick:

We appreciated receiving a draft of GAO's proposed report to Congress entitled, "The Future of Phosphates: Case Study of a Valuable, Depleting Mineral." In general, we concur in the study's conclusions and recommendations. As an independent government agency, Eximbank will continue to incorporate into its decision making process the long-term needs of the United States. This we feel can be done while still fulfilling our mandate to foster exports.

We share GAO's view that current trends in U.S. production and exports of phosphates indicate the United States, now a major exporter of phosphates, may become a far less influential exporter during the next 20 years and will probably become a net importer sometime thereafter. These trends, we agree, could have important economic, and probably strategic, implications for the United States.

We suggest that the section dealing with Eximbank, page 69 of the draft report, be changed to more accurately reflect Eximbank's role in the Soviet Union transaction. It is suggested that the penultimate sentence on page 69 read "In 1974, the Export-Import Bank assisted in the export of approximately \$400 million of U.S. equipment and supplies to be used in the construction of ammonia plants, storage facilities, pumping stations, railroad tank cars and a 1,200 mile pipeline in the Soviet Union. This transaction was part of a program between the Soviet Union and American companies under which superphosphoric acid was to be shipped to the Soviet Union while ammonia, urea, and potash would be shipped to the United States."

The present Eximbank staff was not able to determine the source of the phosphate rock reserves from corporate data cited in the transaction. It is the current practise of Eximbank's engineering staff to require submission of geological reserve studies in support of reserve estimates in those cases in which the project and minerals

(See GAO note, p. 61.)

are interdependent. In other cases dealing with general or country mineral resources, Eximbank will use data published by the Department of Interior or other recognized sources. Nevertheless, it is the practise of Eximbank to use only "measured" or "proved" reserves in the evaluation of a mineral related project.

Please let us know if we can be of additional assistance.

Sincerely,



John L. Moore, Jr.

GAO note: Page references in this appendix refer to the draft report and do not necessarily agree with the page numbers in this final report.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

29 JUN 1979

OFFICE OF
PLANNING AND MANAGEMENT

Honorable Henry Eschwege
Director, Community & Economic
Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Environmental Protection Agency (EPA) has reviewed the General Accounting Office (GAO) draft report entitled "The Future Of Phosphates: Case Study Of A Valuable Depleting Mineral."

EPA has, on an informal basis, previously furnished detailed comments on specific portions of the report. We concur with the recommendations in the report which include the performance of a comprehensive assessment of the Nation's phosphate reserves, a determination of the extent to which non-economic constraints limit development, a review and evaluation of alternatives to import dependency, and a United States Department of Agriculture (USDA) determination of projected phosphate needs. This information is a prerequisite to establishing a national policy on the management of phosphate reserves and resources. We further agree with GAO's recommendation to the Secretary of Interior that he work with the other agencies specified in Chapter 6, including EPA. We feel strongly that in solving one environmental problem such as phosphate depletion, we must ensure that another greater environmental problem is not created.

While reviewing the report, we noted several environmental impacts of mining and manufacturing phosphate which the report did not discuss. EPA believes that all environmental impacts should be considered in establishing a national

policy on the management of phosphate resources. The following examples illustrate some of the environmental problems which can arise as a result of phosphate mining and manufacturing:

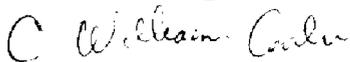
- in mining apatite, the principle mineral source of phosphorus, a large solid waste residue is created and needs to be disposed of in an environmentally acceptable manner.
- in manufacturing liquid phosphoric acid, the use of apatite (which contains 9.7 grams fluoride per 100 grams of phosphorus) results in volatile hydrogen fluoride being released into the air thereby creating an air pollution problem. Stack scrubbing with lime-neutralized recycled pond water is in extensive use as an air pollution control measure in the phosphoric acid industry. Such scrubbing, however, results in tremendous quantities of soluble and free fluoride occurring in the wastewater. The soluble wastewater fluorides are then precipitated by lime and deposited in sedimentation ponds as calcium fluoride. If settling ponds are not properly lined, the calcium fluoride (which is more soluble than the original apatite) leaches into the groundwater.
- some deposits of phosphorus rock contain appreciable amounts of uranium and radium which can present problems for mining operations. In South Carolina and Florida, for instance, most of the ore body is in a fresh water aquifer. Before the phosphate can be mined the water has to be drained. In Florida it is drained into the underlying fresh water aquifer by interconnecting wells. This action places radioactive materials into the drinking water aquifers. However, this problem will be regulated by EPA regulations under Part C of the Safe Drinking Water Act. EPA published proposed technical criteria and standards on April 20, 1979, and proposed procedures to implement those criteria and standards on June 14, 1979.

The report also mentions that salt water intrusion can cause problems in underground water supplies. One place where this can occur is where phosphate is being processed near coastal waters. Salt water intrusion barrier wells will also be regulated by the regulations cited in the preceding paragraph. The proposal provides that salt water barrier wells be inventoried and assessed by States. Results of this effort would then form the basis for future regulations.

EPA is also in the process of finalizing under the Resource Conservation and Recovery Act regulations which were proposed December 18, 1978 (43 FR 58946) that will address a different problem associated with phosphate industry hazardous wastes. These regulations list certain waste streams from the Phosphate Industry as hazardous under the proposed section 250.14(b)(2) (43 FR 58958) and prescribe special standards for their management under the proposed section 250.46-3 (43 FR 59015). Contract studies will support additional waste management regulations in this area.

We appreciate the opportunity to review this report before it is published.

Sincerely yours,



William Drayton, Jr.
Assistant Administrator for
Planning and Management



UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Administration
Washington, D.C. 20230

12 JUN 1979

Mr. Henry Eschwege
Director, Community and Economic
Development Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in reply to your letter of April 20, 1979,
requesting comments on the draft report entitled
"The Future of Phosphates: Case Study Of A Valu-
able, Depleting Mineral."

We have reviewed the enclosed comments of the
Assistant Secretary for Industry and Trade and
believe they are responsive to the matters dis-
cussed in the report.

Sincerely,

A handwritten signature in cursive script, appearing to read "Elsa A. Porter".

Elsa A. Porter
Assistant Secretary
for Administration

Enclosure

Staff Comments on GAO Report
"The Future of Phosphates - Case Study of
a Valuable, Depleting Mineral"

The GAO report has been reviewed by our domestic industry specialists and by our international economists. The report raises a number of questions which should be resolved. In addition, we suggest that the report address the importance of phosphates to the U.S. balance of trade.

With respect to trade, we suggest that the report include a section on the nature and importance of phosphate exports. We suggest that the following points be included:

--The U.S. is in a strong competitive position in world markets. The U.S. has domestic production of two major raw materials (i.e., phosphate rock and sulfur), competitive process technology, efficient processing facilities, and rock reserves and processing facilities near deep water transportation.

--The total value of exports of phosphates (phosphate rock and phosphate chemicals) in 1978 amounted to more than \$1.3 billion. Phosphate rock represented 6.7 percent of all mineral exports; phosphate chemicals represented 8.1 percent of all chemical exports. These provided a significant contribution to the U.S. balance of trade.

--Exports of phosphate chemicals have been increasing more rapidly than exports in the basic mineral. This has led to a considerable increase in the value added within the U.S. from the processing of this domestic mineral resource for sale to foreign markets.

--While the revenues from U.S. exports of phosphate rock are of major importance to the U.S., the quantities exported have accounted for only 25-30 percent of U.S. production of phosphate rock. Such exports have not caused any serious hardship to the U.S. farmer.

--Phosphates (rock and chemicals) from the U.S. are of considerable importance to some countries with which we have a negative trade balance. The seven leading purchasers of U.S. phosphates during 1978 included: Belgium, Brazil, Canada, France, India, Italy, and Japan.

We also have questions on a number of statements in the draft report, such as the following:

--On page ii it is stated that "it is far from certain that the Nation's reserves (of phosphates) will be adequate beyond the year 2000 in the face of steadily rising demand." Therefore, GAO believes "it is essential...that serious efforts be devoted to ensuring that adequate supplies will be available in the future." However, these statements are contradicted by the two long-term U.S. supply/demand projections cited in the study. A United States Bureau of Mines projection cited on pages 23-24 shows that in the year 2000 the U.S. is still producing enough phosphates to export 30 percent after meeting its own domestic consumption requirements. A Chase Econometrics projection cited on page 21 shows that as of the year 2025 the U.S. will still be exporting almost two million tons more of phosphates than it is importing. The numerical differences in the estimates are acknowledged in the report but not analyzed or rebutted, and neither one seems to be reflected in the report's conclusions.

--On page ix it is recommended that the Federal Government respond to the apparent need for a comprehensive assessment of potential U.S. phosphate reserves. Consideration should be given to the implications of requiring verification of proprietary records.

--On pages vi and vii it is stated that the United States will need to reduce exports toward the end of the century. The extent to which exports from the United States would be reduced if management decisions are left to private industry depends on a number of factors which should be considered further. For example, the price level will affect the degree of utilization of present subeconomic resources. Improved production efficiencies are also a factor; TVA expects P₂O₅ recovery in beneficiation to rise from its present level of 60 percent to 91-93 percent. Another factor is the cost performance of United States industry relative to other producers--mainly Morocco.

--On page 17 it is stated that "as prices rise or new technologies lower costs, reserves increase correspondingly." This is a good point, but it is not reflected in the Introduction. Moreover, we believe this important concept should be considered in more depth and adequately reflected in the conclusions of the report. This same comment applies to the last paragraph on page 31 that relates the magnitude of reserves to the price level.

(See GAO note, p. 68.)

From a more general perspective, it is questionable whether evidence has been presented to justify the conclusion that there is "a sure need for greater Government involvement in the management of phosphate resources" (page 63). Based on the study, we believe that a case has only been made for improved government analysis of the economic and technical factors impinging on assurance of adequate phosphate supplies. In fact, the Administration is currently studying this issue as part of its Nonfuel Minerals Policy Review.

In this connection, we might note that the Administration's study is not being conducted on the basis of an a priori assumption that there is a conceptual conflict between our "traditional reliance...on private industry to meet the new demands as they arose" and the "need for the Government to plan for the long-term needs of the nation," as implied on page viii. Therefore, we do not conceive of national planning as necessarily requiring either government "management" of resources or a new "institutionalized" planning process.

There are also ambiguities in the report's treatment of supplies and in other aspects of the report's methodology. A major problem, for example, is that the report does not sufficiently focus on the fact that the issue of U.S. resource "sufficiency" must be analyzed from an international perspective. An examination of the phosphate situation should focus on the global availability and reliability of phosphate supplies, i.e., including those from foreign sources, as well as on the "adequacy" of U.S. domestic resources. Only if a case can be made that the U.S. is likely to incur significant costs as a result of increased foreign dependence would many of the conclusions of this report be convincing.

Based on the information presented in the report on the U.S. and foreign supply/demand situation, we believe many of the conclusions touching on the basic issue of whether there is any proximate cause for concern about supplies are questionable. We have already noted that the available quantitative projections are contradictory. Of course, any projection of supply/ demand over a long-term period contains a large element of conjecture. Even so, it is significant that the conclusions of the report on the "adequacy" of U.S. resources seem largely to mean that the U.S. may eventually become a net importer rather than that world supplies will be inadequate or unavailable to the U.S.

(See GAO note, p. 68.)

The conclusions on page 62 with respect to the need for improved economic data and analysis of the phosphate situation are, in our view, all that can be supported based on the information presented in the report. If the report can be revised to support the conclusion that the U.S. faces a serious problem of supply availability in the foreseeable future, then the conclusion that there should be a thorough review of U.S. policies would be appropriate. Much more detailed analyses of the levels and patterns of world trade in particular would be necessary to support many of the conclusions of this report. Statements such as, "It is probably not in the national interest to allow reduced world prices over a period of time to discourage domestic development" (page 16) require much more elaboration and justification. We also would question whether it is appropriate to review and evaluate alternatives to import dependence (page x) without establishing more precisely the extent to which the U.S. will rely on foreign supplies in the future and the costs of such reliance.

May 29, 1979

GAO note: Page references in this appendix refer to the draft report and do not necessarily agree with the page numbers in this final report.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20500

May 21, 1979

Mr. Harry S. Havens
Program Analysis Division
U.S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Havens,

Dr. Press has asked that I respond to your letter of April 20 requesting comments on your draft proposed report to the Congress entitled, "The Future of Phosphates: Case Study of a Valuable, Depleting Mineral." The study seems to raise three kinds of questions: those related to the likely balance of national and world supply and demand for phosphates in the future; those related to the adequacy of governmental data collection, data analysis and policy analysis functions and those related to research and development. I will address these in turn.

Considerable concern is expressed in the document that the most recent Bureau of Mines projection of phosphate supply, reproduced on page 24 of the draft report, shows a decline in production after 1985, and that, as suggested by the Figure on page 19, domestic consumption could outpace domestic supply sometime after the year 2000. In the meantime, if these projections are realized, U.S. exports of phosphates would decline after 1985. I have no independent basis to evaluate these projections, but would like to point out three things about projections such as these--not unique in any sense to the phosphate case--with which I think the Bureau would also agree.

First, the Bureau's production projections are based on current industry expectations of future production. However, between now and the 1985 to 1990 time period, other producers could decide to come on stream and succeed in doing so. Whether or not this occurs--or to what extent it does--will depend on such things as the adequacy of the resource base, changes in price and technology, availability of land and capital, and the ability of a prospective producer to meet environmental and land use requirements. The projections of the Bureau, therefore, while probably the best estimates available today, are not and should not be interpreted to be maximum possible production.

Second, as with any depleting mineral resource, the highest grade, most easily accessible phosphate rock is being exploited first and will

(See GAO note, p. 71.)

MAY 24 1979
W.S.H.

be totally gone over a time period measured in decades. This in itself is not necessarily a matter of concern. Other resources exist--the Bureau's figures indicate a domestic resource base of 8 billion tonnes--and with improved technology and higher prices much of this might well be exploitable by the year 2000 or thereafter.

Third, if U.S. exports in fact decline after 1985 the result will be a reduction in U.S. export earnings and the need for other sources to replace U.S. supplies on the world market. Fortunately, world reserves are sufficient to enable compensation for a reduction in U.S. exports at prices not very much increased in real terms from those currently prevailing.

The conclusion I derived from these points is that, while the supply/demand balance for phosphates, like any mineral commodity, should be monitored carefully and be frequently reevaluated, there is not now the basis for concern that is expressed and implied in the GAO draft report. In particular, there seems no reason either to replace the market with massive government intervention or to rush into a wholesale revision of environmental standards or land use policy to free up more U.S. phosphate reserves in the near term.

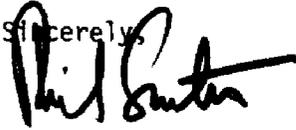
The draft report also addresses the quality of the Government's data collection, data analysis, and policy analysis capabilities and points to several areas thought to be inadequate. Such inadequacies in the area of nonfuel minerals are widely recognized to exist and are by no means limited to the case of phosphates. This is a matter that has been under review within the domestic policy review on nonfuel minerals and is likely to be identified by the Phase 1 draft report, to be available within a few weeks, as an area requiring attention in Phase 2. We are hopeful that one result of the domestic policy review will be concrete proposals to address this important problem.

We have to disagree with the recommendation of the draft report that the Secretary of the Interior prepare a special report to the Congress on phosphates. The Bureau of Mines annually produces one of its series of mineral commodity profiles on phosphates and the Secretary reports annually to the Congress on mining and minerals in fulfillment of the Mining and Minerals Policy Act of 1970. Such reports contain the best information available to the Government on phosphates and will improve as the Government's data and analysis capabilities improve. We see no justification for burdening the Secretary of the Interior with yet another report whose contents will merely be redundant of information already available to Congress.

Finally, we share the view expressed in the report that R&D is necessary to anticipate, offset, and respond to foreseeable trends during the next 25 to 50 years in the area of phosphates. We note that some R&D is underway in the private sector and this is augmented by a R&D program underway in the Tennessee Valley Authority focusing on

phosphate utilization and another in the Bureau of Mines focusing on mineral recovery, water recovery and environmental aspects of phosphate supply. The allocation of government responsibilities in the area of phosphates R&D is specified in a memorandum of understanding between the Tennessee Valley Authority and the Bureau of Mines. In our view this system works rather well and does not require major change. Of course, the Office of Science and Technology Policy should and does from time to time review the R&D programs of government agencies in order to fulfill our responsibilities to provide scientific and technical advice to the President, the Office of Management and Budget and the Congress. However, we cannot agree with the draft report's recommendation that the Office of Science and Technology Policy "coordinate and ensure implementation of an integrated research and development program for phosphates." This operational function should remain with the Department of the Interior, the Tennessee Valley Authority and to some extent the Department of Agriculture.

It is always a pleasure to comment on GAO reports and I hope you will find this brief response of some utility.

Sincerely,


Philip M. Smith
Associate Director
Natural Resources and
Commercial Services

GAO note: Page references in this appendix refer to the draft report and do not necessarily agree with the page numbers in this final report.

(008200)

Single copies of GAO reports are available free of charge. Requests (except by Members of Congress) for additional quantities should be accompanied by payment of \$1.00 per copy.

Requests for single copies (without charge) should be sent to:

U.S. General Accounting Office
Distribution Section, Room 1518
441 G Street, NW.
Washington, DC 20548

Requests for multiple copies should be sent with checks or money orders to:

U.S. General Accounting Office
Distribution Section
P.O. Box 1020
Washington, DC 20013

Checks or money orders should be made payable to the U.S. General Accounting Office. NOTE: Stamps or Superintendent of Documents coupons will not be accepted.

PLEASE DO NOT SEND CASH

To expedite filling your order, use the report number and date in the lower right corner of the front cover.

GAO reports are now available on microfiche. If such copies will meet your needs, be sure to specify that you want microfiche copies.

AN EQUAL OPPORTUNITY EMPLOYER

**UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548**

**OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300**

**POSTAGE AND FEES PAID
U. S. GENERAL ACCOUNTING OFFICE**



THIRD CLASS