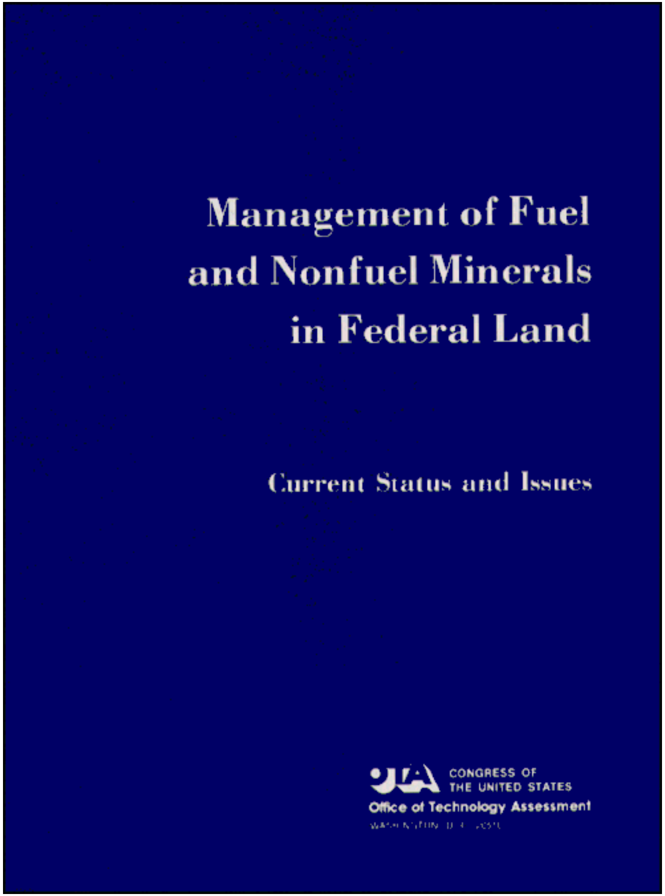
Management of Fuel and Nonfuel Minerals in Federal Land

April 1979

NTIS order #PB-295788



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Washington, L). C. 20402

Foreword

Federal lands constitute about one-third of the geographical area of the United States and contain much of its mineral and other natural resources, In recent years, Congress has increasingly been confronted with difficult questions concerning the development of these mineral resources. As a result, the Office of Technology Assessment was requested to undertake this study by the Technology Assessment Board and several congressional committees, including the Senate Committee on Energy and Natural Resources and the House Committee on Interior and Insular Affairs.

To protect other resources such as forests, grazing land, and wilderness areas, mineral activity has been prohibited or restricted in large portions of Federal lands. It is felt by some that such prohibitions and restrictions may seriously harm the domestic mineral industry and that, within a decade or so, the United States may find itself facing minerals shortages in a world minerals market that is becoming increasingly tight. Others, however, are concerned that continued mineral activity under existing laws and regulations could have major adverse environmental and social impacts.

This assessment examines a series of options that range from continuance of the status quo to major and comprehensive innovations in the management of mineral activities on Federal lands. It is another in the series of assessments of energy and natural resources policies that the Office of Technology Assessment is conducting for the Congress.

Daniel De Simone
Acting Director

OTA Materials Group Staff

Albert E. Paladino, Group Manager (through December 1978)
Audrey B. Buyrn, Group Manager (from January 1979)
Richard W. Wright, Project Director

Technical Support

Stanley Schweinfurth, USGS
Dennis Cox, USGS
John B. Wachtman, NBS

Support Staff

Jacqueline Robinson
Carol Drohan
Bernadette Balakit
Mary Adams

OTA Publishing Staff

John C. Holmes, Publishing Officer
Kathie S. Boss   Joanne Heming

Federal Onshore Mineral Land Management Advisory Panel

Elburt F. Osborn, Chairman
Carnegie Institution of Washington

Walter C. Ackerman
Wyoming Department of Environmental Quality

Earl H. Beistline
University of Alaska

James Boyd
Materials Associates

Marion Clawson
Resources for the Future

John A, McComb
Sierra Club

Leo J. Miller
Texasgu]f, Inc.

OTA Materials Advisory Committee

James Boyd, Chairman
Materials Associates

Earl H. Beistline
University of Alaska

Seymour L. Blum
The MITRE Corp.

Lynton K. Caldwell
Indiana University

Robert Louis Coble
Massachusetts Institute of Technology

Lloyd M. Cooke
Economic Development Council of New York City, Inc.

Frank Fernbach
United Steel Workers of America (retired)

James H. Gary
Colorado School of Mines

Edwin A. Gee
E. I. du Pent de Nemours & Co.

Bruce Hannon
University of Illinois at Urbana-Champaign

Julius Harwood
Ford Motor Company

Franklin P. Huddle
Congressional] Research Service

Elburt F. Osborn
Carnegie Institution of Washington

Richard B. Priest
Sears, Roebuck and Company

N. E. Promisel
National Materials Advisory Board

Lois Sharpe
League of Women Voters

Raymond L. Smith
Michigan Technological University

Simon D. Strauss
ASARCO, Inc.

George A. Watson
Ferroal]oys Association

Acknowledgments

This report was prepared by the Office of Technology Assessment Materials Group staff. The staff wishes to acknowledge the assistance and cooperation of the following contractors and consultants in the gathering and formulation of some of the background data:

Spencer Beresford
Donald M. Carmichael
Perry R. Hagenstein
Harbridge House, Inc.
Robert A. Weeks

The staff further wishes to acknowledge those organizations, both public and private, which reviewed and commented on various draft documents circulated by OTA or provided other types of assistance:

AMAX, Inc.
American Mining Congress
American Petroleum Institute
Anaconda Company
ASARCO, Inc.
Colorado Mining Association
Colorado Open Space Council
Environmental Policy Center
EXXON, Inc.
Federation of Rocky Mountain States
Forest Service, U.S. Department of Agriculture
Friends of the Earth, Inc.
Gilbert, Ray E.
Homestake Mining Company
Joint Federal-State Land Use Planning Commission for Alaska
Kennecott Copper Corp.
Kerr-McGee Corp.
Mobil Oil Corp.
National Association of Counties
National Coal Association
National League of Cities
Natural Resources Defense Council
Northern Plains Resource Council
Northwest Mining Association
Newmont Mining Corp.
Occidental Minerals Corp.
Pillar, Lowell and Associates
Placer Amex, Inc.
Rocky Mountain Oil and Gas Association
Sierra Club
Texasgulf, Inc.
U.S. Department of the Interior
Western Governors Policy Office
Western Oil and Gas Association
The Wilderness Society

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A. Introduction

Congress has the constitutional responsibility for managing and disposing of Federal onshore land, which constitutes approximately 30 percent of all onshore land in the Nation. The Federal onshore land is concentrated in the regions (primarily in Alaska and the 11 Western States) that have either supplied much of our past and current domestic mineral product ion or are considered to hold the greatest promise for future domestic mineral discoveries, or both. Yet increasingly large amounts of the Federal land are being withdrawn from availability for mineral activity, or otherwise highly restricted, to protect both mineral and nonmineral resource uses and activities that Congress or the executive branch believes are inadequately protected under the existing Federal mineral disposal laws. These laws, enacted in piecemeal fashion over more than a century, contain significant gaps in coverage, result in unnecessary expenses for mineral explorers and miners and needless damage to nonmineral resources, do not assure secure tenure or diligent mineral activity, and do not provide incentives or other mechanisms for balancing of mineral and nonmineral resource values at each stage of mineral activity. Changes in the laws t o resolve some of these problems may lead to more efficient mineral activity on nonwithdrawn land and to a halt in or even reversal of the present trend of increasingly large withdrawals. This trend has made it more and more difficult to explore for and develop minerals on Federal land. It may have serious adverse consequences on the domestic mineral industry and, after a deceptive lag of 10 to 20 years (during which time currently known and available mineral deposits are brought into production, but few new deposits are discovered and developed for eventual production), on the U.S. mineral posture in an increasingly tight international minerals environment,

This study was initiated and developed in response to several related requests, Senator Ted Stevens, a member of the Technology Assessment Board, asked the Office of Technology Assessment (OTA) to assess "the crucial factors, including land use, environmental and transportation policies, as they determine the accessibility to domestic mineral resources, " and "the likely economic, social, environmental and other impacts of various policy alternatives designed to increase domestic mineral productility. " Related broad issues of energy and materials supply and use were raised in a request submitted by the Chairman and the Ranking Minority Member of the House Committee on Science and Technology. Representative Morris K. Udall, another member of the Technology Assessment Board and (then) Chairman of the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs (now Chairman of the full committee), requested a study or studies of various natural resource issues as a beginning on an assessment of national growth policy. Representative Udall's request called for a study of resource management policies for land, water, and fuel and nonfuel minerals to: 1) analyze and identify any shortcomings in existing policies and practices, including those involved in choosing between alternative or conflicting uses of natural resources, particularly mineral and nonmineral land uses: 2) critically evaluate and extend prior analyses of these issues to develop a broader analytical framework; and 3) present options for the improvement and coordination of the policies and practices of Federal, State, and local governments in these areas. The study plan, as developed in response to the previously described requests, was supported by a request from the Senate Committee on Interior and Insular Affairs (now the Committee on Energy and Natural Resources). Subsequently, the Senate Committee on Governmental Affairs requested and received a brief interim analysis of the effects of the proposed Department of Energy Organization Act on Federal land management.

The requests covered a very large number of issues. In order to confine the study to manageable scope, while still addressing the principal concerns of the requesters, the study was defined as an analysis of the Federal land management laws and practices that govern exploration for and development and production of fuel and nonfuel minerals in Federal onshore land, exclusive of Indian lands, and the interaction of the Federal laws and practices with State and local controls and payment requirements, Above all, this study addresses the problems associated with establishing efficient and equitable mineral land management to: 1) facilitate the identification, development, and production of the mineral resources in Federal onshore land, 2) do so in an environmentally and socially acceptable manner, and 3) accommodate demands for nonmineral resource uses on such land through provision, as appropriate, for simultaneous, sequential, or dedicated use. The rationale for and the implications of this particular focus of the study are discussed in chapter 1.

This executive summary first sketches the important role Federal onshore land plays in the provision of both minerals and nonmineral resources to the people of the United States, Next, there is a brief description of the stages of mineral activity and the role of the various participants at each stage, followed by an outline of the history and main elements of the Federal laws governing mineral activities on Federal onshore land. Finally, specific issues and options are presented in each of three major areas of concern: 1) the coordination of mineral activities undertaken by different individuals and firms, 2) the coordination of mineral activities with nonmineral activities and values, and 3) the coordination of regulatory and payment requirements imposed on mineral activities by different agencies of the Federal Government and by the different levels of government (Federal, State, and local) in our federal system.

B. The Importance of the Mineral and Nonmineral Resources on Federal Onshore Land

1. Mineral Resources

An adequate, reliable supply of minerals is essential to the economy and security of the United States, Mineral materials are the foundation of industrial society. They provide the physical basis for almost all activities of U.S. citizens. Domestic (United States) consumption of newly mined minerals in 1976 was almost 40,000 pounds, or 20 tons, per person.

An important source of U.S. mineral supply is production from domestic mineral deposits, The demand for newly mined minerals can be reduced, but not eliminated, by conservation, recycling, reuse, and substitution of minerals and mineral products and by changes in consumer buying habits. Although imports can satisfy an important part of the demand, they may make the United States vulnerable to economic and political decisions or events in the foreign producing countries. Even when imports are secure, they may contribute to serious balance-of-trade problems. Moreover, a significant portion of our national economic activity and employment, particularly in certain regions, is based on the mineral-producing sectors. The Bureau of Mines estimated that materials with a value of approximately $200 billion were processed in 1978 from $20 billion of domestically produced nonfuel minerals, $4 billion of reclaimed scrap, and $3 billion of imported nonfuel minerals, and that an additional $19 billion of processed materials were imported. Roughly $58 billion of domestically produced fuel minerals and $40 billion of imported fuel minerals and refined petroleum products were consumed. These raw and processed mineral materials are indispensable to our $2 trillion industrial economy,

Onshore land either presently owned by the Federal Government or obtained from the Federal Government by private parties under the Federal mineral laws is one of the more important sources of domestic mineral resources, The Federal Government owns about 30 percent of the onshore land in the United States. Moreover, the Federal land is concentrated in the areas considered to be most favorable for the occurrence of economic mineralization, Most domestic nonfuel mineral production has come from Federal land areas, which contain the bulk of the known domestic resources of a majority of the metallic minerals. They also contain major resources of coal, oil shale, geothermal steam, and uranium, in addition to proportionally smaller, but nevertheless significant, resources of oil and gas. (Much larger resources of oil and gas may be found in Federal offshore land.) The role of Federal onshore land in the production of essential mineral commodities is analyzed in section B of chapter 2 and appendix A. All the available data indicate that it is clearly in the national interest to consider carefully opportunities for the identification and production of the mineral resources in Federal onshore land.

2. Nonmineral Resources

Federal onshore land contains not only minerals, but valuable nonmineral resources, both commercial (e.g., timber, forage, and water) and noncommercial (e.g., nongame wildlife, archeologic sites, scenic landforms, parks, and wilderness). Initially as a result of historical accident and subsequently by design, the Federal Government became the owner (in trust for the public) of the Nation's most important and unique nonmineral resources, particularly the noncommercial ones. The Government's holdings of such resources are now among the most significant in the world.

C. Mineral Exploration, Development, and Production: Stages and Participants (Chapter 2)

1. Stages

"Mineral exploration " is the process of identifying and investigating "targets" in order to discover an economic mineral deposit. "Development" is the work required to prepare a deposit, once discovered, for production. "Production" is the actual mining, processing, and shipment of the mineral or ore. The final offsite conversion of minerals to a form sufficiently pure for industrial purposes through refining, smelting, and similar processes is excluded from the study.

In general, each stage of mineral activity, from initial geologic reconnaissance of large areas (i.e., hundreds and even thousands of square miles) to actual production, involves applying successively more discriminating and more expensive techniques and heavier equipment to successively smaller land areas (eventually a few square miles or less), The small areas are subjected to detailed surface investigation and three-dimensional physical sampling (e. g., drilling) to determine if they actually contain an economic mineral deposit. If such a deposit is found, it and the immediately surrounding land, as required, are developed for production.

2. Participants

The backbone of the mineral industry in the l9th century was the large number of individual prospectors and employees of small mining companies who found and worked high-grade deposits that were discoverable through examination of the surface of the land, Major deposits were usually syndicated or turned over to larger firms for development and production. Well into the 20th century, individuals using conventional prospecting techniques continued to discover a large proportion of the economic mineral deposits, although development and production (which involved greater costs and more complex technology) became more and more the province of larger firms.

Data on current exploration and mining activities, however, show that the roles of the individual prospector and the small firm have declined sharply in recent years because of the low-grade or hidden character of most of the remaining undiscovered deposits in the onshore United States. The discovery and development of these lower grade or hidden deposits require advanced technology, multidisciplined staffs, and large expenditures, The available data indicate that, with some exceptions, individual prospectors and small firms no longer make discoveries of significant commercial mineral deposits, The available data also suggest, although less clearly, that they do not often identify or delineate the targets that the larger firms then investigate for an economic deposit. Most individual prospectors stake out claims on land that might be mineralized, investigate the surface more or less diligently within the limits of their funding and expertise, and try to get the larger firms to perform detailed exploration of the claimed area. The larger firms form the geologic models, identify the targets, and discover, develop, and produce the deposits.

Some individual prospectors and small exploration firms provide technical and consultant services to or perform contract or “farm out” work for the larger firms, or occasionally initiate their own projects with financing from the larger firms or from local investors. A more independent role is played by small firms in the development and production stages. Small product ion firms account for all or much of the product-ion of some of the more common minerals. They operate, according to one survey, over 75 percent of all mines, and they account for 5 percent of the total value of U.S. production. The small mines are important sources of local employment and of production of smaller deposits.

D. History and Main Elements of the Existing Federal Onshore Mineral Laws (Chapter 3)

1. The Mining Law of 1872

During the 19th century, settlement of the public domain (the vast Federal territorial lands) was encouraged by enactment of laws providing for free, or almost free, disposal of the public domain to individuals and firms for mining, logging, farming, ranching, irrigation, railroad, and other purposes.

The Mining Law of 1872 was enacted during this period. It originally governed the disposal of all minerals other than coal on the public domain. It still authorizes any person to enter on the public domain to explore for and mine valuable deposits of almost all the non fuel minerals.

Rights are acquired under the Mining Law by actual discovery of a “valuable mineral deposit” and physical “location” (staking) of a mining claim encompassing the deposit. Claims may be located on any public domain land that has not been withdrawn from the operation of the Mining Law. No permission need be obtained from nor notification given to the Federal landowner prior to locating a claim. Each claim is limited in size to about 20 acres, but a person can locate as many claims as he wants. A valid discovery must be made on each claim. If a discovery is made, the claimant can acquire ownership of the surface as well as the minerals by performing at least $500 worth of mineral development work, complying with lengthy and sometimes expensive application procedures, and paying $2.50 or $5 per acre, depending on the type of claim, for a title document known as a “patent. ” The claimant can mine without obtaining a patent, in which case there is no charge by the Government for the extraction of the minerals or the use of the surface. (There is, as for any other business, a multiplicity of Federal and State taxes (see chapter 6, section E for a discussion of the State taxes).)

Under the literal language of the Mining Law, discovery must precede location of the claim, However, the courts have created the pedis possessio doctrine, which permits location of a claim prior to discovery and protects the locator against encroachment by other miners as long as he is in actual possession of the claim and diligently exploring for minerals. The doctrine applies separately to each claim in a group of

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claims; it protects only those claims actually being occupied and worked. Moreover, it does not protect the explorer from an ouster by the Government, through the process of land withdrawals.

An unpatented mining claim must be maintained by the performance of at least $100 worth of "assessment" (development) work each year (in practice, a commercial mineral developer will often spend much more than the minimum statutory amount). Assessment work can be combined for groups of claims in common ownership, if the work benefits all the claims in the group. There are no assessment work requirements for patented claims. Both patented and unpatented claims continue indefinitely with or without mineral production.

The Mining Law authorizes the States where the Mining Law applies to prescribe procedures for locating and recording mining claims, to specify the amount of annual assessment work required above the $100 per claim minimum, and even to establish rules for working mines on patented claims necessary for their complete development. Generally, the States have only specified procedures for locating and recording claims. The Federal Land Policy and Management Act of 1976 requires, for the first time, that information about the original location and subsequent holding of unpatented claims be recorded with the Federal land manager as well as with the States.

2. The Mineral Leasing Act of 1920 and Related Leasing Laws

Early in the 20th century, as a result of public concern over monopolization and depletion of mineral and nonmineral resources on the Federal lands, certain resources began to be reserved from disposal. National forest reserves were created to protect timber and watersheds; national parks were created to preserve scenic, recreational and wildlife values; and naval petroleum reserves were created to maintain a secure source of oil and gas for the national defense. Similarly, the fossil fuel, fertilizer, and chemical minerals and the land containing them were reserved from disposal under the Mining Law and made subject to leasing at the discretion of the Secretary of the Interior under the Mineral Leasing Act of 1920 and related statutes.

The Mineral Leasing Act of 1920 was a major departure from the earlier policy for disposal of Federal minerals. The absolute right to enter, locate, develop, mine, and (if desired) purchase mineral land under the Mining Law and the Coal Act of 1873 was replaced, for land containing the fossil fuel, fertilizer, and chemical minerals, with a discretionary permit and leasing system. The Secretary of the Interior was authorized to issue prospecting permits and leases for exploration for and development and production of such minerals and, within broad statutory limits, to establish rentals, royalties, and other conditions to ensure competition, diligent development, the highest use of the land, and payment to the public for the appropriation of its mineral resources,

The Mineral Leasing Act has been amended numerous times since its initial passage in 1920, especially with respect to oil and gas. However, its fundamental structure and purposes remain unaltered. Achievement of these purposes has been impeded by shortcomings in the Act itself and in its administration.

Subsequently, additional laws were passed (or executive actions taken) reserving more lands from disposal under the Mining Law and the nonmineral land laws. Minerals on some of these lands were made subject to lease under special leasing laws. Separate laws were also passed authorizing leasing of some or all minerals on various tracts of Federal land acquired for special purposes outside the public domain. Eventually, all the remaining public domain was reserved from disposal under the homestead and other nonmineral land laws, although much of the public domain continues to be subject to disposal under the Mining Law.

3. Sale of Common-Variety Minerals

Common varieties of sand, stone, gravel, pumice, pumicite, or cinders were removed from location under the Mining Law and, together with common varieties of clay and other mineral materials, made subject to disposal (the minerals only, not the surface) through competitive bidding by the Surface Resources Act of 1955. If the land involved has been withdrawn for the use of a Federal department or agency, or a State or local government, no disposal may be made without the consent of that governmental unit.

E. Issues and Options

The remainder of this executive summary summarizes the material in chapters 4, 5, and 6 on issues and options for facilitating the identification, development, and production of mineral resources on Federal onshore land, while accommodating demands for nonmineral resource uses on such land through provision, as appropriate, for simultaneous, sequential, or dedicated use.

The discussion here, as in the chapters, is divided into three major areas: 1) coordination of mineral activities undertaken by different individuals and firms (chapter 4), 2) coordination of mineral activities with nonmineral activities and values [chapter 5), and 3) coordination of regulatory and payment requirements imposed on mineral activities by different agencies of the Federal Government and by the different levels of government (Federal, State, and local) in our federal system (chapter 6). Within each of these three areas of concern, options are presented in ascending degree of the amount and character of change involved when compared with the existing distinct systems: 1) no changes at all, 2) moderate adjustments to the existing distinct systems, 3) major adjustments to the existing distinct systems, and 4) for the first two areas of concern only, adoption of a comprehensive new approach. In each option other than the “no change” options, an attempt is made to eliminate unnecessary or duplicative regulations, to address questions of efficiency and equity in other regulations, and, where it seems appropriate, to replace regulatory restrictions with more flexible payment requirements or incentives. The options include changes in the Federal mineral land laws only. More general options, such as changes in Federal tax, trade and environmental laws that would address some of the issues raised in this study from a global perspective rather than as a special issue for Federal mineral land management, are beyond the scope of this study.

The identically numbered options, other than the "no change" options, for the three areas of concern are merged in table 1 at the end of this executive summary, The advantages and disadvantages of the elements of the options are discussed in greater detail in chapters 4, 5, and 6. Many of the elements are controversial; some are highly controversial. This report has not examined in depth the entire range of impacts that would be expected from the implementation of the options presented below.

F. Issues and Options Related to Coordination of Mineral Activities Undertaken by Different Individuals and Firms (Chapter 4)

Option 1. The Existing Systems ("No Change" Option)

The existing laws that govern mineral activities on Federal onshore land were enacted over more than a century. Different provisions within the same law or in different laws were enacted for land in different States, for land acquired by different methods, for different minerals, or for different geologic configurations of the same mineral. The resulting collection of laws contains significant gaps in coverage, treats physically similar lands or mineral deposits differently, and otherwise makes distinctions that often seem arbitrary or are difficult to apply.

The patchwork of existing mineral laws creates legal and practical barriers to multiple-mineral exploration and development on the same tract of Federal land. It also creates uncertainty about the procedures to be followed to find and develop the growing number of mineral resources, such as zeolites, that cannot easily be classified as being subject to one law or another.

Tenure for mineral activities is uncertain and insecure under each of the existing laws. Under the Mining Law, there is no way to obtain exploration rights secure against the Government even after particular targets have been staked, and the pedis possessio doctrine provides only very weak protection against other mineral explorers, Under the leasing and sale laws, exploration rights valid against other mineral explorers and the Government can be obtained, but the granting of such rights is at the complete discretion of the Secretary of the Interior. Development and production rights for all minerals under the Mining Law and for nonfuel minerals under the leasing laws depend on satisfaction of the shifting and uncertain "discovery of a valuable mineral deposit" test,

On the other hand, the existing laws provide very few effective requirements or incentives for diligent exploration, development, or production once mineral rights have been acquired. Speculators or inadequately financed explorers or developers can tie up promising mineral land for many years, often indefinitely, or can burden future mineral activity by retaining overriding royalties although they have done nothing to develop the land. It is difficult, if not impossible, to prove noncompliance with such work requirements as do exist, and the Government may not be able to cancel mineral rights even when noncompliance has been proved. Many of the claim location and work requirements imposed by the Federal and State governments under the Mining Law do not promote the identification and [development of economic mineral deposits, but rather result in needless damage to the land and expense to the explorer or developer. However, some States have recently changed their discovery work requirements to reduce such needless damage and expense.

The maximum acreage limits on individual mining claims or mineral leases are, in some cases, insufficient for modern mineral projects and techniques, These limits can prevent formation of economic mining units for competitive leasing and can cause unnecessary and unproductive work when the work requirements specified for each claim or lease cannot be aggregated for contiguous claims or leases. Minimum acreage limits either do not exist or are not set high enough to prevent splintering of economic mining units by speculators, making it more difficult to assemble such units, administer the laws, and reduce the anticonservation effect of overriding royalties,

Expense and uncertainty exist under the leasing laws as a result of the blurred distinctions between known and unknown mineral areas, Competitive bonus bidding for known mineral areas places individuals and smaller firms at a disadvantage. Gross royalties inserted in leases for known and unknown mineral areas can result in failure to produce lower grade minerals that otherwise could be efficiently recovered.

Finally, the Mining Law has some outmoded provisions (such as the provisions for extralateral rights and tunnel sites and the distinctions among lode and placer claims and millsites) that create problems for the mineral industry without serving any useful purpose.

Option 2. Moderate Adjustments to the Existing Distinct Systems

Moderate adjustments could be made to some of the existing distinct systems that would eliminate or reduce a good part of the inefficiency and uncertainty that now exist. These adjustments would be ‘‘moderate’ in the sense that they would not alter the basic character of the present systems, Consequently, they would not affect aspects of a system that are a key part of its structure, nor would they eliminate the gaps and uncertainties that arise from the existence of a number of distinct systems.

For example, the tunnel site, lode versus placer, and extralateral right provisions in the Mining Law could be eliminated. Maximum limits on the size of individual claims under the Mining Law could be replaced with much larger maximum limits on the area that could be treated as a unit for the purpose of satisfying work requirements. Damaging and unproductive claim marking and location requirements could be replaced with filings in the local land office, as is currently the practice under the leasing laws. The existing annual work requirements could be increased slightly each year a claim is held, and work performed in excess of the requirement for a particular year could be “banked” and applied toward requirements in subsequent years. Payments could be allowed in lieu of actual work. Failure to file proof of such work or make payment every year would result in automatic cancellation of the claim. If it is desired to require payments to the Federal Government for production of minerals under the Mining Law, then the payments probably should be structured as a share of net profits (gross income less expenses and a minimum return on investment) in order to avoid inefficiencies that may result from other types of mineral value payment requirements. It should be noted, however, that payments for mineral value are much less important, from the standpoint of either efficiency or equity, than payments in lieu of work requirements or payments for damage to nonmineral resources.

Similarly, maximum acreage limits could be eliminated from the leasing laws. An escalating, payable, bankable work requirement could be introduced similar to the one outlined above for the Mining Law and already in effect for oil shale and geothermal steam leases. Gross royalties could be replaced by profit-share payments.

Minimum sizes could be specified for claims and leases, and overriding royalties could be eliminated, severely limited, or required to be based on net profits rather than on gross income,

Claims and leases could be terminated automatically after 15 to 20 years if development had not yet been completed—that is, unless there were a well or mine producing or capable of producing. The escalating, payable, bankable work requirement could be replaced, after development had been completed, by a requirement of annual commercial volume production, or payment of an advance royalty on such production in lieu of actual production. The Secretary of the Interior could be authorized to suspend any work or production requirement for good cause shown in a particular case, but might not be allowed to extend the 15- to 20-year period allowed for completion of development.

These adjustments could greatly improve the efficiency of mineral activities. However, substantial problems would remain. For example, the work requirements, although improved, would still be insufficient to ensure diligent mineral activity, and tenure for exploration, development, and production, especially for the nonfuel minerals, would continue to be uncertain and insecure.

Option 3. Major Adjustments to the Existing Distinct Systems

Further adjustments, in addition to those outlined in the previous "moderate adjustments" option, would be necessary to provide for secure tenure and diligent activity under the mining and mineral leasing laws. These adjustments would eliminate or revise major elements of each separate system. However, they would still not eliminate the gaps and uncertainties created by the existence of a number of distinct systems.

Secure exploration rights could be created under the Mining Law by granting to each claimant an exclusive right to explore, valid against the Government as well as against other explorers, for a 2-year period, perhaps renewable for an additional 2 years for good cause shown. In addition, the "discovery of a valuable mineral deposit" test for acquiring and maintaining development and production tenure could be eliminated. Any explorer willing and able to begin substantial development activity upon termination of the exploration period would automatically be granted tenure for development and production. Alternatively, development and production tenure could be granted initially along with the exploration tenure, subject to the condition that exploration be completed within 2 (perhaps extendable to 4) years. Either way, the tenure package would be subject to the work requirements and time limits on development, and the produce-or-pay conditions on production, outlined above in the "moderate adjustments" option. Moreover, to prevent speculation in and tying up of mineral land, the escalating annual work requirements would be applied to exploration as well as development and increased to a level comparable to actual expenditures on good faith exploration and development. (The annual work requirements could be either uniform requirements revised periodically on the basis of reported expenditures on actual projects, or ad hoc negotiated requirements built into a "development contract.")

Patents (ownership documents) would continue to be granted under the Mining Law, but only after commencement of development. To prevent abuse of the liberalized tenure provisions, a patent would grant ownership of the minerals only, not the surface. Use of the surface, for mining-related purposes only, could be allowed upon payment of an appropriate rental. The mineral ownership would revert to the Government if the annual work or production requirements were not satisfied or if the surface were used for nonmineral purposes.

Similar adjustments could be made under the leasing laws. The "discovery of a valuable mineral deposit" test for acquiring development and production tenure for nonfuel minerals under the leasing laws could be replaced by automatic grants of such tenure, as outlined immediately above for the Mining Law, and subject to the same work requirements, time limits, and conditions. These work requirements, time limits, and conditions could also replace similar but less effective provisions currently applicable to the tenure granted for exploration for and development and production of the fuel minerals under the leasing laws. Again, the escalating work requirements would have to be increased to a level comparable to actual expenditures on good faith exploration and development in order to avoid speculation in and tying up of mineral land.

Finally, the distinction between known and unknown mineral areas could be eliminated from the leasing laws and avoided under the Mining law, since (a) profit-share mineral value payments should satisfy those who believe that the Government should receive payment for its mineral resources, (b) the substantial escalating work requirements should deter speculation, and (c) the elimination or restriction of overriding royalties should also deter speculation and minimize burdens on production resulting from such speculation. Competitive bidding or a lottery could be reserved for those situations where more than one person filed a claim or applied for a lease for the same tract of land during, for example, any 10-day period.

As is discussed below, several of these major adjustments would eliminate some of the strongest protections of nonmineral values that now exist under the mining and mineral leasing laws (e. g., the "discovery of a valuable mineral deposit" test for acquiring development and production tenure under the mining and mineral leasing laws and the ability to withdraw claimed land from continued exploration under the Mining Law). Therefore, it is doubtful that these adjustments could be made without also making other changes to ensure proper balancing of mineral and nonmineral resource values. (See option 4 immediately below and option 3 in section G.)

Option 4a. Replacement of the Existing Distinct Systems With a Comprehensive System for All Minerals

If all the moderate and major adjustments listed above were made to the existing distinct systems, the various systems would be practically identical in structure, requirements, and effects, and there would be little reason for continuing the distinctions among minerals and lands covered by the systems.

Thus, the confusion and costs involved in applying the lines that separate the systems, and the impediments to efficient multiple-mineral operations inherent in such line-drawing, could be eliminated by combining all minerals and lands under one comprehensive system [either location, leasing, or some other system). A claim or lease under this comprehensive system would grant exclusive rights for all minerals.

The major remaining obstacle to such a comprehensive system would be the theoretical distinction between a miner's absolute right of access under the Mining Law and his access subject to the discretion of the Secretary of the Interior under the leasing and sale laws. But the "absolute" right of access under the Mining Law can be and increasingly has been blocked or restricted through land withdrawals or through delays or restrictions on rights-of-way or other land use permits. Withdrawals can now be made at any point during exploration under the Mining Law, so that exploration access and tenure are even more uncertain under the Mining Law than they are under the leasing and sale laws. One of the major adjustments to the Mining Law listed above would provide for exploration tenure secure against such land withdrawals. But it is doubtful that such an adjustment could be made without eliminating the absolute right of access, unless better provisions for coordinating mineral and nonmineral activities were also adopted. If such better provisions were available, they could be applied also to the leasing and sale laws in order to reduce the need for Secretarial discretion over access under those laws.

In sum, the need (or lack of need) for Secretarial discretion over access is the same under each of the adjusted distinct systems, and the resolution of the discretion issue should be the same for each distinct system, or for any comprehensive system replacing the distinct systems. In other words, the discretion issue should not deter consideration of adopting a comprehensive new system.

Option 4b. Partial Replacement of the Existing Distinct Systems With a Comprehensive System for Nonfuel Minerals Only

For a number of reasons, it might be considered desirable to exclude the fuel minerals (except perhaps uranium) from a comprehensive system like the one described above.

First, Congress has given considerable attention to the laws governing some of the fuel minerals—oil, gas, geothermal steam, and coal. Congress might not want to alter laws in which it had already invested so much effort, even though those laws contain many defects in common with the systems governing nonfuel minerals. This is actually an argument against making any adjustments at all to the fuel mineral leasing systems, rather than an argument against including them, once adjusted, in a comprehensive system.

Second, it would be difficult to define the Department of Energy's proper role, under its recently granted authority over some aspects of fuel mineral leasing, in a comprehensive system that combined all minerals under each claim or lease. This difficulty would be eliminated if, as is suggested (on other grounds) in the third option in section H, the Department of Energy's authority over fuel mineral leasing were revised or revoked.

Third, there are large, known, untapped resources of some fuel minerals—e,g,, coal and oil shale. It has been argued that greater control should be exercised over these fuel minerals in order to prevent premature or speculative leasing and undesirable cumulative damage to the physical and socioeconomic environments, But such control would clearly be available under a comprehensive all-mineral system that made access subject to the discretion of the Secretary of the Interior, Even under a system of nondiscretionary access, these concerns could be handled adequately by appropriate diligence, payment, nonmineral resource protection, and socioeconomic impact provisions in an all-mineral system,

G. Issues and Options Related to Coordination of Mineral Activities With Nonmineral Activities (Chapter 5)

Option 1. The Existing Systems ("No Change" Option)

The existing laws treat mineral exploration, development, and production as distinct activities outside the mainstream of the land use planning and management process for Federal onshore land, even though mineral and nonmineral resource uses are unavoidably intertwined. These laws reflect the belief that mineral production is the best use of any tract of land and thus make mineral activity the preferred use on any Federal land that is open to such activity, Except for recent enactments governing coal, the laws contain no explicit procedures for coordinating mineral activities with nonmineral activities.

Regulations have been promulgated under the mining and mineral leasing laws to control the impacts of mineral activities on surface resources, These regulations are couched in broad language and do not contest the miner's preferred right to explore for and develop the minerals in a tract. The regulations are not tailored to varying land characteristics. They do not attempt to control the method of development, but rather seek to mitigate its impact on surface resources by relying on negotiated approval of operating plans.

The regulations applicable to activities under the Mining Law do not cover most Federal land. They do not apply to unpatented mining claims outside the national forests or to patented mining claims outside the national parks or wilderness areas. The Forest Service regulations, which were adopted in 1974 against a background of uncertainty about the extent of the Forest Service's authority to control the impacts of

Mining Law activities, have minimal sanctions, do not require filing of notices of activity by most mineral explorers, and are sometimes hesitantly enforced. However, the Forest Service has imposed and enforced strict surface protection requirements in certain areas.

Many provisions in the Mining Law result in unnecessary damage to surface resources and disruption of surface use and management. For example, the Federal and State claim marking and work requirements (including State discovery work requirements and Federal pedis possessio and assessment work requirements) require a mineral explorer to disturb the surface without any benefit necessarily being obtained in terms of efficient or diligent mineral activity. The pedis possessio requirements also encourage mineral explorers to attempt to prevent use of the surface by others. The irregular shapes of claims, coupled with the miner's right to acquire title to the surface as well as to the minerals, lead to a jigsaw pattern of surface ownership that can frustrate efficient planning and management of surface use. Federal land use planning and management are further inhibited by the knowledge that any plan or use can be preempted at any time by mineral activities under the Mining Law, unless the land is withdrawn from mineral entry, or even by nonmineral activities on a nearby patented claim, Medium- or long-range land use planning is similarly inhibited under the mineral leasing laws when leases are issued or can be renewed for indefinite periods without any production.

On the other hand, because the regulatory controls on mineral activities under the existing laws, although generally weak, are broadly worded and applied in an ad hoc manner to specific mineral projects, they can create considerable uncertainty with respect to the requirements that will actually be imposed on a particular project. Technically, the controls cannot go beyond the restrictions expressed or implied in the governing regulations (or lease), and they cannot substantially interfere with the miner's right to develop the mineral deposit as he sees fit. But the broad wording of the regulations, together with the miner's desire to avoid the delays involved in administrative or judicial appeals, give the responsible Federal officer considerable leverage to impose substantial restrictions on mineral activities. Furthermore, strict conditions can be imposed on nonfuel mineral projects under the mineral leasing laws after exploration and before development, even if such conditions would make development and production uneconomic, since a lease is required for development and production after successful exploration under a prospecting permit.

Additional uncertainty with respect to mineral tenure results from the use of the "discovery of a valuable mineral deposit" test for acquiring development and production rights to any mineral under the Mining Law and to nonfuel minerals under the mineral leasing laws. Under the present interpretation of the test, nonmineral values are not balanced directly against mineral values in order to decide whether mineral development and production rights should be granted, although such a comparative value test has been used in the past and could enjoy a resurgence. However, some nonmineral values are considered indirectly to the extent that regulations protecting such values impose costs on the miner. Such costs are included in an increasingly comprehensive definition of the considerations a prudent miner would take into account in deciding whether a mineral deposit is valuable. This indirect approach must necessarily leave out a fairly large range of nonmineral values. Thus it does not go far enough, in the opinion of surface resource users. On the other hand, miners believe that it goes too far in second-guessing their profitability calculations and exposing them to the danger of losing tenure after considerable effort has been spent on exploration.

Activities under the mining and mineral leasing laws are subject to Federal and State air quality, toxic sustances control, and other environmental laws of a general nature that impose stringent requirements for mitigation of certain impacts resulting from mineral activity. However, these general environmental laws do not reach the central issues of land resource allocation and use that are at the core of today's debate over Federal mineral land management,

The existing laws require very few payments for damage to or appropriation of nonmineral resources. Nominal payments of $2.50 or $5 per acre are required to obtain title to the surface under the Mining Law, and nominal annual rentals of only $0.25 to $2 per acre are required under the mineral leasing laws. In addition, bonds to ensure reclamation, if feasible, and payments for damages to privately owned crops, agricultural improvements, and grazing values may be required. These payment requirements are not sufficient to ensure proper balancing of mineral and nonmineral resource values.

The lack of adequate regulatory or payment mechanisms under the existing laws has been partially responsible for the withdrawal of increasing amounts of Federal land from the operation of the mining and mineral leasing laws in recent years, Formal withdrawals of land from the operation of the Mining Law have been almost double those under the mineral leasing laws, if only normal withdrawals are taken into account (that is, omitting the unique situation created by the Alaska Native Claims Settlement Act). (See chapter 5, section G for the calculations and analysis.) This is because initial access to land for mineral activities under the Mining Law is a statutory right that can be blocked only by withdrawals, while initial access under the mineral leasing laws is at the discretion of the Secretary of the Interior, who can block access by refusals to lease as well as by formal withdrawals. The amount of land either formally withdrawn or highly restricted (for example, by policies that discourage leasing or issuance of necessary rights-of-way) is approximately the same for the Mining Law and the mineral leasing laws. Withdrawals and antileasing restrictions continue to be made, and are maintained, to protect mineral and nonmineral resource uses and values that Congress or the executive branch believes are inadequately protected by existing regulations and payment requirements. Mineral activity is thereby completely precluded, even though properly restricted mineral activities might be entirely compatible with protection of such uses and values. (An extensive analysis of withdrawals and other restrictions affecting mineral activity in 1975 is contained in appendix B and is summarized in section G of chapter 5.)

Conversely, mineral activity continues to be the preferred use on nonwithdrawn land under the Mining Law and on leased land under the mineral leasing laws. Mineral rights, once acquired, override all nonmineral resource values, regardless of the relative values of the mineral and nonmineral resources. Mineral rights may be acquired by simply staking out a claim under the Mining Law. Advance notice to or permission from the Federal or private surface owner is not required. The Secretary's discretion to grant access under the mineral leasing laws may be exercised, as it was until very recently, routinely in favor of granting access, with little attention paid to the potential impact on nonmineral resources, except in those few cases where access must also be approved by the Federal agency responsible for management of the surface.

The Mining Law has been abused by persons who are not interested in mineral activity but rather want to make use of or even obtain title to the surface. This abuse has been made possible by the absolute right of entry under the law, the very weak and practically unenforceable controls over diligent activity, and the lack of adequate controls over use of the surface. Even though some actions have been taken to curb this abuse, such as removing common-variety minerals from location under the Mining Law and requiring all claims to be recorded at the Federal land office, some abuse remains because of the underlying difficulties with enforcing provisions of the Mining Law.

Option 2. Moderate Adjustments to the Existing Distinct Systems

Almost all the moderate adjustments discussed in option 2 in section F, dealing with improved coordination of mineral activities undertaken by different individuals and firms, could also improve coordination of mineral activities with nonmineral activities.

For example, unnecessary surface damage, jigsaw land use patterns, and uncertainty about land status are caused by existing Federal and State claim location and marking requirements under the Mining Law. These problems could be greatly reduced by replacing the physical location procedures with filings in the local Federal land office according to subdivisions of the public land surveys. For unsurveyed land, claims could be required to be rectangular in shape, oriented north-south or east-west, and depicted and described (through reference to permanent physical features) on the best available map of the area. A survey of the claim could be required as a precondition to development. The surface damage attributable to unproductive pedis possessio and assessment work requirements under the Mining Law could be reduced by replacing the maximum size limits on individual claims with generous limits on the size of an area that could be treated as a unit for the purpose of satisfying work requirements, and by allowing payments in lieu of actual work and "banking" of excess work. Payments for mineral value comparable in magnitude to those required by non-Federal landowners could be instituted to avoid possible underpricing and inefficient use of Federal land.

Similar adjustments, also described in option 2 in section F, could be made to maximum acreage limits, work requirements, and payments for mineral value under the mineral leasing laws.

The remaining adjustments outlined in option 2 in section F, such as minimum sizes for mining claims and mineral leases, time limits on development tenure, and produce-or-pay conditions on production tenure, would make it easier to keep track of land status and would prevent land from being held indefinitely without any development or production.

Other adjustments could also be made that would improve coordination of mineral and nonmineral activities without making major changes in the existing systems. For example, the existing requirement of consent by the surface management agency to issuance of leases for certain minerals on certain lands could be extended to leases for all minerals on all lands, (The requirement would not apply to mining claims under the Mining Law.) Ad hoc, broadly worded surface use regulations, similar to those now in existence for some mining claims and all leases, could be applied across the board to mineral activities on all lands under all the Federal mineral laws. Such regulations could include a prohibition on any residential use of the surface of a mining claim or mineral lease without permission from the surface management agency or surface owner. No surface-disturbing mineral activity could proceed without first filing a notice of intent with the surface management agency or surface owner.

These adjustments would eliminate or revise many regulations that cause needless and unproductive expense to the mineral explorer or miner and unnecessary adverse impacts on nonmineral resources, particularly under the Mining Law. They would also reduce some of the uncertainty over land use management and planning under the existing systems, by placing some diligence-related conditions on the duration of mineral tenure and by making all mineral activities subject to Forest Service type regulations requiring limited mitigation of impacts on surface resources.

However, the adjustments would not resolve the most serious problems involved in coordinating mineral activities with nonmineral activities under the existing systems, On the one hand, they would not reduce miners' uncertainty about nonmineral resource-related controls over mineral access and tenure. On the other hand, they would not affect any person's absolute right to locate mining claims on any nonwithdrawn area of the public domain, and to obtain ownership of the surface as well as the minerals upon discovery of a valuable mineral deposit. Nor would they affect the absolute preference given to mineral activity on any land covered by a mining claim or mineral lease. Mineral rights, once acquired, would continue to override all nonmineral resource values. Thus, the adjustments would not significantly reduce the pressure for withdrawals of land from mineral activity in order to protect mineral and nonmineral resource values.

Some additional moderate adjustments could be made to lessen slightly the adverse effect that withdrawals have on mineral availability. Stale withdrawals no longer needed to protect nonmineral resource values could be identified and eliminated through a better withdrawal review program. Or, if such a program would be impractical because of the poor condition of land records, a fresh start could be made by terminating all withdrawals, except those made by Congress, that are not confirmed by the responsible agency within a certain number of years—a sort of rerecordation requirement for withdrawals analogous to the recordation requirement for mining claims. But, the latter approach would run the risk of inadvertently leaving important nonmineral resources unprotected.

In addition, some continuing mineral appraisal activity on withdrawn lands could be provided through a specific Government program for periodic assessment of the mineral resource potential of such lands. The program might include detailed Government exploration and evaluation where needed to decide whether certain withdrawn land should be reopened to private mineral activity.

Option 3. Major Adjustments to the Existing Distinct Systems

Several of the most serious problems involved in coordinating mineral activities with nonmineral activities under the existing systems would be eliminated by the major adjustments described in option 3 in section F for improved coordination of mineral activities considered by themselves. These include: replacing pedis possessio exploration tenure under the Mining Law with a secure, limited-in-duration exploration right; establishing more realistic, flexible, and enforceable work requirements under the mining and mineral leasing laws; eliminating the "discovery of a valuable mineral deposit" test for acquiring development and production tenure under the laws; limiting patents (fee title) under the Mining Law to the minerals in the claimed land, with a right to use the surface for mining-related purposes on payment of rent; and eliminating or restricting overriding royalties.

Two of the above adjustments—the elimination of the "discovery of a valuable mineral deposit' test under the mining and mineral leasing laws and the provision of secure exploration tenure under the Mining Law—would greatly reduce the uncertainty now faced by explorers and miners under the mining and mineral leasing laws, An analogous adjustment would make the "preference right to a lease" for successful prospectors under the mineral leasing laws a clear option exercisable by the prospector, rather than a mere right of first refusal should the Government decide to issue a development-production lease. These adjustments, however, would eliminate some of the most important protections of nonmineral values that now exist. To compensate for the loss of these protections, the statutory right of access under the Mining Law could be converted to access at the discretion of the Secretary of the Interior or the surface management agency, or both, as is now the case under the mineral leasing and sale laws. (Unlike now, the access under each law, once granted, would be secure for exploration, development, and production.) In addition, the surface use regulations under each law could be strengthened. The surface management agencies could be given clear authority to control the surface impacts of mineral activity, including the power to prohibit some or all surface impacts when necessary to protect important surface values. Finally, miners could be required to pay for damage to some publicly owned as well as privately owned surface resources and facilities in order to encourage mineral activity that is efficient from the standpoint of total resource use,

These adjustments could provide for better balancing of mineral and nonmineral resource values than occurs under the existing systems. They would substantially reduce the need to rely on the withdrawal power to protect nonmineral resource values. They would also greatly reduce the uncertainty that currently exists with respect to maintaining exploration tenure under the Mining Law and acquiring development and production tenure for the nonfuel minerals under the mining and mineral leasing laws, However, there still would be considerable uncertainty about the acquisition of exploration tenure and about the specific nonmineral resource protection requirements that would be applied after tenure is acquired in any particular case. Perhaps these uncertainties could be reduced by guidelines limiting the Government's discretion over access and over specification of nonmineral resource protection requirements after access is granted, But excessively restrictive guidelines would not adequately protect nonmineral resource values, given the current broad nature of nonmineral resource protection requirements.

Option 4. A Shift to Integrated Mineral and Nonmineral Resource Management

The adjustments listed in the two preceding options do not resolve the fundamental dilemma of how to provide for open access to and secure tenure on Federal land for private mineral exploration, development, and production while also assuring proper balancing of mineral and nonmineral resource values during each stage of mineral activity (see chapter 5, subsection C(4)).

One approach that might go a long way toward resolving this fundamental dilemma would build on the emerging practice under the mineral leasing laws of basing surface use restrictions on analysis of the land types and land use characteristics of particular areas. In certain instances, these area-specific restrictions have been developed and promulgated as part of the normal land use planning process.

Surface use restrictions tied to land classifications established by the surface management agencies as part of their normal land use planning process might provide greater assurance of adequate protection of nonmineral resource values on Federal land, since such restrictions could vary for different areas to take account of the vast differences in surface values and their sensitivity to disruption from mining. Because the restrictions would be much more specific and localized and would be published in advance in the land use plan for an area, they should also greatly reduce mineral explorers' and producers' uncertainty about the surface use conditions applicable to the various stages and types of mineral activity in the area.

If specific restrictions tied to land types and values in an area could be devised and promulgated as part of the normal land use planning process, and if such restrictions were adequate to protect the important nonmineral resource values in the area, there should be much less pressure for withdrawal of land from mineral activity. Moreover, there would be much less need for making the acquisition of mineral rights depend on the discretion of the Secretary of the Interior or the surface management agency. Once the new system was firmly in place, access to Federal land under the mineral laws could be made nondiscretionary, and many, if not all, of the existing withdrawals perhaps could be revoked. Access to certain areas might still be very highly restricted in order to protect very important nonmineral resource values, but it would not be completely precluded.

A surface use restriction might be too protective for the less unusual nonmineral resource values, because the restriction could not be violated no matter how valuable or potentially valuable the mineral resources in an area might be. This problem can be overcome, in part, by relaxing the restrictions that protect these less unusual nonmineral resource values as mineral activity successfully progresses from exploration through production. For example, there might be severe limits on or even prohibitions against roadbuilding or other types of surface disturbance in certain areas during exploration, which would be relaxed or eliminated for development and production.

For the easier-to-value nonmineral resources, surface use restrictions might be replaced entirely by compensation requirements. A schedule of payments could be developed along with the surface use restrictions as part of the land use planning process for an area, with some nonmineral resource values being absolutely protected through restrictions and others being conditionally protected through compensation requirements. The individual explorer or miner could decide on his own whether the potential mineral values were worth the cost of paying for damage to the conditionally protected nonmineral resource values, and he could structure his project to minimize such required compensation by minimizing the damage.

In sum, this option would (a) replace the existing open-ended and broadly worded surface use regulations promulgated primarily at the national level with much more specific and predictable conditions tied to land types and uses at the local level, (b) substitute flexible charges for absolute restrictions where appropriate, and (c) ensure open access and secure tenure once such conditions and charges were firmly in place.

H. Issues and Options Related to Coordination of Federal, State, and Local Controls and Payment Requirements (Chapter 6)

Option 1. The Existing Systems ("No Change" Option).

The institutional setting of Federal onshore mineral land management—that is, the division of authority horizontally among the Federal agencies and vertically between the Federal and State governments—is as critical as the substantive content of the laws. The historical development of the mineral laws and their administration has resulted in coordination difficulties along both dimensions.

Along the horizontal dimension, the traditional separation of mineral resource disposal and management from multiple-use management of nonmineral resources under the Federal land laws has been carried over into the administration of the mineral laws themselves. The mineral disposal and management function has been lodged in two agencies in the Department of the Interior. It has thereby been separated from the management of the various nonmineral resources by surface management agencies such as the Forest Service and the Fish and Wildlife Service. Furthermore, the mineral leasing function entrusted to the Department of the Interior has itself been split into mineral (economic and engineering) aspects and nonmineral (surface impacts) aspects, with responsibility for mineral aspects given to the U.S. Geological Survey (USGS) and responsibility for nonmineral aspects given to the Bureau of Land Management (BLM). The new Office of Surface Mining has a significant role in both the mineral and nonmineral aspects of coal mining operations. BLM is solely responsible for the mineral aspects of Mining Law activities, but it shares responsibility with some surface management agencies for the nonmineral aspects.

Because minerals are bound up in the land, mineral resource management invariably affects nonmineral resource management, and nonmineral resource management often affects mineral resource management. During the era of extensive land disposal, these interrelationships were not of serious concern to most people. Given the current policy of retention and multiple-use management of Federal land, however, the formal separation of mineral resource management from nonmineral resource management and the formal distinction between ‘‘economic’ (mineral-related) and ‘‘multiple-use” (nonmineral-related) aspects of mineral management itself quickly break down in practice, causing substantial coordination problems and preventing integrated management of Federal land resources.

These problems have been perceived by USGS and BLM, which have moved to joint responsibility for many aspects of mineral leasing on land under BLM’s jurisdiction, despite the formally mandated separation of functions. However, during the creation of the Department of Energy (DOE) by a new administration, the artificial distinction between “economic” and “multiple-use land management” aspects of fuel mineral leasing was incorporated in the Department of Energy Organization Act, which transferred the “economic” aspects from the Department of the Interior to DOE. Now, two separate departments, rather than two agencies in the same department, must contend with this distinction and its adverse consequences for integrated land management.

Some recognition of the intimate connection between mineral resource management and overall land management has been provided by the requirement, in all recent mineral leasing laws, that mineral leases may be issued only with the consent of the surface management agency and subject to such conditions as it may include to ensure adequate utilization of the land for the purposes for which it was acquired or is being administered. But this requirement as yet applies to only a few minerals and a few land categories. (Although there is no such formal requirement for land under BLM’s jurisdiction, the same effect is achieved, because BLM is the mineral leasing agent for all Federal land as well as surface manager of its own land.)

The surface management agencies generally are not given any legal role in supervising compliance with surface use restrictions applied to mineral activities, although they have the expertise and are best located to enforce such restrictions. (The principal exception is the Forest Service’s enforcement of surface use restrictions applied to mineral activities under the Mining Law in the national forests.) Enforcement is rather the responsibility of USGS (except for surface impacts of coal mining operations, which are the responsibility of the Office of Surface Mining), which has a mineral-related expertise and mission and often has neither an office near nor familiarity with the area under lease.

Along the vertical dimension of the institutional framework, the coordination problems are even more complex, Mineral activities on Federal land can have substantial effects on local and State economies and ways of life, which under our federal sys-

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tern of government are the primary concern and responsibility of local and State governments.

Generally, the existing mineral laws strike a reasonable balance between Federal and State regulatory jurisdiction over private mineral activities on Federal land. The laws explicitly or implicitly allow the States to impose more stringent restrictions than those imposed by the Federal Government, as long as the State restrictions do not conflict with the Federal ones and do not disrupt Federal land management.

There are, however, some problems with respect to State regulation of mineral activities on Federal land. The most obvious are the anachronistic provisions in the Mining Law for (a) State specification of procedures for locating and maintaining claims and (b) State insertion of development conditions in patents. Less obvious, but potentially troublesome, are the provisions in the Surface Mining Control and Reclamation Act of 1977 that (a) allow private owners of the surface overlying Federal coal to veto surface mining of such coal [and hence extract the value of the federally owned coal as well as the value of the privately owned surface as the price for not exercising the veto) and (b) allow the States to take over enforcement of Federal reclamation standards on Federal land (even though many State enforcement programs are underfunded, understaffed, and vulnerable to conflicts of interest).

More serious issues are raised by State taxation of mineral activities on Federal land and by the distribution of Federal revenues generated under the mineral laws.

State severance taxes and other mineral-related taxes based on the gross amount or value of production are in effect gross royalties and can have the adverse anticonservation effects on mineral and nonmineral resources associated with gross royalties. The tax levels in some States are so high that they may prevent mining of some Federal mineral deposits and may cause mining of only the high-grade portions of other deposits. They also may inflate the prices paid by consumers and reduce Federal mineral revenue.

None of the Federal revenues generated under the mineral laws are retained by the Federal agencies administering the laws to pay for the costs of such administration, which is often substantially underfunded, None of the revenues are turned over to the surface management agencies to be used to repair damage to surface resources or to replace resources lost as a result of mineral activities. Only 10 percent of the revenues is retained by the Federal Government to be deposited in the general fund of the Treasury, The remaining 90 percent is channeled by law to the Western States, either directly through payments to the States themselves or indirectly through the Reclamation Fund to subsidize irrigation projects.

The Federal mineral revenues, and additional Federal funds derived from fees imposed on surface coal miners by the Surface Mining Control and Reclamation Act, are turned over to the Western States to enable them to cope with the adverse socioeconomic impacts of mineral activities on Federal land. But the funds are made available without any showing of need, and, in fact, the major mineral-producing States receive more than adequate revenue from State mineral-related taxes to cope with adverse socioeconomic impacts. (Generally, the problem is not insufficient State revenue, but rather ensuring that such revenue reaches the local unit of government that needs it, in a timely manner.) The Federal revenues thus subsidize the general budgets of these few States.

Option 2. Moderate Adjustments to the Existing Distinct Systems

Horizontal coordination among Federal agencies could be improved by extending the requirement of consent by the surface management agency to the issuance of a mineral lease from the few situations in which it now applies to all mineral leases (and to mining claims if access under the Mining Law is also made discretionary) and by giving the surface management agency joint or sole responsibility for enforcing the surface use restrictions on a mining claim or mineral lease.

Vertical coordination between the Federal and State levels of government could be improved by eliminating State authority under the Mining Law to specify procedures for locating and maintaining claims and to insert development conditions in patents, by requiring Federal surface management agencies to perform "backup'" inspect ions of reclamation of surface-mined Federal coal land when the State has taken over responsibility for enforcement of reclamation, and by encouraging Federal and State efforts to develop coordinated planning and permitting procedures,

In addition, rentals or other payments by mineral explorers or producers designed to compensate for damage to or loss of nonmineral values could be turned over to the Federal surface management agency rather than to the State, with a stipulation that such payments be used to restore or replace the damaged or lost nonmineral values. The 10 percent of the Federal mineral revenues now placed in the Federal general fund, or such smaller or larger percentage as seems appropriate, could be retained instead by the agency or agencies responsible for administering the mineral laws in order to provide more adequate funding for such administration.

The remainder of the Federal mineral revenues could be allocated to the States affected by mineral activities on Federal land, but only to the extent needed to cope with adverse socioeconomic impacts that cannot be handled by the States themselves through their own mineral taxation systems. The balance of the revenues not allocated to the Federal agencies or the States could be placed in the Federal general fund.

Option 3. Major Adjustments

At the Federal level, more integrated management of mineral and nonmineral resources on Federal land could be promoted by revoking the recent transfer of certain fuel mineral leasing functions from the Department of the Interior to DOE, and by making each surface management agency fully responsible for administration of the Federal mineral laws on land under its jurisdiction, The roles of USGS, BLM (on land not under its jurisdiction), and DOE would thus be reduced to those of advisors and coordinators on issues within their expertise, unless a surface management agency should ask them to take a more active role (for example, agencies administering small isolated tracts of land might wish to have BLM administer the mineral laws on such land).

Finally, all grants of Federal mineral revenues to the producing States could be abolished. States would have to use the revenues derived from their own mineral-taxing powers to cope with the adverse socioeconomic impacts of mineral activities, Thus, they would not be able to make the Federal minerals bear a disproportionate share of the costs of coping with impacts caused by mineral activities on non-Federal as well as on Federal lands. Federal loan programs could be adopted to provide funds needed for planning and construction by impacted communities prior to receipt of the substantial revenues anticipated from State taxes on mineral production,

Table 1 .—Options for Improving Coordination
(Does not include Option 1: "No Change")

(2) Moderate adjustments to existing systems	(3) Major adjustments to existing systems	(4) Comprehensive new approach
Minlng Law 1 Not Ice of intent before any surface-disturbing mineral activity (N) 2 Replace location with filing in Federal land offlee (M, N) 3 No tunnel sites, extralateral rights, lode/placer distinction (M) 4. No State location. work, or patent rules (M. N, 1) Leaslng acts 1 Surface agency consent for all leases (N, 1) All laws 1 Low escalating, payable, bankable work requirements for exploration and development stages (M, N) 2. Commercial-volume production, or advance royalty, requirement for production stage (M, N) 3 Forfeit tenure if annual work or production requirement not satisfied (M, N) 4. Acreage limits for purpose of satisfying work requirement only (M. N) 5 Limit on exploration and development period (M, N) 6. Minimum size for tenure units, and restrictions on overriding royalties (M, N) 7 Surface use regulations, including no residential use without surface agency consent (N) 8 Surface agency enforcement of surface use regulations (N. 1) 9 Eliminate "'stale"' withdrawals (N) 10 Government mineral investigation on wlthdrawn land (N) 11. Use of rentals and other surface-related payments to restore surface values (N, 1) 12 Profit-share production payments (M, N) 13 Share Federal mineral revenue with States only if State mineral taxation system unable to cope with adverse Impacts (1)	Moderate adjustments, plus: Minlng Law 1 Replace pedis possessio with secure exploration tenure (M, N) 2 Discretionary access (N) 3 Title to minerals only, conditioned on work, production and surface use requirements (M, N) Leasing acts 1 No known/unknown mineral area distinction (M) All laws 1. Guidellnes to limit Government discretion on access (N) 2. Competitive biddlng (or lottery) for overlapping simultaneous filings only (M) 3. Increase work requirements to level of actual good faith expenditures (M, N) 4. No 'valuable mineral deposit" test (M, N) 5. Use of surface for mining-related purposes only, upon payment of appropriate rental (M. N) 6. Strengthen surface use regulations to allow prohibition of certain impacts (N) 7 Payments for damage to certain surface resources (N) 8. Revoke transfer of certain fuel mineral leasing functions to DOE (M, N, 1) 9 Administration of mineral laws by surface agencies, BLM (except on its land). USGS, and DOE coordinate and advise only (N. i) 10 No grants of Federal mineral revenue to States, Federal loans if needed for front-end impact costs (1)	Moderate and major adjustments. plus 1 All lands and all (or only non fuel) minerals under the same system (M) 2 Claim/lease grants rights for all minerals (M. N) 3 Nondiscretionary right of access (N) 4 Surface use restrictions, or compensation requirements for easier-to-value surface resources, based on land types and land use in each area. restrictions relaxed for less unique surface resources as mineral activity progresses from exploration to production: restrictions and compensation schedules published lin advance in land-use plan for area (N) 5. Eliminate many or all withdrawals (N) M— Improved coordination of mineral activities N— Improved coordination of mineral activities with nonmineral activities 1— Improved institutional coordination among the Federal agencies and between the Federal and State governments

1.

Introduction

Introduction

Under the Constitution (article IV, section 3, clause 2), Congress is responsible for regulating and disposing of the Federal lands. In the past several years, Congress has faced a number of difficult issues relating to this responsibility. In particular, there has been considerable concern over the constraints on and effects of mineral exploration, development, and production on onshore Federal lands, which comprise about 30 percent of all the land in the Nation and contain significant mineral and non mineral resources. This report undertakes to analyze these constraints and effects, and through such analysis to develop options for promoting efficient and equitable mineral activities on onshore Federal lands. The report focuses on the Federal laws, policies, and practices for management and disposal of minerals on onshore Federal lands, exclusive of Indian lands.

A. Background

In recent years, Congress has faced a number of complex problems related to its constitutional responsibility over Federal lands. Those lands contain minerals that could contribute substantially to the national supply; but mineral exploration, development, and production on Federal onshore lands are hindered by a complicated system of laws and regulations built up gradually over more than 100 years. Moreover, defects in this system have led to the withdrawal of increasing amounts of Federal land from availability for mineral activities in order to protect mineral and nonmineral resource uses and activities. On the other hand, expansion of mineral production on these lands without legal and administrative reform could result in major social and environmental impacts, because the Federal onshore lands are generally located in sparsely populated areas and contain some of the Nation's most spectacular scenery and fragile ecosystems.

This study was initiated and developed to address these issues, in response to several related requests. Senator Ted Stevens, a member of the Technology Assessment Board, asked the Office of Technology Assessment (OTA) to assess "the crucial factors, including land use, environmental and transportation policies, as they determine the accessibility to domestic mineral resources, " and "the likely economic, social, environmental and other impacts of various policy alternatives designed to increase domestic mineral productivity. " Related broad issues of energy and materials supply and use were raised in a request submitted by the Chairman and the Ranking Minority Member of the House Committee on Science and Technology. Representative Morris Udall, another member of the Technology Assessment Board and (then) Chairman of the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs (now Chairman of the full committee), requested a study or studies of various natural resource issues as a beginning on an assessment of national growth policy, Among other things, Representative Udall requested a critical examination and extension of prior analyses of resource management policies for land, water, fuels, and other minerals to 1) develop a broader analytical framework, 2) analyze and identify any shortcomings in existing policies and practices, including those involved in choosing between alternative or conflicting uses of natural resources, particularly mineral and nonmineral land uses, and 3) develop options for improvement and coordination of the policies and practices of Federal, State, and local units of government in these areas. The studies were desired to provide information relevant to legislation and other matters pending before the Interior Committee, including revision of the mining and mineral leasing laws for Federal land and other legislation affecting development, use, and conservation of Federal land. The study plan, as developed in response to the previously described requests, was also supported by a request from the Senate Committee on Interior and Insular Affairs (now the Committee on Energy and Natural Resources).

The study has benefited from continuing communication with congressional staff, especially the staffs of the House Committee on Interior and Insular Affairs and the Senate Committee on Energy and Natural Resources. In turn, Congress and congressional staff have made use of interim results of the assessment which were distributed in March 1976, in several specific areas of congressional concern: for example, legislation on mineral land withdrawals, surface mining of coal, mining in the national parks, mineral law revision, and Alaska land classification.

In July 1976, congressional staff participated in an OTA Workshop on Legislative Strategies for Federal Mineral Land Management attended by representatives of industry, Government agencies, and environmental groups.

At the request of the Senate Committee on Governmental Affairs, in April 1977 OTA prepared a brief analysis of the effects of the proposed Department of Energy Organization Act on Federal land management, based on results of the study then in hand.

B. Objectives

1. The Focus of the Study

This study is one of several studies by the OTA Materials Group aimed at analyzing alternative responses to problems of materials supply and use. Although these studies focus on specific problems or issues, they have been planned to provide a better understanding of the overall materials cycle, from discovery of materials to their eventual reuse or disposal.

The focus of this study is on the discovery and production of minerals (including onsite processing, if any, and removal of the minerals from the mine site), and on the impacts on air, land, and water of such discovery and production. It is further restricted to a particular source of mineral discoveries: onshore land owned by the U.S. Government. No attempt is made to analyze the appropriate level of mineral production on Federal onshore land in comparison with other sources of mineral supply (for example, imports or recycling) or with methods of decreasing demand (for example, improved product design),

The principal purpose of this study is to analyze the Federal land management and disposal laws, policies, and practices (and selected State and local laws, policies, and practices) that significantly affect mineral exploration, development, and production on Federal onshore land. Above all, the study addresses the problems of establishing an efficient and equitable mineral land management system that will:

- facilitate the identification, development, and production of mineral resources on Federal onshore land,
- do so in an environmentally and socially acceptable manner, and
- take into account demands for nonmineral resource uses on such land through provision, as appropriate, for simultaneous, sequential, or dedicated use.

2. Limitation to Federal Onshore Mineral Land

A complete study of all the factors affecting or affected by domestic mineral activities would be a prohibitively complex task, involving not only issues of physical access to and management of mineral land, but also tax, capital, transportation, energy, employment, import, export, environmental, and other issues. Accordingly, this study focuses on the issues of physical access to and management of Federal onshore mineral land. There are several reasons for this particular focus.

First, Congress is directly responsible under the Constitution for the disposal and management of Federal lands. [1] When this study was initiated, Congress faced a number of difficult issues related to the disposal and management of Federal mineral land-for example, surface mining of coal, Alaska land disposal, coal leasing, oil shale development, mining law revision, public land management authority, and mining in the national parks.

Second, onshore Federal land is a very significant portion (approximately so percent) of the total national onshore land area,

Third, over 93 percent of the onshore Federal land is in the 11 contiguous Western States and Alaska, which contain much of the known domestic resources of metallic, fuel, and other minerals. The Federal acreage amounts to 64 percent of the total land in these States, not including federally reserved mineral rights underlying an additional 5 percent of the State land. There has been an impressive history of mineral production from the Federal onshore land, and the Federal land remains a very important source for future production of many minerals. [2]

[1] "Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States." U.S. Const. Art. IV, § 3, cl. 2. See ch. 6, sec. C.

[2] See app. A.

Fourth, as has been noted, mineral exploration, development, and production on Federal land is subject to a complex, unwieldy system of laws and regulations, built up over more than 100 years, and to a wide variety of restrictions for environmental, national security, water resource, agricultural development, and other purposes. There appears to be substantial room for coordination and improvement of the existing laws and practices, especially if, as seems likely, the Federal land is expected to provide a significant portion of domestic mineral supply.

Fifth, the present laws and practices, combined with evident pressures for large-scale development of Federal energy resources, could result in major social and environmental impacts, since the Federal land is generally located in sparsely populated areas and contains some of the Nation's most spectacular scenery and sensitive ecosystems.

Sixth, the study is limited to onshore Federal land because of the significant differences in the technology and natural environment of onshore and offshore mineral activities. Moreover, OTA already had commenced separate studies related to offshore oil,[8] which is the only significant mineral currently being developed or produced on Federal offshore land,

Although the study does not directly analyze broader issues such as overall tax, transportation, energy, or environmental policy, it does address the general impacts of alternative legal arrangements for physical access to and management of minerals on Federal land, Similarly, although it focuses on alternative Federal legal arrangements, attention is paid also to their interaction with State and local laws, policies, and practices affecting mineral activity on Federal land.

Finally, it should be noted that the term "Federal land, " as used in this study, does not include Indian land.[4]

C. Structure and Contents

This report analyzes the substance and impacts of existing Federal land management and disposal laws, policies, and practices (and related State and local laws, policies, and practices) that significantly affect exploration for and development and production of minerals on Federal onshore land. The report also describes a number of possible options for improving the existing systems.

Chapter 1 (this chapter) describes the purpose and scope of the assessment.

Chapters 2 and 3 provide background data for the analysis. Chapter 2 describes the importance to the Nation's economy of the mineral resources on Federal onshore land. It also presents an overview of the technology, acreages, costs, times, risks, and

[3]See, e.g., Office of Technology Assessment, U.S. Congress, *An Analysis of the Feasibility of Separating Exploration From Production of Oil and Gas on the Outer Continental Shelf* (1975); Office of Technology Assessment, U.S. Congress, *Coastal Effects of Offshore Energy Systems* (1976).

[4]For information on Indian land, see Federal Trade Commission, Bureau of Competition, *Staff Report on Mineral Leasing on Indian Lands* (1975); U.S. General Accounting Office, *Management of Indian Natural Resources*, Senate Comm. on Int. & Ins. Affairs, 94th Cong., 2d sess. (Comm. Print 1976); American Indian Policy Review Commission, Task Force Seven, *Report on Reservation Resource Development and Protection* (1976).

parties involved in the various stages of mineral activity. Chapter 3 outlines the historical development and main elements of the existing Federal onshore mineral land management systems. Additional background on the role of Federal land with respect to production of essential mineral commodities is provided in appendix A.

Chapters 4 through 6 contain the actual analysis. These chapters examine the current status of the Federal onshore mineral land management systems, identify problems related to that status, and present options for improvement in each of three major areas of concern: coordination of mineral activities undertaken by different individuals and firms (chapter 4); coordination of mineral activities with nonmineral activities (chapter 5); and coordination of Federal, State, and local controls and payment requirements (chapter 6).

Appendix B develops statistical data on the availability of Federal onshore land for mineral exploration, development, and production in 1975. Its primary focus is on land classification actions that restrict such availability.

Appendix C contains the results of an OTA survey of the mineral industry. The survey was designed to obtain descriptions of the techniques used and estimates of the parties, costs, acreages, and times involved in exploration for and development and production of various types of mineral occurrences on onshore land in the United States.

2.

Mineral Exploration, Development, and Production: Technology, Participants, and the Role of Federal Onshore Land

Mineral Exploration, Development, and Production: Technology, Participants, and the Role of Federal Onshore Land

A continuing supply of newly mined minerals is essential to maintain the U.S. economy. Federal onshore land has been and is expected to remain a major source of domestic mineral discoveries.

In general, mineral activity occurs in several stages, ranging from target identification and target investigation to development and production. Each stage involves the application of more discriminating and expensive techniques to smaller land areas. Large areas containing thousands of square miles must be available for exploration in the initial stages, from which smaller target areas of only a few square miles or less can be selected for actual detailed investigation and possible development. Each successful exploration project must pay for 10 to 100 failures.

Conventional prospecting, which was until recently the source of almost all mineral discoveries, is no longer a significant source except perhaps in Alaska, because practically all visible indications of mineralization have already been identified in more than 100 years of intensive prospecting. The individual prospector has been largely replaced by modern exploration groups in medium- and large-sized companies as the source of almost all new mineral discoveries.

A. Minerals in the Economy

Mineral materials provide the physical basis for almost all activities of each U.S. citizen, whose per capita share of domestic consumption of new (mined) mineral materials in 1976 amounted to almost 40,000 pounds.[1] The pervasive use of minerals in the economy has been aptly illustrated by McDivitt and Manners, who noted in 1974 that:

> Today the mineral products of the earth are so commonly used that they affect every aspect of our lives, and today the average American is the largest consumer of minerals the world has ever known. Each year he uses, or has used on his behalf, a remarkable variety of minerals in quantities that would overwhelm him if his quota

[1] U.S. Bureau of Mines, *Status of the Mineral Industries, 1977*, at 2 (1977)

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for the year were to be dumped on his doorstep on New Year's morning! In 1970, per capita consumption of minerals in the United States (the average amount of material devoted directly or indirectly to each person) included nearly 1,400 pounds (620 kilograms) of steel—a man's car perhaps; 44 pounds (20 kilograms) of aluminum—for containers, kitchenware, house siding, etc.; 20 pounds (9 kilograms) of copper—much of this used in the electrical industry; less than a pound (0.4 kilogram) of tin—one-third of which went into tin cans; and a host of other less easily identifiable metals.

This is by no means the end. Few of us have any idea of the amount of fuel we consume in a year. The 3.4 tons of crude oil allocated to every American on a per capita basis and used for transport, industrial, and heating purposes, may not come as a surprise. But less directly that same person consumes (in oil equivalent tons) a further 2.5 tons of natural gas and 1.6 tons of solid fuels. This latter figure is equivalent to nearly **2.3** tons per person of actual coal and lignite, over 60 percent of which is converted into electricity, and much of the rest is used to produce each person's 1,400 pounds of steel, In addition to these minerals, each American uses some 440 pounds (ZOO kilograms] of salt, only a very small part of which takes the form of food seasoning: nearly 70 pounds (over 30 kilograms) of sulfur, the bulk of which is used to produce sulfuric acid, which in turn goes into fertilizer production; and over 994 tons of sand and gravel, most of which is used by the construction industry for buildings and highways. The list goes on, and the quantities continue to mount.'

Adequate supplies of minerals are essential for the maintenance of our economy. Reliable and reasonably priced supplies are essential to the smooth functioning of the economy and to our national security in a world subject to frequent political and military conflict,

Conservation, recycling, reuse, and substitution of minerals and mineral products are worthwhile objectives, However, there are limits on the contribution they can make, especially under present practices, policies, and attitudes, toward meeting the present and projected requirements for individual mineral commodities.[3]

Furthermore, a significant portion of our national economic activity and employment, particularly in certain regions, is based on the mineral-producing sectors of the economy, '

Considering all of the above, as well as the increasing difficulties of exploring for and producing minerals in foreign countries,[5] it is clearly in the national interest to consider carefully opportunities for the discovery, development, and production of domestic mineral resources.

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'See National Araderny of !+ lenccs and Nat]onal Academy of Engineering, Nuhonul ,Muterj(l/s Pol]cy; Proceedings of u Joinf Meeting (1975); Ntitional Cummisslon on Nlaterlals Policy, Moterl-(JI N(wis un(i the Environment 7'oda} (Ind T(mmorrow (1973); U.S. Bureau of Nflnes, (l]mmod]t}' I)otu SummorIes, 1!)76 (1976): U.S. Bureau of hlines, Mlner{d F(lct$ (Jn(l Proh]ems, 1975 Edit] on. Bull. 667 [1976); U.S. Council on [nternatlonal Economic Poli(y, SpeC;Iu) Report: Critlca) Imported Mu(eriu]s (1974); U.S. Department of the Interior, ivflrurw und Minerals Policy, 1976 (1976),

'U.S. Bureau of Mines, Status of the Mineral Industr]cs, 1977, at 4-5 (1 977].

'W'althler, ''The Shrinking W'orld of F;xploratlon, " pts, 1 and z, M]nlnx Englneerlng, April and Nlav 1976,

B. The Role of Federal Onshore Land

The Federal Government owned one-third of the onshore land in the United States in 1975. (The Federal percentage will drop to just over 27 percent when the transfer of about 150 million acres to the State of Alaska and the Alaskan Natives is completed.) More than 93 percent of the Federal onshore land was in the 11 contiguous Western States and Alaska, and the Federal acreage amounted to 64 percent of the total land in those States. (When ,the Alaskan land transfers are completed, more than 91 percent of the Federal onshore land will be in the 11 contiguous Western States and Alaska, and, the Federal acreage will amount to 51 percent of the total land in these States.) The Federal Government also has reserved mineral rights in an additional 5 percent of the acreage of these States,'[6] (See figure 2.1.)

'In the past, the Federal onshore land has proven to be a source of large reserves of a. wide variety of essential minerals. In addition, for some minerals (for example, coal) large resources[7] on Federal onshore land can be predicted on the basis of current knowledge, while for some other minerals (for example, copper) a large potential can be inferred on the basis of past experience and geologic evidence.

Minerals in Federal onshore land are explored for, developed, and produced under a variety of laws, which are summarized in chapter 3. The principal laws are the Mining Law of 1872, as amended, the Mineral Leasing Acts of 1920 and 1947, as amended and supplemented, the Geothermal Steam Act of 1970, and the Surface Resources Act of 1955, as amended. In general, the Mining Law applies to metallic mineral deposits (for example, copper, silver, and uranium) and deposits of most nonmetallic minerals (for example, asbestos and fluorite). The Mineral Leasing Acts apply to the fossil fuel minerals, the fertilizer minerals (phosphate and potash), and the chemical minerals (sodium and sulfur), The Geothermal Steam Act applies only to geothermal steam and associated resources. The Surface Resources Act applies to common varieties of sand, stone, gravel, pumice, pumicite, or cinders. Minerals subject to the Mining Law are generally referred to as "locatable" or "hardrock" minerals; those subject to the Mineral Leasing Acts or the Geothermal Steam Act are referred to as "leasable" minerals; and those subject to the Surface Resources Act are referred to as "saleable" or "common variety' or "construction" minerals.

In 1975, petroleum and natural gas production from about 5.5 million acres of producing leases on Federal onshore land amounted to approximately 6 percent of the national total and was valued at over $1.64 billion.' Large areas of the Federal onshore land not yet thoroughly drilled are considered favorable for the occurrence of petroleum and natural gas, In 1975, more than 84 million acres were under lease for petroleum and natural gas exploration and development. More than 90 percent of the leased acreage was in the 11 Western States and Alaska.[9]

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[6] Derived from data in U.S. Bureau of Land Management, *Public Land Statistics, 1976*, tables 7 and 17 (1977). The 11 contiguous States are Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[7] For definitions of reserves, resources, etc., see app. A.

[8] U.S. Geological Survey, Conservation Division, *Federal and Indian Lands Oil and Gas Production, Royalty Income, and Related Statistics, Calendar Year 1975* (1976).

[9] Ibid.

Figure 2.1.—Principal Federal Landholdings in 1976

SOURCE: U.S. Geological Survey, Special Maps Branch, 1977.
Note: Alaska is shown here at a reduced scale.

Includes areas of interspersed ownership containing at least 25-percent Federal land.

Substantial deposits of coal, phosphate, and sodium compounds are also known to exist on Federal onshore land, and large resources of these minerals are under lease. The value of production at the mine or wellhead of all leasable minerals on Federal onshore land[10] in 1975 was more than $2.21 billion. Their cumulative production value for 1920 through 1975 was more than $22.5 billion,]'

Detailed records are not kept for production of hardrock minerals on Federal land unless they are produced from leases on Federal acquired land. (The value of production of hardrock minerals on acquired land was included in the $22.5 billion cumulative production value of all leasable minerals given above.) Nevertheless, some idea of the importance of Federal land for hardrock mineral production can be obtained from the data on mineral production in the Western States because, as was pointed out above, 64 percent of the acreage in the Western States, including Alaska, is owned by the Federal Government, and most hardrock mines on what is now private land in the Western States have passed into private ownership through location on Federal land under the Mining Law, In 1975, the Western States produced the following approximate amounts of the Nation's domestic primary[12] mineral supply: 92 percent of the copper, 84 percent of the silver, and almost 100 percent of the nickel. In fact, the bulk of the known domestic resources of a majority of the metallic minerals is situated in the West.[13]

The role of Federal onshore land in the production of 14 representative essential" mineral commodities is described in appendix A. Of the 14 mineral commodities, 7 (coal, copper, nickel, phosphate rock, silver, sodium carbonate, and uranium) have a relatively high potential for occurrence on Federal onshore land, 6 (geothermal steam, fluorspar, lead, natural gas, petroleum, and potash) have a more moderate potential, and 1 (iron ore) has only limited, but possibly locally important, potential. Even minerals with lesser Federal land potential may take on added significance when viewed within the context of national needs and the reliability of imports.

Figures 2.2 and 2,3 provide an overview of the importance of Federal onshore land for mineral exploration, development, and production. Figure 2.2 overlays the Federal onshore land map in figure 2.1 with the base and precious metal mining districts. Figure 2.3 shows the location of the major coalfields in the coterminous United States. As can be seen from the figures, most of the Nation's known mineral resources are concentrated in Federal land areas.

All the data support the conclusion of the Public Land Law Review Commission in its 1970 report that:

> Present knowledge about the geology of mineralization in the United States, combined with the geographic pattern of established mining districts, indicates a strong probability that the public land areas of the West generally hold greater promise for future mineral discoveries than any other region.

Indian land is not included as 'Federal land'' in this report.

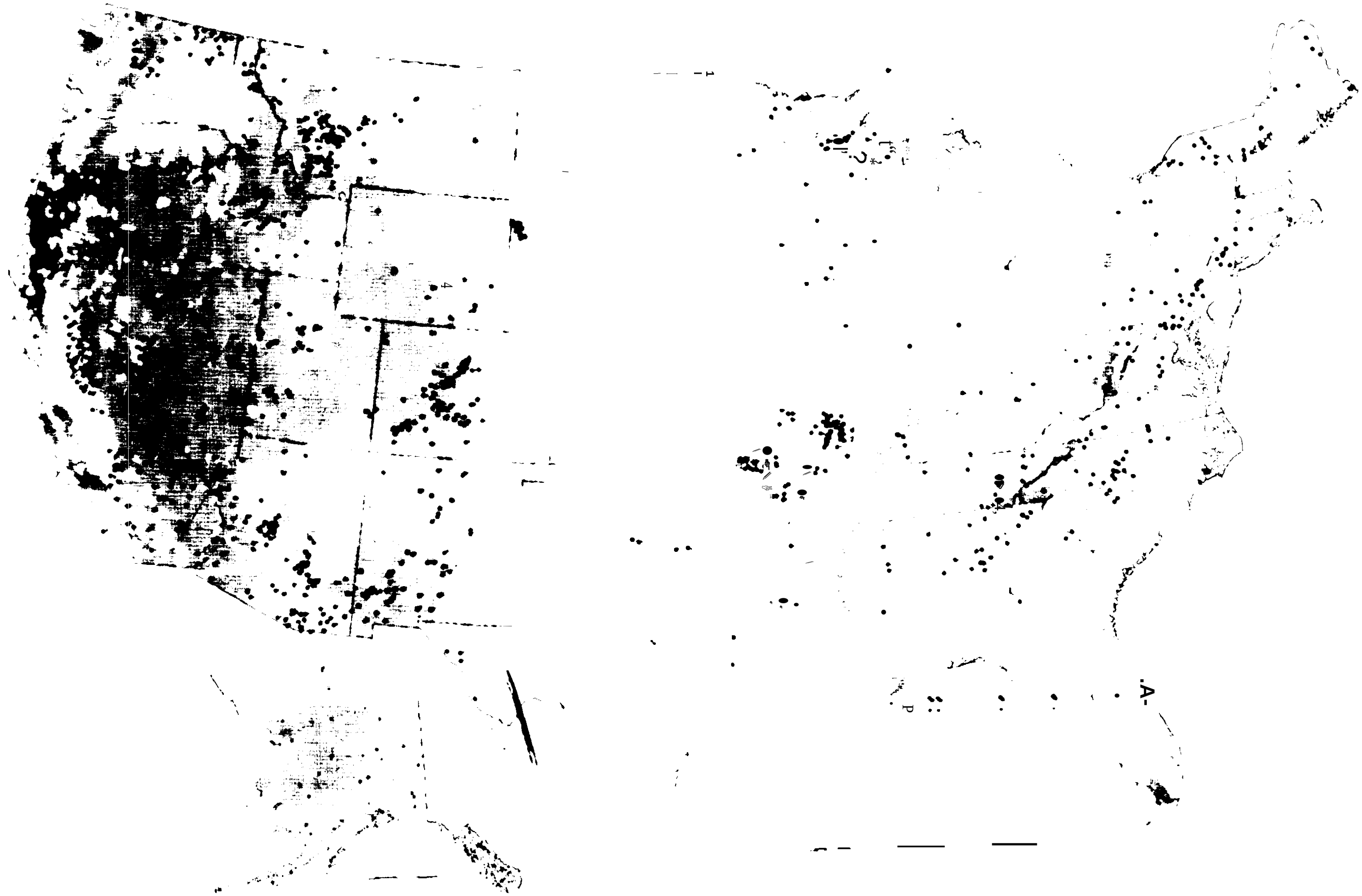
[11] U. S Geological Survey, Conservation Division, *Federal and Indian Lands Coal Phosphate, Potash, Sodium, and other Mineral Production Royalty Income and Related Statistics, Fiscal Year 1975* (1976).

[12] As used here, primary mineral commodities are new materials, not recycled, reconditioned, or reused, which have been produced from deposits of naturally' occurring materials in the Earth's crust.

[13] U. S. Bureau of Mines, *Commodity Data Summaries, 1976* (1976).

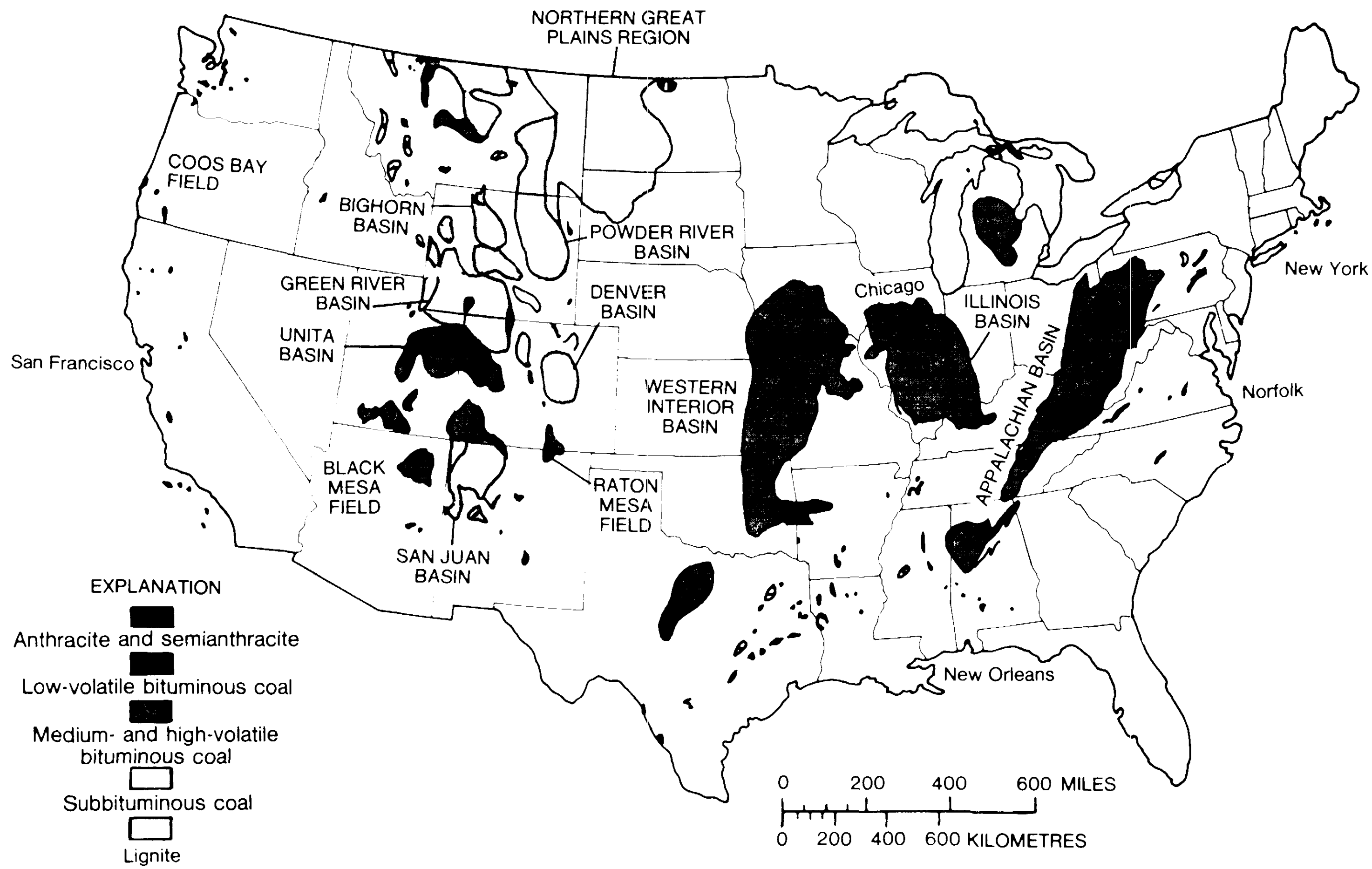
'Essential in the sense that industry requires an assured supply In order to perform its funct ions,

Figure 2.2.—Base and Precious Metal Mining Districts in Relation to Federal Landholdings in 1976



SOURCE: U.S. Geological Survey, Special Maps Branch, 1977.
Note: Alaska is shown here at a reduced scale

Figure 2.3.—Coalfields of he Conterminous Un ted States



SOURCE P. Averitt. *Coal of the United States, January 974* U S Geological Survey Bul 1412, at 5 (1975).

Consequently, we have concluded that it is in the public interest to acknowledge and recognize the importance of mineral exploration and development in public land legislation.[15]

C. Mineral Exploration, Development, and Production: Stages and Technology

1. Stages

Mineral activity can be roughly divided into six stages, which require application of successively more discriminating (and more expensive) techniques to successively smaller land areas in order to identify, develop, and produce an economic mineral deposit.

A "full sequence" mineral project would involve the following stages:[16] 1) appraisal of large regions in one or more countries, primarily if not exclusively through review of office records and published maps and literature, to select particular regions considered favorable for occurrence of the mineral or minerals being sought; 2) reconnaissance of the selected region, through airborne or on-the-ground instrument surveys and sampling, to identify particular target areas considered likely to contain economic mineral deposits; 3) detailed investigation of the surface of the target area through more closely spaced surveys and sampling and the use of more discriminating (and more costly) techniques; 4) drilling or other three-dimensional physical sampling of the target area to discover whether an economic mineral deposit actually exists; 5) development of mine workings, processing plants, roads, and the infrastructure necessary for production from the deposit; and 6) actual production.

The first two stages are collectively referred to as target identification. The next two stages are collectively referred to as target investigation. The process of identifying and investigating targets in order to discover an economic mineral deposit is known as mineral exploration.

Development is the work required to bring a deposit, once discovered, to the point of production. Production is the actual mining, concentration, and shipment of the mineral to market.

Full-sequence mineral activity occurs for only a few projects. A project will be abandoned at any stage if the results are not encouraging. Some of the initial stages may be skipped or abbreviated if the information ordinarily obtained in those stages is already available to the company as a result of its or others' prior work, or is easily obtainable through surface inspection (for example, an economic mineral deposit that shows or "outcrops" on the surface).

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[15] Public Land Law Review Commission, *One Third of the Nation's Lend* 122(1970).

[16] Bailly, 'exploration Methods and Requirements, " in American Institute of Mining Engineers, *Surface Mining*, at 19 (1968): [J, S. Department of Agriculture, Forest Service. *Anatomy of a Mine From Prospect to Production*, Gen. Tech. Rep. INT-35, at 23-68 (1977) (hereinafter cited as Anatomy of a Mine); Halbouty, "Giant Oil and Gas Fields in the United States," 52 Am. *Ass'n Petr. Geol Bull.* 1115 (1968).

2. Technology

The six stages of mineral activity and the techniques typically used in each are listed in table Z. I. Only rarely will an actual mineral project utilize all or even most of the techniques listed for each stage. Many of the techniques, owing to cost or physical characteristics, are suitable only for certain types of deposits in certain types of geologic environments.

Table 2.1 .— Typical Techniques for the Six Stages of Mineral Activity

		Stages	Typical techniques
EXPLORATION	TARGET IDENTIFICATION	Regional appraisal (Stage 1)	Geologic compilatlon (includlng geophysical and geochemical data) from office files and published maps and literature. Photogeologic study of available land photographs Analysis of available remote sensing data. Field inspection from air or on the ground.
EXPLORATION	TARGET IDENTIFICATION	Reconnaissance of region (Stage 2)	Reconnaissance geologic mapping and sampling. Reconnaissance geochemical (stream sediments, water, soils, etc.) surveys. Reconnaissance geophysical (magnetic, gravity, electromagnetic, seismic, radiometric, Induced polarizatlon, etc.) surveys (usually airborne). Reconnaissance (stratigraphic) drilling. Rapid laboratory analysis of samples. Field inspectlon of outcrops and anomalous areas.
EXPLORATION	TARGET INVESTIGATION	Detailed surface investigation of target area (Stage 3)	Detailed geologic mapping and sampling Detailed geochemical surveys Detailed geophysical surveys (usually on-the-ground). Detailed laboratory analysis of samples. Field Inspect Ion.
EXPLORATION	TARGET INVESTIGATION	Detailed three-dimensional physical sampling of target area (Stage 4)	Drilling, logging, trenching, pitting, sinking shafts. Detailed laboratory analysis of samples and amenability testing. Down-hole geophysical surveys. Recovery of bulk samples and ore dressing tests. Investigation of suitability of water, land surface, and infrastructure for mine-related facilities. Feasibility and evaluation studies.
		Development (Stage 5)	Drilling to block out deposit or drilling of production wells. Construction of mine workings, plants, facilities, roads, powerlines, pipelines, town sites, etc.
		Product ion (Stage 6)	Operation of mine (surface, pit, or underground) or wells and related facilities.

SOURCE Adapted from similar tables prepared by Paul Baily See appendix C

An understanding of geologic concepts, the geology of ore deposits and their geologic settings, and geologic maps is essential in each stage of mineral activity. In particular, mineral exploration is increasingly based on conceptual models developed by analyzing the geologic setting or environment of all the known occurrences of a particular type of deposit, The "occurrence model" developed prior to or during the first one or two stages of exploration (regional appraisal and reconnaissance) is used to guide the exploration for additional deposits of that type through identification of target areas with similar geologic environments .17

Most mineral exploration techniques other than geologic compilation, conceptualization, investigation, and mapping are based on specific chemical or physical properties, and are applicable only to mineral occurrence types that possess the appropriate properties, For example, geophysical exploration techniques are designed to detect mineral deposits (or geologic environments favorable for the occurrence of those deposits) through measurement of their characteristic physical properties, such as density (e.g., gravity and seismic surveys for geologic settings favorable for oil and gas deposits or certain sodium and sulfur deposits); magnetic behavior (e.g., magnetometer survey for magnetic iron, copper skarn, and nickel ores and for magnetic geologic environments favorable for asbestos-bearing serpentine); electromagnetic response (e.g., electromagnetic survey for massive sulfide ores on the Canadian Shield); electrical behavior (e.g., self potential (SP) survey of natural electrical current developed during weathering of certain metallic sulfides); electric response (e.g., induced polarization (1P) survey of mineralized ground); and radioactivity (e.g., geiger counter or scintillometer radiometric survey for surface or near surface uranium, thorium, and potassium deposits). " Many mineral occurrence types cannot be detected by using some or even all of these techniques. This is due to either the lack of the required physical characteristics, the "washout" of those characteristics by background "noise" from the surrounding rock, the existence of similar behavior or response characteristics in nonmineral rock, or the high cost of using a particular technique over large areas.

Similarly, geochemical analysis of water, stream sediments, vegetation, soil, and rocks can determine a pattern of trace elements indicative of nearby surface or subsurface ore bodies of a particular type. This works better for some mineral occurrence types and some areas than for others, although it is more widely applicable than the various geophysical techniques,

Trenching, digging of pits, exploration drilling, or sinking of exploration shafts is usually required in the final stages of exploration for each mineral occurrence type, in order to obtain proof of the existence of the ore body. Drilling is the most common technique, and it is sometimes used in earlier exploration stages (for example, the reconnaissance stage) to investigate the geologic setting of an area. Such reconnaissance drilling is referred to as stratigraphic or "off structure" drilling.

Many of the techniques are applied rapidly to broadly spaced sample points in the earlier stages of exploration, and then are applied more thoroughly in a tighter pattern in the later stages.

[1].M]ller, "Corporfltlons, ore Discovery, and the Geologist, " 71 Econorn]c Geology 836 [1976); Ad Hoc Geologlca] Committee on Remote Sensing From Spare, Geolo~Icd Remote Sens]ng From Sp(lce (1977).

"An[lt(Jmv of o Mine, note 16, at 35-38,

3. The Relative Roles of the Various Exploration Techniques

The mineral exploration techniques discussed in the previous subsection can be divided into four general methods: conventional prospecting, geologic inference, geophysical anomaly, and geochemical anomaly.

"Conventional prospecting" refers to the search of surface areas for outcropping ore bodies or oil seeps—the type of exploration popularly typified by the Old Sourdough prospector and his burro. This romantic image of conventional prospecting was not completely accurate even during the era of the California Gold Rush, It has now given way to prospecting by individuals with four-wheel-drive vehicles, bulldozers, and varying degrees of geologic training or knowledge, The principal feature of prospecting is the search for surface expressions of economic mineral deposits.

Geologic inference is the mental "search" of the subsurface for hidden ore bodies through the use of geologic expertise. It includes projections of continuations of known ore bodies, which have been separated and significantly displaced from those bodies as a result of faulting, shearing, and folding of subsurface strata. Increasingly, as was pointed out in the previous subsection, geologic inference includes the formulation of a conceptual model for all the known occurrences of a specific type of deposit, and the use of that model to predict the locations of undiscovered occurrences and to guide the instrumented and physical exploration of the predicted locations,

"Geophysical anomaly" refers to the measurement of specific physical properties (magnetism, electrical conductivity, density, radioactivity, etc.) of the subsurface to locate anomalies that could indicate the presence of a particular type of mineral deposit. (An anomaly is a variation from the usual behavior or response of the nonmineralized host rock.)

Similarly, "geochemical anomaly" refers to the measurement of specific chemical properties and constituents of surface soils, vegetation, water, and sediments to locate anomalies that could indicate the presence of a hidden ore body.

Conventional prospecting accounted for most of the mineral discoveries made in the United States prior to 1940. In fact, one estimate attributes at least 90 percent of the ore produced to date to conventional prospecting.[19] However, data on recent discoveries in the United States and Canada indicate that conventional prospecting now plays a very small role in the discovery of economic mineral deposits.

Albers has recently published data on 62 U.S. metal mines discovered between 1941 and 1970, inclusive. Only those mines with a production capacity of at least 150,000 tons per year were included. Table 2.2 shows the distribution by principal exploration method of the 62 discoveries.

Bailly has added 10 discoveries to the 51 shown by Albers for the 1951-70 period to arrive at the distribution of discoveries shown in table 2.3.

Similar data for Canada have been compiled by Derry and Booth for discoveries made through 1975 of nonferrous metallic deposits and asbestos. Discoveries prior to

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Table 2.2.—Discoveries of U.S. Metal Mines, 1941-70

Year of discovery	Principal exploration method								Total number
	Conventional prospecting		Geologic inference		Geophysical anomaly		Geochemical anomaly		
	Number	%	Number	%	Number	%	Number	%	
1941-45	1	25	2.5	63	—	—	0.5	12	4
1946-50	1	14	6	86	—	—	—	—	7
1951-55	0.5	5	7.5	68	3	27	–	—	11
1956-60	1	7	10	77	1	8	1	8	13
1961-65	—	—	11	79	3	21	—	—	14
1966-70	—	—	9.5	73	2.5		1	8	13
1951-70	1.5	3	38	74	9.5	19	2	4	51

SOURCE: Derived from Albers, "Discovery Rates and Exploration Methods for Metallic Mineral Deposits in the U. S., 1940 -1976," 178 *Eng. & Mining J. 71 (1977).*

Table 2.3.—Discoveries of U.S. Metal Mines, 1951.70

Year of discovery	Principal exploration method								Total number
	Conventional prospecting		Geologic inference		Geophysical anomaly		Geochemical anomaly		
	Number	%	Number	%	Number	%	Number	%	
1951-55	1	8	9	75	2	17	—	—	12
1956-60	2	13	10	67	2	13	1	7	15
1961-65	—	—	13	87	2	13	—	—	15
1966-70	—	—	15	79	2	11	2	10	19
1951-70	5	3	47	77	8	13	3	5	61

SOURCE: Bailly, "Changing Rates of Success in Metallic Exploration, " paper presented at the GAC-MAC-SEG-CGU Annual Meeting, Vancouver, British Columbia, April 25, 1977.

1965 are limited to those for which production was commenced or recommenced since 1955 or for which production was planned, The distribution of discoveries by principal exploration method is shown in table 2.4,

All these data are incomplete and based on limited knowledge of actual discoveries (which are often kept secret, particularly the most recent ones).[20] Nevertheless, they clearly demonstrate the greatly reduced role of conventional prospecting as a method for discovering new metal deposits in both the United States and Canada, Con-

[20] Bailly, "Changing Rates of Success in Metallic Exploration," at 2, paper presented at the GAC-MAC-SEG-CGU Annual Meeting, Vancouver, British Columbia, Apr. 25, 1977; Cranstone and Martin, "Are Ore Discovery Costs Increasing?" in Canadian Department of Energy, Mines and Resources, Mineral Resources Branch, *Canadian Mineral Exploration, Resources and Outlook*, MR 137, at 5, 6, 8, 10 (1973).

Table 2.4.– Discoveries of Canadian Metal Mines Through 1975

Year of discovery	Principal exploration method: Conventional prospecting		Geologic inference		Geophysical anomaly		Geochemical anomaly		Total number
	Number	0/0	Number	0/0	Number	%	Number	%	
Pre-1 920	26	93	2	7	—	—	—	—	28
1920-29	12	80	3	20	—	—	—	—	15
1930-39	13	87	2	13	—	—	—	—	15
1940-50	13	76	4	24	—	—	—	—	17
1951-55	16	46	14	40	5	[redacted]	—	—	35
1956-60	6	25	4	17	14	[redacted]	—	—	24
1961-65	4	27	4	27	5	[redacted]	2	13	15
1966-70	2	10	4	20	13	[redacted]	1(?)	5	20
1951-70	28	30	26	28	37	[redacted]	3	3	94
1971-75	1	4	4 + 1 (?)	19	15	[redacted]	[redacted]	11	26*

● No principal exploration method was given for 2 discoveries in 1971-1975

SOURCE: Derry, "Exploration Expenditure, Discovery Rate and Methods, " 63 *C/M Bu//etin 362(1970)* (Pre-1920 through 1964); Derry and Booth, "Mineral Discoveries and Exploration Expenditure—A Revised Review 1965 -1976," paper prepared for 1977 CIM Symposium (1965 through 1975).

ventional prospecting was the principal exploration method for only 7 out of 61 of the reported metal discoveries in Canada and for none of the reported metal discoveries in the United States after 1960.

There is fairly uniform agreement on the reason for this sharp decline. Most of the metallic ore bodies that are exposed or directly indicated through visual inspection of the surface have already been identified in more than 100 years of fairly intensive surface exploration. The remaining deposits are hidden beneath the surface with no direct visual clues as to their existence, and they can be discovered only through careful geologic analysis aided in varying degrees by geophysical and geochemical techniques.[21] This is less true in the remoter regions of Canada and Alaska than in the lower 48 States,[22] but the trend is unmistakable in all three regions,

The decline in conventional prospecting as a successful exploration method is not confined to the metallic minerals. Almost all of the easily found visible indications of economic mineral deposits in the lower 48 States have been identified. For example, conventional prospecting for oil and gas deposits through visual identification of oil seeps, salt domes, and other surface indications gave way during the early 1920's to geophysical techniques (primarily seismic) since most visible surface indications had already been found and tested.[23] Similarly, although there was a brief revival of conventional prospecting, aided by inexpensive radiation detectors, when uranium

[21] *Geological Remote Sensing From Space*, note 17, at 5-1; Pennsylvania State University, Department of Geosciences, *Report on the Workshop: Research Frontiers in Exploration for Non-Renewable Resources* 4, 16, 21-23, 64-65 (1976); U.S. Department of the Interior, *Mining and Minerals Policy, 1977*, at 82-83, 85 (1977).

[22] U.S. Geological Survey, Office of Resource Analysis, *Comparative Study of Canadian-United States Resource Programs*, ch. A, at 52 (Comm. Print, U.S. Senate Comm. on Appropriations, 1976); Hawley and Whitney, "The Economic Importance of the Small Miner and Small Mining Businesses in Alaska," in Office of Technology Assessment, U.S. Congress, *Analysis of Laws Governing Access Across Federal Lands*, vol. II, Working Papers (1978).

[23] *Geological Remote Sensing from Space*, note 17, at 3-3.

emerged as a valuable mineral in the wake of World War H, "most of North America is now considered explored for high-grade surface [uranium] ore bodies because of the efficiency of radiometric techniques; virtually all serious exploration is now done by subsurface drilling."[24]

Mineral exploration today, therefore, relies primarily on geologic inference based on substantial geologic knowledge and creativity. Geophysical and geochemical surveys are included in most exploration projects, and they are the principal method used to locate target areas in a large number of successful Canadian exploration projects and a smaller (because of differences in geology) but still significant number of U.S. exploration projects. The targets in almost all cases must be explored by drilling to determine the actual existence and location of the hypothetical mineral deposit.

Conventional prospecting has rarely resulted in the discovery of an economic mineral deposit over the past 30 years. It does, however, serve as a source of information on mineral "showings" (surface "expressions" of mineralization insufficient in themselves to indicate the presence of an economic mineral deposit) that can be combined with other sources of information (for example, company files, maps, and published articles) on the geology and mineralization of a region or area in order to serve as the basis for sophisticated exploration, utilizing geologic inference. In essence, conventional prospecting today is a device whereby new or, more often, old mineral showings are continually brought to the attention of mining company exploration groups to serve as a supplement to the geologic and mineral data stored in company files.

D. Mineral Exploration, Development, and Production: Cost, Acreage, and Time Requirements

1. General Considerations and Statistics

Mineral activity is an expensive business with long leadtimes between investment and payout, if any. Although the figures vary for different types of mineral occurrences, and also for individual projects within each type, in general each successive stage of mineral activity is more expensive and takes more time than prior stages. Each successive stage, up to the development stage, also focuses on smaller tracts of land.

The costs, acreages, and times for a particular mineral project depend in large part on the type of mineral occurrence. Table 2.5 lists most of the known types, excluding common-variety minerals such as limestone, common clay, and sand and gravel. They are broken down into four general categories of geologic configuration, which, reading from left to right, result in increasing difficulty in discovering a deposit, all other things being equal.

Surficial mineral occurrences are generally unconsolidated, unburied mineral deposits and result from weathering or deposition during late geologic time. Examples

[24] Ibid., at 5-3; see *Anatomy of a Mine*, note 16, at 37.

Table 2.5.—illustrative Mineral Occurrence Types

SURFICIAL		NONSURFICIAL					
		Strata bound-extensive		Stratabound-discrete		Discordant	
Geologic Environment	**Typical Ores**	**Geologic Environment**	**Typical Ores**	**Geologic Environment**	**Typical Ores**	**Geologic Environment**	**Typical Ores**
Aluminous Clays and Laterites	•Bauxite, •Kaolinite	Bedded Precambrian	•Iron, Copper, Gold	Marine Sedimentary	“ 011 and Gas Bromine Barite	Breccia Pipes	“ Uranium, Molybdenum, Copper Gold, Diamond
Laterites	‘ Nickel (Cobalt)	Marine Sedimentary	•Phosphate, Iron, 011 Shale, Manganese	Continental Sedimentary (Sandstones and Fossil Placers)	•Uranium (Vanadium), Gold, Titanium	Porphyries	•Copper-Molybdenum, Gold, Tin
Stream Placers	Gold, Silver, Platinum, Tin, Rare Earths, Iron, Gem Stones	Marine Evaporite	•Potassium, * Sodium, *Sulfur “ Gypsum, Lithium Magnesium	Lacustrine Evaporates	•Gypsum, “ Trona “ Boron	Pegmatities	Lithium, Fluorine, Beryllium, Rare Earths Mica, Feldspar, Columbium, Tantalum
Coastal Placers	Titanium, Zirconium, Chromium, Rare Earths, Gem Stones	Continental Sedimentary	•Coal, 011 Shale ‘ Boron, “ Sodium	Fossil Laterites	Bauxite	Vein and Replacement Deposits	*Gold, •Silver Copper Alunite, Mercury, Lead, Zinc, Barite, Fluorine, Tungsten, Molybdenum, Uranium, Iron Graphite, Gem Stones, Native Sulfur Gilsonite
Residual Deposits	Barite, Iron, Manganese Tifanium, Phosphate, Columbium Vermiculite	Continental Volcanlc	Bentonite	Young Tuffs and Related Sedimentary	Beryllium, Mercury Fluorite, Native Sulfur	Massive Sulfide Pipes	Copper-Lead-Zinc - Sliver (Gold, Pyrite)
Brines m Evaporates	Ž Sodium, • Potassium, • Magnesium, • Boron, Lithlum, Tungsten	Stratiform Igneous Complexes	* Iron, Chromium, Platinum Group Metals, Vanadium	Shale Hosted Massive Sulfides	•Copper-Lead-Zinc-Silver	Rhyolitic Volcanic	•Tin Tungsten, Bismuth
Supergene Enrichment	Copper, Silver, Lead Zinc, Gold, Manganese			Carbonate Stratiform	• Zinc-Lead-Barite-Fluorine (Copper, Cobalt)	Mafic and Ultramafic Intrusive	Nickel-Copper, Olivine
				Volcanogenic Massive Sulfides	• Copper Lead-Zinc-Silver (Gold Pyrite Barite)	Podiform Ultramafic	Chromium Copper, Iron Nickel, Asbestos
				Metamorphic	Garnet, Kyanite Graphite	Anorthosite Complexes	Titanium, Iron, Vanadium
						Veins in Ultramafic	Asbestos, Talc
						Veins m Metamorphosed Dolomites	Talc
						Salt Domes	* Sulfur
						Carbonatite and Alkalic Complexes	Phosphate Rare Earths Iron, Titanium Columbium, Copper

•Described In Ad Hoc Geological committee on Remote Sensing from Space Geological Remote *Sensing from Space (* 1977) are sodium and potassium deposits in evaporite brines and gold and silver deposits in stream placers.

Stratabound-extensive mineral occurrences are large, laterally continuous mineral deposits confined to a single stratum in the earth. Examples are coal and oil shale in continental sedimentary basins, iron in bedded Precambrian strata, and stratiform igneous complexes.

Stratabound-discrete mineral occurrences are randomly distributed and/or discontinuous mineral deposits largely confined within specific strata in the earth. Examples are oil and gas in marine sedimentary basins and copper-lead-zinc in shale-hosted and volcanogenic massive sulfides.

Discordant mineral occurrences are mineral deposits that cut through strata and/or are related to intrusive rocks, volcanic activity, or other geologic intrusions. Examples are sulfur in salt domes and copper in porphyrins.

Figure 2.4 depicts the differences among the four geologic configurations.

The difficulty, and hence cost and time, of discovering a mineral deposit of any geologic configuration is increased when the deposit is buried rather than exposed on the surface entirely or in an outcrop. The deeper the deposit, the more difficult it will be to find, especially since currently available geophysical and geochemical exploration techniques generally cannot penetrate very far beneath the surface.

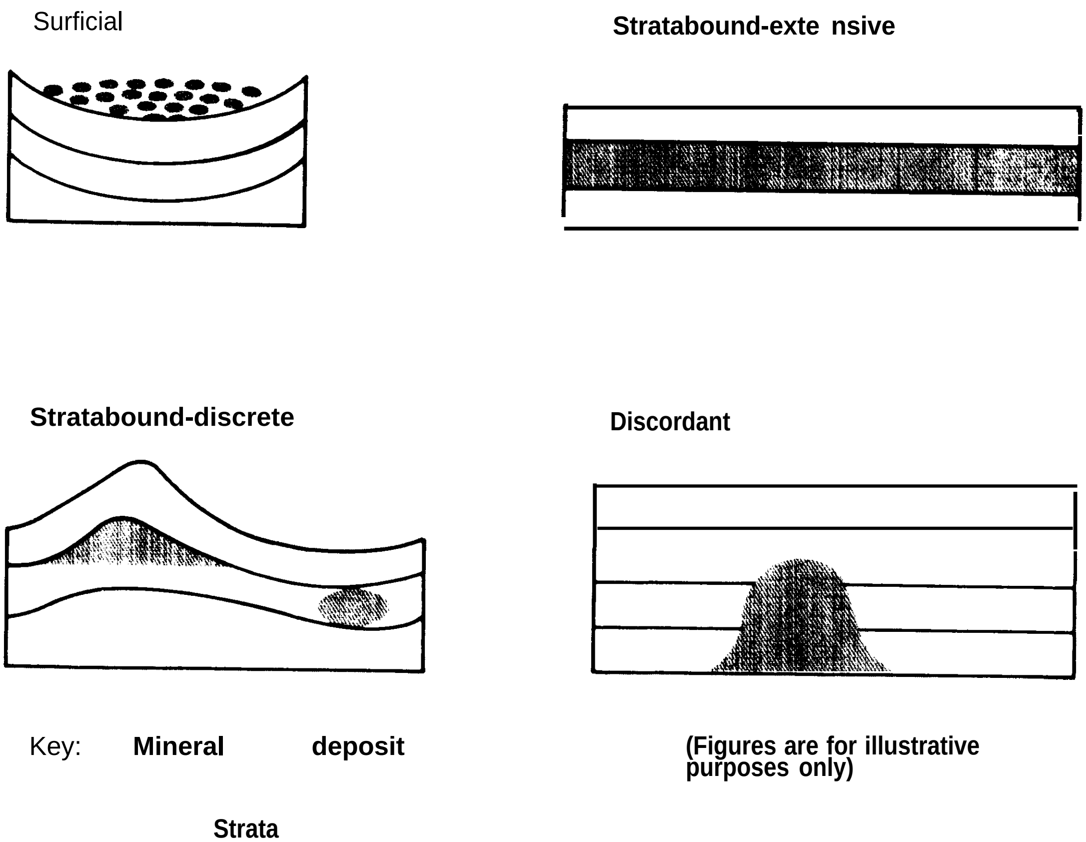
The depth of the deposit will also affect the costs, acreages, and times involved in development and production. Generally, surface mining is less expensive than underground mining. Open pits can be used at shallow to intermediate depths for large ore bodies, but they require large acreage just for the sloping pit walls. Minerals such as oil, gas, and sulfur, which can be produced in liquid form, can be developed at fairly great depths using wells.

Table 2.6 presents estimated cost, acreage, and time ranges for the exploration and development stages of typical mineral projects involving surficial, stratabound-extensive, stratabound-discrete, and discordant mineral deposits in 1977. The table is based on the data collected in appendix C for 32 of the mineral occurrence types listed in table 2.5. Acreages through stage 2 are for the extent of land included in the search; acreages from stage 3 on are for the land for which a land position has been established through purchase, option, lease, or claim. Costs are direct costs only and do not include overhead or the cost of land acquisition. Times assume normal progress without substantial delays caused by adverse economic climate or regulatory processes.

2. Target Identification

In the first two stages of exploration (regional appraisal and reconnaissance), regions ranging from 1,000 to 100,000 square miles are assessed through compilation and analysis of available data, and portions of a region covering 10 to 100 square miles each are studied through field inspections, widely spaced geochemical sampling, and airborne geophysical surveys. The results are brought together on maps. They are then geologically analyzed in light of the characteristics of known occurrences of the type of

Figure 2.4. —Mineral Occurrence Configurations



mineral deposit being sought, in order to select smaller target areas for detailed investigation in stages 3 and 4. The first two stages may cost anywhere from a few thousand to more than a million dollars, and will usually take anywhere from a few months to a couple of years to complete, assuming continuing success.[25]

The two most significant aspects of the first two stages both have to do with the acreage involved. First, there is usually no need to establish a land position (that is, acquire mineral development and production rights) on any or all of this acreage in order to protect the exploration investment made during these two stages. Although that investment may total several million dollars for the largest and most complex exploration projects, it is spread over thousands of square miles, and the reconnaissance techniques utilized [except for reconnaissance stratigraphic drilling) do not involve significant occupation or disturbance of any particular area, Thus, the competition is unlike-

[25] Bailly, "The Problems of Converting Resources to Reserves," *Mining Engineering*, January 1976, at 1, 3-4; Bailly, "Mineral Exploration and Mine Developing Problems," paper presented at the Public Lands Law Conference, University of Idaho, Oct. 10, 1966, updated by author initially on June 30, 1967, and subsequently in communications with OTA in 1976.

Table 2.6.—Estimated Cost, Acreage, and Time Ranges for the Exploration and Development Stages of Typical Mineral Exploitation Projects in 1977

Costs do not include land or overhead costs. (K = Thousand) (M = Million)

				MINERAL OCCURRENCE CONFIGURATION															
				Surficial				Stratabound-extensive				Stratabound-discrete				Discordant			
				Cost ($,	Acres	Time (mos.)	$ Per Acre p. yr.	Cost ($)	Acres	Time (mos.)	$ Per Acre p. yr.	Cost ($)	Acres	Time (mos.)	$ Per Acre p. yr.	Cost ($)	Acres	Time (mos.)	$ Per Acre p. yr.
EXPLORATION	TARGET IDENTIFICATION	STAGE 1	Low	2K	640	1		1K	3.2K	0.2		2K	640K	1		1K	640	0.5	
			Avg.	39K	21M	7	.003	38K	146M	8	.0004	96K	18M	9	.007	25K	86M	6	.0006
			High	590K	640M	18		362K	640M	42		680K	640M	62		635K	640M	60	
		STAGE 2	Low	8K	640	1		1K	3.2K	0.2		8K	2.6K	1		2K	640	0.5	
			Avg.	80K	216K	10	0.44	135K	982K	10	0.16	783K	1.9M	11	0.45	82K	266K	9	0.41
			High	1.0M	6.4M	40		1.1M	6.4M	90		22M	25.6M	60		1.5M	6.4M	48	
	1 + 2		Avg.	119K		17	0.26	173K		18	0.09	879K		20	0.25	107K		15	0.25
	TARGET INVESTIGATION	STAGE 3	Low	2K	100	2		0	200	1		5K	100	1		2K	40	0.3	
			Avg.	72K	4K	11	20	536K	6.5K	12	82	205K	26K	10	9.5	123K	3.9K	10	38
			High	360K	60K	40		5.7M	25K	48		1.8M	1.5M	88		1.3M	40K	90	
		STAGE 4	Low	49K	600	6		25K	200	6		24K	100	1		23K	40	3	
			Avg.	2.5M	4.1K	29	252	1.7M	6.6K	29	107	4.3M	7.3K	27	262	1.5M	1.7K	22	481
			High	14.3M	60K	186		7.7M	25K	78		30M	128K	160		16M	30K	72	
	3 + 4		Avg.	2.6M		40	188	2.2M		41	100	4.5M		37	194	1.6M		32	343
	1 to 4		Avg.	2.7M		57		2.4M		59		5.4M		57		1.7M		47	
DEVELOPMENT		STAGE 5	Low	5.1M	1K	36		22M	1K	12		362K	500	4		3.5M	50	12	
			Avg.	81M	4K	52	4.7K	81M	9K	25	4.3K	79M	6.8K	22	6.3K	26M	—	30	—
			High	502M	13K	156		185M	25K	42		361M	100K	90		406M	6.4K	84	

ly to be able to discern and preempt the potential target areas. In fact, the explorer himself will not be sure precisely which areas are desirable as targets until the first two stages have been completed: target identification is the very purpose of these two stages. However, the explorer may wish to establish some sort of limited land position in areas where reconnaissance stratigraphic drilling is done, if only because the drilling may uncover economic mineralization (even though its primary purpose is knowledge of general subsurface geology).

Second, although it is unnecessary (and usually impractical) to establish a land position prior to the first two stages, it is imperative that mineral rights be obtainable at the end of those stages (or at least prior to detailed surface disturbance in stage four) for the selected target areas. Because it is not known initially where specific targets may be identified, all or almost all of the acreage being investigated in stages 1 and 2 must be available for the establishment of a land position. That is, large areas containing thousands of square miles must be available for mineral development and production in these stages, from which smaller target areas of only a few square miles can be selected for actual acquisition of mineral rights at the end of the stages. If the large areas are not available, the smaller areas are likely to be passed by or explored much less efficiently as a result of unwillingness to commit the large sums necessary for sophisticated regional modeling and reconnaissance.

If a mineral discovery were made as a result of the exploration efforts in stages 1 and 2, prior to any actual drilling or other three-dimensional physical exploration, the explorer would immediately want to acquire a land position for the area of the discovery,

3. Target Investigation

In the final two stages of exploration (detailed surface investigation and three-dimensional physical sampling of a target area), a target (ranging initially from 1 to 10 or more square miles) is investigated through detailed field inspections, geochemical sampling, and ground and airborne geophysical surveys. In this way, it is reduced to a smaller target (ranging from a fraction of a square mile to several square miles) for drilling or other three-dimensional physical sampling to determine if the hypothetical economic mineral deposit actually exists. These two stages may cost anywhere from tens of thousands to tens of millions of dollars, and they will usually take one to several years to complete, assuming continuing success.[26]

As was stated above, the explorer will want to acquire a land position as soon as the target area has been reduced to a few square miles or less, and is unlikely to do any three-dimensional physical sampling until mineral rights have been acquired for most of the target area.

Actual physical discovery of economic-grade mineralization usually does not occur until three-dimensional physical sampling is undertaken in stage 4, although, in increasingly rare cases, such a discovery may be made in earlier stages as a result of surface outcropping of the ore body. Exploration continues after the first discovery of

[26]Ibid

economic-grade mineralization until it has been determined that there is enough ore to support a commercial mining operation. Once it has been determined that there is an economic mineral deposit, perhaps 1 or 2 years after the initial physical discovery of economic grade mineralization, exploration ceases and development begins.

4. **Development**

In the development stage, the land position is adjusted and firmed up to cover the fraction of a square mile or few square miles actually containing the mineral deposit or required for mining-related facilities such as processing plants, waste disposal sites, roads, and powerlines. Enough of the deposit is blocked out to support the initial planned production capacity (usually the entire deposit is not blocked out until the very last years of production), production wells or mine workings are developed, and mining-related facilities are constructed in preparation for production.

Development costs and times vary widely, depending on the type of deposit and the planned production method. An onshore oilfield or gasfield can usually be developed for initial production in 1 to 3 years, at an average cost in 1973 of around $140,000 per development well,[27] or $7 million for a 50-well development effort. Typical coal mines, both strip and underground, can be developed in a few years at a cost, excluding land acquisition costs, of $25 million to $80 million. The typical surface mine will produce 2 to 4 times more coal per year than the typical underground mine.[28] One to four years were required for the development of each of 11 selected Arizona copper mines, including both open pit and underground mines, with underground mines generally taking longer to develop.[29] A typical large Arizona open pit copper mine would cost well over $100 million to develop.[30]

These development times and costs, however, assume normal progress on a mineral deposit that is currently economic in a region with fairly well-developed infrastructure (e.g., transportation and power network, public facilities, commercial organizations). The infrastructure issue will be considered in subsection 6 below. The economic issues will be discussed here.

Particularly for the metallic minerals, development may be delayed for many years, and a property may pass through various owners (including occasional abandonment) and various cycles of interest and renewed evaluation, owing to one or more of the following economic factors:

a. The deposit is of too low a grade to be economic, given current technology and prices;

b. The owners of the deposit have abundant reserves of higher grade or more profitable ore that can easily supply all the metal they can possibly sell;

“Estimates of the Economic Cost of Producing Crude Oil, Ser. No, 94-27 (92-1 17], Senate Comm. on In!. & Ins. Affairs, 94th Cong., 2d. sess. 250-251 IComm. Print 1976) (table 3, 1ine 10 plus line 11, divided by table 4, line 1 minus iine 6).

“U.S. Bureau of Mines, Busic Estimated Cap]ta] Investment und Operating Costs for Coal Strip ‘Mines. Inf. Circ. 8703 [1976); U.S. Bureau of Mines, Basic Estimuted Capitol Investment and Operating Costs for Underground Bituminous Coal Mines Developed for Longwa)l Mining, Inf.Circ.8715 (1976).

z9U, S. Bureau of Mines, Time Required in Developing Selected Arizona Copper Mines, Inf. Circ. 8702, table 1 (1 976].

‘0U.S, Bureau of Mines, Comparu!]ve Porphyry Copper Mining and Processing Costs—Alaska and Ar~zono, Inf. Circ. 8685 (1974].

c. The owners cannot raise the necessary capital, or cannot afford at the present time to take on the financial risk of bringing a new mine into production, or can finance only one deposit at a time to production;
d< Market outlets are not currently available; or
e. T'he owners prefer to await higher prices. "

Technically, there has not been a discovery of an economic mineral deposit if the first factor is the reason for nondevelopment: the subeconomic deposit is either "put on the shelf" for later development with improved prices or technology, or serves as part of the general geologic information base used to develop subsequent exploration.

Factors similar to those listed above are cited by Albers as affecting the discovery-to-production time for some of the 50 U.S. metal mines producing in mid-1976 that were developed from discoveries made between 1940 and 1975, inclusive. His data indicate that it took from less than a year to 23 years to proceed from initial discovery to initial production on the 50 mines, with an average interval of 7 years and a median of 6 years. All but two of the mines were developed in 14 years or less, the two exceptions taking 16 and 23 years, " Since part of the discovery-to-production interval includes much of stage 4 of exploration, Albers' data correlate fairly well with the 1 to 4 years for "normal progress" development cited above for an economic mineral deposit.

Although economic and technologic factors were the major causes of development delays in the past, and continue to be important factors in the present, regulatory delays due to social and environmental considerations are becoming increasingly important.

5. **Production**

Production generally lasts for 20 years or more, and the costs of production vary widely depending on the mineral deposit. Bureau of Mines studies estimate the annual production costs (excluding depreciation, royalties, rents, fees, and taxes) for typical coal strip mines to be $12 million to $18 million; for typical underground coal mines, $9 million to $17 million; and for a typical large Arizona open pit copper mine, $27 million.[33] Annual production costs for minerals such as oil and gas produced by well and transported from the field without processing are considerably lower, averaging less than $5,000 per producing oil or gas well in 1973[34] or around $250,000 for a 50-well production unit.

Production from metal mines tends to be more cyclic than production from nonmetal mines, and mines may be closed or abandoned and subsequently reopened with changes in technology or prices.[35]

"Factors (b) through (e) are taken from Cranstone and Martin, note 20, at 6. See also LT. S. General Accounting Office, Inocc urate ,%tlmates of W'estern Coal Reserve~ ShouJd Be Corrected. EMD-78.32, July 11, 1978, at 22-26.

"Albers, "Discovery Rates and Explanation Methods for Metallic Mineral Deposits in the [J. S., 1940-1976,"' 178 Eng **and** Mmmg] 71 (1977),

"See the sources cited in notes 28 and 30.

"Est~mates of the Economic Costs of Producing (jrude od, note 27, at 250-251 (table 3, line 16 divided b> table 4, Ilne 19)

'[l.S. Bureau of Mines, Time I?equlred m Develop]rtg SeJected Ar]zona Copper M]nes, Inf. Clrr. 8702 (1976).

6. Infrastructure Costs

The term "infrastructure" refers to a system that includes the transportation network, public facilities, housing, hospitals and other health facilities, utilities, and commercial organizations required to support the population and activities in a given geographic area.

The important role infrastructure plays in the success of a mineral project is discussed in this subsection. The impacts mineral activity can have on the existing infrastructure of an area are discussed in section B of chapter 6.

The importance of an adequate infrastructure for mineral activities cannot be overstated. For example, for many minerals the cost of transportation from mine to market equals or greatly exceeds the costs of finding and producing the mineral: prime examples are coal, construction minerals, and industrial minerals. High costs of transportation, or the complete lack of transportation (other than air access), can render even the highest grade metal deposit uneconomic.[36]

The importance of infrastructure can be dramatized best by reference to Alaska, although the same considerations apply to a lesser degree to the remoter areas of the lower 48 States.

Alaska has a very limited surface transportation and power network, primarily confined to the areas around and between Anchorage and Fairbanks and not extensive even in those areas.[37] The population is quite small, and there are no major manufacturing centers. All major items must be shipped in from Canada or the lower 48 States, and high wages and fringe benefits must be paid to attract labor.

This combination of elements raises the cost of almost every item or service in Alaska, and has rendered much of its timber and mineral resources uneconomic now and for the foreseeable future. '8 The total value of hardrock (metallic and industrial) minerals produced in Alaska in 1971 was less than $4 million,[39] although Alaska is believed to contain substantial hardrock mineral resources.

The impact of infrastructure-related costs on mineral activity in Alaska is graphically demonstrated by a Bureau of Mines analysis of the comparative costs of producing a hypothetical porphyry copper ore body in Alaska and Arizona.[40] The Alaska site chosen was an area 10 miles north of Lake Clark and approximately 145 air miles southwest of Anchorage in the Alaska Range just west of Cook Inlet. The Arizona site chosen was approximately 45 miles northwest of Tucson. Both sites were presumed to be within 10 miles of a highway: an existing highway in Arizona and a proposed highway corridor in Alaska.

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[36] U. S. Bureau of Mines, Estimated Costs to Produce Copper ut *Kennicott, Alaska*, Inf. Circ. 8602(1973); see *Comparative* Study *of Canadian-United* States Resource Programs, note 22, ch. A, at 26-27, 32-44, 58.

[37] U.S. Bureau of Land Management, Multimodal Transportation *and* Utility Corridor *Systems in Alaska:* A *Preliminary*, Conceptual *Analysis*, October 1974, at 27-33.

[38] Krutilla and Brubaker, "Alaska National Interest Land Withdrawals and Their opportunity Costs, ' m Background *Information for Alaska* Lands Designations, House Comm. on Int. & Ins. Affairs, 95th Cong., 1st sess. 158, 198-232 (Comm. Print No. 4, 1977).

[39] U.S. Bureau of Mines, *Minerals* Yearbook, 1972, *Volume II*, Areu Reports; Domestic 56, table 1 (1974) (antimony, barite, gold, mercury, platinum group metals, silver, tin, and uranium, all in relatively minor amounts),

[40] U.S. Bureau of Mines, Comparative Porphyry Copper Mining and Processing Costs —*Alaska* and *Arizona*, Inf. Circ. 8656 (1974).

The mineral price required to support a mine was calculated by the Bureau of Mines to be almost twice as high in Alaska as for the same size and grade ore body in Arizona. The Arizona mine would be an economic success; the Alaska mine would not. One of the major advantages of the Arizona operation was access to developed transportation and power systems. The Arizona operation required only construction of a spur railroad line and connecting gas service, while the Alaska operation required construction, equipping, maintenance, and operation of an electrical generator, gas pipeline, railroad line, barge dock, and air strip. There were also added costs in Alaska for a larger and more self-sufficient townsite, more substantial structures to protect personnel, machinery, and ore concentrate from the cold and to guard against damaging the permafrost, larger inventories of parts and supplies, a larger maintenance and support force, the overall higher cost of transportation for all materials and personnel, and the overall higher cost of labor.

Another Bureau of Mines study, comparing the cost of asbestos mining and processing at two equally remote sites 55 miles apart in Alaska and Canada, estimated that, for identical deposits, the Alaskan operation would cost about 30 percent more for development and 35 percent more for production, primarily because of higher Alaskan labor rates.” An asbestos deposit was actually being mined at the Canadian site, while an apparently “commercial” asbestos deposit at the Alaska site was not even being developed.

Perhaps the best known example of the problems and costs of developing infrastructure is the Prudhoe Bay Trans-Alaska Pipeline operation. The final cost of constructing the basic transportation system (the pipeline and pipeline road) was estimated in 1975 to be $7 billion to $10 billion, exclusive of the vast network of feeder pipelines leading into Pumping Station No. 1 at Prudhoe Bay. Another billion or so was estimated for workers’ housing, roads, docks, airport facilities, communications and utilities. and other forms of infrastructure.

E. Mineral Exploration, Development and Production: Chances of Success

Mineral activity is a very risky business, particularly in the exploration stages. For every successful project resulting in discovery of an economic mineral deposit, there are many unsuccessful projects. Therefore, the actual cost of discovery of an economic mineral deposit is not merely the cost of the successful project, but also includes the cost of all the related unsuccessful ones. The few successes must be profitable enough to cover the many failures.

However, calculation and interpretation of rates of success, and of cost per success (including the cost of failures), for mineral explorat on projects are complicated by several factors.

[9] U.S. Bureau of Mines, *Comparative Asbestos Mining and Processing Costs, Alaska Versus Yukon Territory*, Inf. Circ. 8672 (1975).

First, the division of projects into successes and failures, where success is defined as discovery of an economic (currently commercially developable) mineral deposit, is artificial and somewhat misleading. Many exploration projects result in the discovery of mineral deposits that, although not currently commercial because of low ore grade or lack of infrastructure, may be commercially developable in 10 to 50 years as a result of advances in technology, development of infrastructure, or simply higher prices for the minerals. Such discoveries, which are sometimes referred to as "technical successess"[42] or "on-the-shelf" deposits, are clearly not total failures, Furthermore, even when no significant concentration of mineralization is discovered, the information developed on the surface and subsurface geology and on trace mineralization is almost always valuable to future exploration activity. In fact, mines have been "discovered" in company files that contain such information formerly not thought to be worth following up, but subsequently found to be extremely significant in light of new technology or new theories of ore formation.'[)]

The value of such "unsuccessful" mineral exploration in Canada has been discussed by Cranstone and Martin as follows:

> Annual dollar exploration expenditures for metals in constant (1971) dollars have increased from about $12 million in the 1946-50 period to $87 million in 1971; it is therefore likely that a substantially greater amount of potentially useful information as well as currently uneconomic mineral deposits have been added to inventory than withdrawn from it in the form of previously discovered on the shelf deposits during the past 26 years.
>
> Consider the case of porphyry copper and porphyry molybdenum deposits in B.C. Ore tonnage discovered in these deposits during the period 1961-71 has a 'value' of $25.6 billion. However, available information suggests that additional submarginal ore in the 14 porphyry deposits counted herein as discoveries, plus submarginal tonnage in another 30 porphyry deposits, amounts to more than 5 billion tons, with metal 'value' of more than $17 billion almost equalling the $21 billion 'value' of total Canadian metal production during these 11 years, Most of these currently uneconomic deposits, as well as others discovered during the 1946-71 period, will likely be profitably mined in the future, constituting an additional but unknown present 'value' of discoveries, "

They conclude that "The true discovery cost of orebodies found in the past 10 years is less than the apparent cost because of the vast tonnages of presently marginal and subeconomic mineral deposits also found in this period."[45]

Second, the published success/failure data often include mere listings, submittals, and cursory examinations of prospects, which involve minimal time and expense, together with the more intensive and expensive detailed suface and three-dimensional (e.g., drilling) investigation of particular targets. Consequently, it is difficult to sort out the really serious efforts in order to calculate success/failure ratios. For example, a 1967 compilation of success/failure data for various nonfuel mineral exploration programs,[46] when broken down into the exploration stages (as has been done in table z. 7)

[42]Miller, note I 7, at 840

[43]Lowell, "EXpll)ril tion Strategy,' in *Report on the Workshop: Research Fron tiers in Explora tion for Non-Renewable Resources,* note 21, at 52-64.

[44]Cranstone and Martin, note 20, at 11-12.

[45]Ibid., at 13.

[46]Bailly, "hllnera] Explora tion and Mine Developing Problems," note 25. at 10-1.1.

Table 2.7.—Success Data for Selected Nonfuel Mineral Exploration Programs

Exploration stages	Exploration program									
	Government/private			Private						
	Strategic Minerals 1939-49	AEC Uranium 1948-65	Defense Minerals 1951-58	Total Canada (Annual)	Phelps Dodge 1962	Phelps Dodge 1966	Int'1 Nickel pre 1958	Texas Gulf 1959-61	5 SW Firms 7	Bear Creek 1963-66
TARGET IDENTIFICATION										
1. Regional appraisal and 2. Reconnaissance (Possible targets submitted or identified):	7	7	3888	7	7	3137	?	Several 1000	?	1649
(Possible targets examined):	10071	15000	?	60007	73	1077	?	Several 100	352	7
TARGET INVESTIGATION										
3 Detailed surface investi-gation:	1342	7	?	7	7	1077	100 +	?	47 +	7
4. Detailed 3-D physical sampling:	7	7	?	7	"few"	16	7	66 +	23	60
DISCOVERY (Mineralization):	?	7	7	?	?	"Few Still being worked on"	7	7	?	15
(Some tonnage):	1053	4317	7	7	7		7	7	?	8
(Mine tonnage):	7	6437	374	7	7		1	?	2	5
(Commercial ore deposit):	7	7	45+	5	0		7	1	7	1?
(Outstanding ore deposit):	1	7	Term Zinc	7	0		?	1	?	7

SOURCE Derived from data in Bailly, "Mineral Exploration and Mine Developing Problems" 10-12 (1967)

in order to sort out the serious efforts involving detailed target investigation (stages 3 and 4, or preferably stage 4 only, in which drilling is undertaken), has so many holes in the data that it is impossible to calculate any overall success rate. (The data suggest that certain programs resulted in the discovery of 1 to 10 deposits with sufficient tonnage for a mine, but with varying prospects for economic success, for each 100 targets investigated in stages 3 and 4).

Third, the published success/failure data are usually calculated for targets or for individual applications of technology (e. g., drilling) to a target, rather than for mineral exploration projects, which may include a number of more or less intensively investigated targets as part of a coordinated regional exploration effort. For example, the Texas Gulf exploration program listed in table 2.7 was actually a single project staffed by a single geologist, who coordinated a series of airborne electromagnetic surveys and drilling of various targets based on a new theory of ore formation for the region. The Kidd Creek copper-zinc-silver discovery that resulted from the project is an outstanding deposit, which made the project an unqualified success. This was recognized from the beginning as the most promising target, although it was not drilled until late in the project because of delays in acquiring mineral rights."'

[4] Miller, note 17, at 843

The published data for oil and gas exploration similarly focus on parts of projects rather than on the projects themselves. In fact, the oil and gas data do not even focus on the targets that make up a project, but rather focus on the number of wells drilled. Several wells are often drilled for each oil and gas target before a discovery (if any) is made, Thus, success rates reported for oil and gas exploration, which are rates per well drilled rather than per target drilled or per project, may understate the success rate when considered in terms of targets or projects.

The published success rates per well drilled in 1975 indicate that one out of seven onshore and offshore new-field ''wildcat" wells—exploration wells drilled in areas not already proved to contain commercially producible oil or gas—resulted in discovery of economic oilfields or gasfields. One out of 55 onshore and offshore new-field wildcat wells drilled in 1975 resulted in significant discoveries—i.e., discoveries estimated to have found fields with reserves of more than 1 million barrels of oil or 6 billion cubic feet of gas each, Almost one out of four of all onshore and offshore exploratory wells—including new-field wildcats, extensions or outposts, new-pool wildcats, deeper-pool tests, and shallower-pool tests—were completed successfully as producers.[48]

Fourth, the published data on rates and costs of successful exploration, when available at all, are almost always for the mineral industry as a whole. Thus, the complete failure records of many marginal firms, often formed to take advantage of tax shelters, are included with and dilute the success records of the more established and professional firms. Obviously, it is the success rate of the individual firm, and not the industry as a whole, that is crucial in terms of that firm's ability to stay in business, Similarly, the cost of a discovery should be based on the total expenditures and success/failure ratio of the individual firm, rather than the industry-wide total expenditure and success/failure figures, which include many very unsuccessful firms.

When mineral exploration expenditures are available for an individual company, they are usually found in the company's annual reports, and include overhead, land acquisition and holding costs as well as direct expenditures for actual exploration activity. They also generally cover exploration activities worldwide, rather than only in the United States (the latter is the relevant figure for discussions of domestic mineral exploration activities), Finally, the expenditures are rarely tied to annual projects or targets investigated, so that it is impossible to get a measure of exploration efficiency.

OTA sought to make up for the lack of data on success rates and expenditure levels for individual firms' onshore U.S. exploration activities by surveying a small sample of firms in 1977 to find out what minerals they were exploring for, and how much effort (staff, money, projects, etc.) was being expended on such exploration with what results. The surveyed firms included some of the better known hardrock exploration firms active in the United States, All were exploring for most of the metals, including uranium, and to a lesser extent the fertilizer minerals. Some were exploring for the chemical and/or industrial minerals. A few were exploring for geothermal resources and/or construction minerals, The survey also included two of the larger U.S. oil companies (both of which were exploring for uranium, and one of which was exploring for the fertilizer and chemical minerals and, to a lesser extent, the metals),

"1'' 'U S. Wildcat-Success Rate Highest Ever, " *Oil and Gas J.*, June 7, 1976, at 60, The survey confirmed that oil and gas exploration is almost always handled by distinct companies, or divisions within companies, which explore for oil and gas only. Coal and oil shale are also handled separately, and "exploration"' for them is mainly an engineering effort to secure information on the size and quality of deposits already known to exist. Exploration for all other minerals is generally lumped together in a single group (company or division).

The results of the survey are tabulated in table 2.8, which divides the companies into groups according to their annual (1976 or 1977) onshore U.S. exploration budget for the specified minerals. For each group, the table lists:

1. the range in exploration budget, excluding land costs, for the firms in the group,
2. the number of firms in the group,
3. the range in size of the domestic onshore exploration staff, divided into professional and support staff,
4. the range in number of possible target areas or prospects seriously considered (i.e., at least some field examination) for detailed exploration during the year,
5. the range in number of target areas for which a land position had been established or maintained during the year,
6. the range in number of projects actively underway in stages 3 and/or 4 (detailed surface investigation or three-dimensional physical sampling) during the yea r,
7. the range in cumulative number of such active projects (counting each multiyear project only once) over a lo-year period, based on the cumulative number reported for the last X years (X being defined by various companies as anywhere from 3 to 25 years),
8. the range in cumulative number of immediate successes (development begun or projected in the near term) over the same lo-year period,
9. the range in cumulative number of technical successes (development begun or projected within the next 25 years—i.e., a property being held with that expectation, whether or not it is immediately developable),
10. the range in immediate success rate (cumulative immediate successes divided by cumulative active projects), and
11. the range in technical success rate.

For the companies surveyed, 0.6 to 8.6 out of every 100 onshore U.S. detailed exploration projects for minerals other than oil, gas, coal, or oil shale were immediately successful, i.e., led to actual or imminent development and production, while 5 to 12.8 out of every 100 onshore U.S. exploration projects for oil and gas were immediately successful. The oil and gas success rates are not improved by including "on the shelf" technical successes, whereas the nonfuel mineral success rates climb to 2 to 16 out of 100 when technical successes are included. This difference is probably explained by the current high prices for oil and gas that are making completion of smaller oil and gas wells profitable'" and thus keeping such wells "off the shelf. "

When the immediate and technical success rates for oil and gas are compared with those for the nonfuel minerals, it appears that the chances of complete failure are approximately the same for both. If this is indeed true, it may reflect the fact that ex-

"*Oil (111(1 Gas/* June 20, 1977, a I 34

Table 2.8.–Selected Individual Firm Exploration Statistics (Ranges) for Onshore United States

			Minerals other than oil, gas, coal, oil shale			Oil & gas
1976 (1977) onshore United States exploration budget, excluding land cost		Low Average High	\$1.5 Million \$3.4 Million \$5 Million	\$6.5 Million \$8.4 Million \$10 Million	\$14 Million \$18 Million \$22 Million	\$30 Million
Number of firms within specified budget range			5	3	4	2
1976 domestic onshore exploration staff	Professional	Low Average High	15 26 55	11 35	50 64 75	— 110 —
	support	Low Average High	8 15 31	5 16 24	50 65 90	— 95 —
1976 possible target areas seriously considered		Low Average High	50 105 200	43 70 160	20 125 150	50 — 100
1976 targets for which land position existed		Low Average High	12 20 40	25 37 45	10 40 80	25 25
1976 active projects (Stage 3 and/or stage 4)		Low Average High	6 10 12	23 28 35	 25 40	25 — 25
Cumulative active projects for 1 O-year period		Low Average High	51 98 150	116 168 245	60 185 400	200 — 250
Cumulative immediate successes for 10-year period		Low Average High	0.5 2.6 6	7 10 13	4 7 12	10 — 32
Cumulative immediate and technical successes for 10-year period		Low Average High	1.9 7 15	9.1 13.8 22.5	8 11.5 18	10 — 32
Immediate success rate (successes divided by active projects)		Low Average High	0.6% 2.6% 5.1%	5.0% 6.2% 8.6%	2.0% 5.5% 8.3%	5.0% — 12.8%
Technical (includes immediate) success rate		Low Average High	2.5% 6.7% 1 0.0%	6.3% 8.0% 9.2%	2.0% 9.7% 16.7%	5.0% — 12.8%

ploration for oil and gas today, at least onshore, involves a search for increasingly smaller fields,[50] with increasingly complex geology, at greater depths.[51] The chance of missing a discovery by siting a drill a few hundred feet off target may be as large today for oil and gas as it is for the nonfuel minerals. ’2

No matter how the data in table 2.8 are interpreted, it is clear that, for each company surveyed, 80 percent or more of the exploration projects for both oil and gas and the nonfuel minerals were failures. These were projects that involved some detailed

[50] Ibid., at 32, 33, 34.

[51] U.S. Department of the Interior, 1 *Final Report of the Task Force on the Availability of Federally Owned Mineral Lands* 54 (1977).

[52] See ibid., at 55.

exploration in stages 3 and/or 4, and thus required substantial effort in terms of time and money.

The cost and duration of an unsuccessful project would normally be less than those of a comparable successful project, with the amount of reduction depending on how early in the exploration sequence the project is abandoned (see appendix C for the costs and durations of successful projects). Bailly estimated in 1964 that the total cost of all failures in hardrock exploration was perhaps 5 to 10 times as high as the total cost of all successes.[53] Given such a cost ratio, an exploration company should expect to spend 80 to 90 percent of its budget on failures.

Actually, the laws of probability require that an exploration firm be able to suffer through a string of failures that is often much longer than would be indicated by the average success/failure ratio. The governing concept, known as the ‘‘law of gambler’s ruin, ” has been aptly described by Slichter:

> This rule expresses the rather serious chance of going broke when the odds for success are small, merely by a normal run of bad luck regardless of the long-run expectations of gain. The only sure way of avoiding this special risk of gambler's ruin is to have enough capital, and the will, to continue the play many times and thus ride out the inevitable runs of bad luck. For example, i f the probability of success is one in ten for each venture, there is a 35 percent chance that ten successive ventures will fail in a row. But if one has the capital to continue the play through a run of 100 failures, then the chance of gambler’s ruin is only 3 in 100,000. ”

The high cost of modern mineral activity, discussed in section C, and the low probability of success and its associated law of gambler’s ruin discussed in this section, carry obvious adverse implications for the smaller participants in mineral activities in the United States today.” Those implications will be addressed in the next section.

F. Mineral Exploration, Development, and Production: Participants

Mineral exploration, development, and production on Federal onshore land is conducted primarily by the private sector, although State and Federal geologic and mineral agencies are involved to a substantial degree in the first two stages of exploration and occasionally in later stages.

The backbone of the mineral industry during the 19th century was the mass of individual prospectors and small miners who found and worked the surface deposits. Major deposits were usually syndicated or turned over to larger firms for development and production. Even well into the 20th century, individuals using conventional prospecting techniques (see subsection C(3)) continued to discover a large proportion of the economic mineral deposits, although development and production (which involved

[53] Bailly, "Methods, Costs, Land Requirements and Organization in Regional Exploration for Base Metals," paper presented at AIME Meeting, Alaska Section, Fairbanks, Alaska, Mar. 18-21, 1964, at 18.

[54] Slichter, "The Need of a New Philosophy of Prospecting," 12 *Mining Engineering* 570 (1960).

[55] Bateman, "Exploration Program for Small Mining Companies," *Mining Congress J.*, December 1963, at 45; Going, "An Industry Analysis of Exploration Activity," in *Canadian Mineral Exploration, Resources and Outlook*, note 20, at 13.

greater costs and more complex technology) became more and more the province of the larger firms.[56] A number of the major mines still in production today were developed from discoveries by individuals or small groups prior to or during the first half of this century,[57]

Data on current exploration and mining activities, however, indicate that the roles of the individual prospector and small miner have declined sharply in recent years as a result of advancing technology, greatly increased costs, and the low grade or hidden character of most of the remaining undiscovered deposits in the onshore United States,

In order to put these data into perspective, it is necessary to have clear and reasonable definitions of terms such as "individual prospector, " "small miner, " "small firm, " and so forth. The definitions chosen for this study are:

- Individual Prospector (or Explorationist): no more than two people working together spending less than $10,000 per year on mineral exploration;
- Small Firm: no more than 50 people working together spending less than $250,000 per year;
- Medium-Sized Firm: expenditures of less than $2,500,000 per year; and
- Large Firm: expenditures of $2,500,000 or more per year.

These definitions although arbitrary appear to be reasonable, Allowing for increased costs of exploration at a serious level, but retaining the emphasis on what can be done through individual effort and finances, a limit on expenditures of $10,000 per year seems generous for the ''individual prospector.

The American Mining Congress (AMC) surveyed 41 large mining companies in 1976 to obtain data on the role of the "small miner" in mineral exploration in the United States. However, the AMC statistics, reproduced in table 2.9, are ambiguous, because the AMC definition of "small miner" would include exploration groups as large as those of some of the largest exploration firms (or exploration divisions of major firms).

The AMC defined a small miner as "an individual, partnership, or corporation which is not listed on a major stock exchange; or which has a capitalization of less than $1,000,000; or which employs fewer than 50 persons; or which produces less than [50 to 200 thousand tons annually]."[58] But 1) an exploration firm need not be, and usually is not, engaged in production, 2) the only major capital asset of an exploration firm is its land holdings, and even the land is normally not capitalized until the development stage, and 3) even the large exploration firms, including the exploration divisions of most of the 41 mining firms surveyed by the AMC, have fewer than 50 professional employees devoted to onshore mineral exploration in the United States (see table 2.8).

[56] Lacy, " Technical Developments That Should Be Considered In Drafting Mining Legislation," in University of Arizona, College of Mines, *Symposium on American Mineral Law Relating to Public Land Use* 159, 161-163 (J C. Dotson ed. 1966).

[57] Delcour and Rees, " The Role of the Small Miner," paper presented at the 1977 American Mining Congress Convention, Sept 13, 1977, at 6 (hereinafter cited as "AMC Small Miner Survey"), citing U. S. Bureau of Mines, "Major Mines Found by Small Miners," unpublished report, 1976, See also Albers, note 32

[58] AMC Small Miner Survey" note 57, at z.

Table 2.9.—AMC Survey of Small Miner Property Submittals

‘tear	Total no. of submittals A	Submitted by individuals and small companies B		Individual and small company figures only: Rejected c	Examined D		Deal made E	Drilled F	Dropped G	Still under consider-at ion H	Brought into prod uction or planned I	Other d ispo-sit ion J
			% of A			% of B						
1970	2,452	2,191	89%	1,482	917	42°0	116	102	222	35	16	72
1971	2,266	1,918	85%	1,353	818	42°0	86	83	211	47	13	44
1972	2,374	1,970	83%	1,347	862	44°0	93	78	214	41	12	65
1973	2,550	2,060	81%	1,356	954	46°0	106	88	244	67	12	41
1974	2,777	2,381	86%	1,629	1,028	43%	112	92	315	95	12	54
1975	2,992	2,621	88%	1,808	1,139	43%	115	93	301	154	18	70

SOURCE Delcour and Rees, ‘The Role of the Small Miner, ” paper presented at the 1977 American Mining Congress Convent Ion, Sept 13, 1977

Thus, although the AMC definition of “small miner’” seems appropriate for firms engaged in mining (mineral production), and in fact is very similar to the OTA “small firm*’ category as applied to production activities, it is not helpful in attempting to sort out the role of various-sized individuals and groups in mineral exploration, which was the primary focus of the AMC survey.

Moreover, the meaning of the AMC statistics themselves is unclear, even assuming that the statistics primarily represent submittals by individual prospectors and small firms as defined by OTA. The terms “submittal,’” “rejected, ” “examined, ” “dropped,” and so forth were not defined, The table reproduced in table 2.9 (without statistics) was the questionnaire. Discussions with the authors of the survey indicate that the primary conclusion to be drawn from the statistics is that large firms do pay attention to “small miner”’ submittals, since 42 to 46 percent of such submittals were examined. “Examination,” however, could range from a quick check of the literature or files on the area in question (the more usual procedure) to a field trip to inspect the property, More importantly, the authors indicated there was no way of knowing whether the “submittals” were completely spontaneous offerings of mineralized property, which themselves sparked the interest of the larger firms, or rather represented reactions by holders of mining claims to expressed or known interest in an area by a larger firm based on the larger firm own geologic appraisal and targeting.

The number of ‘*submittal” properties listed by the AMC survey as having been “brought into production or planned” each year comes close to (and may even exceed) the total number of discoveries that probably were made in each year (compare table 2.3 in subsection C(3)). It is hardly likely that all U.S. discoveries resulted primarily from “small miner” submittals. In fact, the data compiled by Albers and Bailly and presented in tables 2.2 and 2.3 in subsection C(3) indicate that no significant U.S. metal mine discoveries reported since 1960 have been primarily the result of conventional prospecting, which is the stock-in-trade of the individual prospector (although the more modern individual explorationist will also use geologic inference and geochemical techniques on a limited scale). This apparent contradiction may be resolved simply by the fact that almost all mineralized or potentially mineral ground in the United States is blanketed by mining claims, so that firms wishing to explore in an area must make arrangements with the owners of those claims. If all such arrangements were counted as "submittals," almost all discoveries would be on "submittal" properties.

This was precisely the case with the Mt. Taylor uranium discovery, which is the only example cited in the AMC survey of a discovery by a small miner. The AMC survey attributes the discovery to an individual prospector, Robert H. Sayre, Jr., who "staked claims on National Forest land in New Mexico, managing to interest a small uranium firm, the Bokum Corporation, in drilling. " But information provided to OTA by Sayre and an officer of the Bokum Corporation is different. Sayre did stake claims on the land, first in 1957 and later in 1969. The "targeting" involved in selecting the land consisted simply of drawing a straight "trend" line between two known deposits and searching county land records for unclaimed land along that line, No exploration, development, or assessment work was done beyond the effort expended in staking the claims. The Bokum Corporation was interested in the area and learned that Sayre had claims on the land, so it worked out a deal with Sayre to enable it to drill the land. The first drill hole, in 1970, intersected uranium ore. At the time, the Bokum Corporation was either a large medium-sized firm or a small large firm, using the OTA definitions of firm size.

Other sources of data on the role of various groups in current onshore mineral exploration invariably cite the drastically reduced role of the individual prospector. For example, Simon Strauss, Vice Chairman of ASARCO and one of the leading officials in the AMC, recently observed:

> Those who like to remember the good old days will hark back to the period a hundred years or so ago when the great, wide, open spaces of the West were being explored and populated by the white man, when the rich bonanza discoveries of California, Arizona, Montana, Idaho, Colorado and Nevada brought overnight wealth to the skilled or lucky prospector. Mines were opened from the grassroots then and the number of individual operations was very large. Why can't it be like that now?
>
> For the obvious reason that the surface of this country—and most others for that matter—has been scoured by professionals. The chances of finding a rich surface outcrop are minimal. This is not to say that new finds are not being made—on the contrary , . . . But these discoveries are of deposits that for the most part are hidden from the naked eye. They have been made as a result of tenacious geological deductions— and at great expense. The lone prospector with burro and pick ax is unlikely to spot them, although the rare exception does occur. Today, exploration is a team effort using the tools of modern man—costly tools.'"

Strauss' statement is confirmed by the data presented in subsection B(3), which demonstrate that conventional prospecting for surface outcrops and other surface "expressions' of economic mineralization now plays a very small and declining role in U.S. mineral exploration, at least outside Alaska. (Conventional prospecting may con-

Strauss, "Competition in the Nonferrous Metal Markets, *Mining Congress. J.*, June 1977, at 49; accord, U.S. Geological Survey, *Mineral Resource Perspectives 1975*, Prof. Paper 940, at 7 (1975); Bailly, "Mineral Exploration Trends and Prospects," paper presented at the Semicentennial Seminar on Exploration Geophysics, Colorado School of Mines, Nov. 18, 1976, at 5, 8, 21-22, 24; *Anatomy of a Mine*, note 16, at 21, 23.

tinue for a while to be important in Alaska, because of its less thoroughly explored state. On the other hand, the remoteness of much of Alaska and the high cost of doing anything there may independently lead to a reduced role for the individual prospector, as the less remote areas become more thoroughly explored.’)”)

Canada generally falls somewhere between the lower 48 States and Alaska in terms of the thoroughness with which it has been explored for surface expressions of economic mineral deposits. Yet, even in Canada the role of conventional prospecting has diminished radically in recent years, as shown by Derry’s data, which are presented in table 2.4 in subsection C(3).

Paul Bailly has combined exploration budget data with Derry’s data on Canadian discoveries to show the role played in such discoveries by various-sized exploration groups. Bailly’s results are shown in table 2.10. They indicate that none of the commercial metallic mineral discoveries reported by Derry for 1958 through 1973 were made by individual prospectors or small firms [using the OTA expenditure-based definitions), even though individual prospectors and small firms accounted for 50 percent of the firms actively exploring from 1968 through 1973.

At OTA’S request, six of the larger U.S. mining and mineral exploration firms and one major oil and gas company estimated industry-wide ranges for costs, acreages, and times involved in exploration for and development and production of 32 different mineral occurrence types (which include almost all the nonconstruction mineral occurrence types for which exploration is currently being undertaken). The completed forms, which are collected in appendix C, include estimates of the percentage of total domestic onshore activity undertaken today by individual prospectors, small firms, medium-sized firms, and large firms in each of the six stages of mineral activity for

Table 2.10.—Commercial Metallic Mineral Discoveries in Canada According to Canadian Exploration Budget of Discoverer During Discovery Year

Canadian exploration budget of firm (1971 dollars), including land costs	Percentage of firms with given budget out of al I firms act ively exploring in 1968-73	Discoveries during 1958-67		Discoveries during 1968-73	
		Number	0,0	Number	%
5 to 10 million	10%	1	4%	2	10%
2.5 to **5** million		3	11%	1	5%
1 to **2,5** million		**8**	30%	7	35%
0.5 to 1 million	10%	10	37%	8	40%
0,25 to 0.5 million	30%	5	18%	2	10%
0.0 to **0.25** million	50%	0	0%	0	0%
Total	100?40	**27**	10070	20	100°/'0

SOURCE Bailly, “ Mineral Exploration Trends and Prospect s.” paper presented at the Semi centennial Seminar on Exploration Geophysics, Colorado School of Mines, Nov. 18, 1976, figure 4.

[10]See the data in Hawley and Whitney, note 22, at 3-12 to 3-14

each mineral occurrence type. These estimates are compiled in table 2.11. The estimates indicate that individual prospectors play a minimal active role in the first three stages of exploration for all but a few mineral occurrence types (placers, marine evaporates, carbonate stratiform, and certain vein deposits), and almost no role in the more expensive stages of detailed physical exploration, development, and production. Small firms are more active in the first three stages, but their role drops substantially during the last three stages.

Table 2.1 1.—Estimated Percentage of Total Domestic Onshore Activity Undertaken by Various-Sized Groups in Each of the Six Stages of Mineral Activity

Mineral occurrence type	Indiv. prospector						Small firm						Medium firm						Large firm					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
SURFICIAL																								
1. Aluminous Clay & Laterite	5	5	5	1	1	1	5	10	5	4	2	2	15	25	5	20	5	5	75	60	85	75	92	92
2. Laterites: Nickel	0	0	0	0	0	—	0	0	0	0	0	—	0	0	0	0	0	—	X	X	X	X	X	—
3. Stream Placer: Gold, Tin	X	—	X	0	0	—	X	—	X	X	X	—	X	—	X	X	X	—	0	—	0	0	0	—
4. Coastal Placer: Titanium	0	10	20	0	0	0	33	30	20	0	0	0	33	30	30	50	50	50	34	30	30	50	50	50
5. Residual Deposit: Phosphate	0	0	0	0	—	—	10	10	10	0	—	—	30	30	30	35	—	—	60	60	60	65	—	—
6. Brines in Evaporites	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Supergene: Base & Precious	9	2	0	0	0	0	9	8	8	0	0	0	32	25	30	12	5	5	50	65	62	88	95	95
8. Supergene: Silver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X
STRATABOUND—EXTENSIVE																								
1. Precambrian: Gold, Uranium	3	1	0	0	—	—	20	20	20	10	—	—	35	35	35	40	—	—	42	44	45	50	—	—
2. Marine Sedim.: Phosphate	0	0	0	0	—	—	10	10	5	0	—	—	40	40	10	40	—	—	50	50	85	60	—	—
3. Marine Evaporite: Potash	15	15	15	2	0	—	25	25	20	10	2	—	30	30	35	38	38	—	30	30	35	50	60	—
4. Continental Sed.: Coal	12	20	0	0	0	—	20	23	10	10	10	—	33	28	45	45	45	—	35	29	45	45	45	—
5. Stratiform Igneous: Metals	0	0	0	0	—	—	0	0	0	0	—	—	0	0	0	0	—	—	X	X	X	X	—	—
STRATABOUND—DISCRETE																								
1. Marine Sedim.: Oil & Gas	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Continental Sed.: Uranium	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	0	0	0	0	0	0
3. Lacustrine Evaporites	0	0	0	0	—	—	10	10	5	0	—	—	30	30	30	30	—	—	60	60	65	70	—	—
4. Fossil Laterite & Clay	2	5	5	1	1	1	3	10	5	4	2	2	15	25	15	20	5	5	80	60	75	75	92	92
5. Shale Mass. Sulfide: Cu	0	0	0	0	0	0	10	10	10	5	0	0	30	30	30	20	20	20	60	60	60	75	80	80
6. Shale Mass. Sulfide: Pb-Zn	0	0	0	0	0	—	0	0	0	0	0	—	0	X	X	X	0	—	X	X	X	X	X	—
7. Carbonate Stratiform: Ba-F	8	8	9	4	2	—	17	17	25	20	22	—	28	31	33	37	38	—	47	44	33	39	38	—
8. Carbonate Strat.: Pb-Zn-Cu	6	7	4	0	0	0	14	14	14	13	14	10	30	25	40	42	43	45	50	55	42	45	43	45
9. Volc. Mass. Sulfide: Metals	0	0	0	0	0	—	30	30	30	10	0	—	30	30	30	35	30	—	40	40	40	55	70	—
10. Metamorphic: Graphite, etc.	0	0	0	0	0	—	50	50	50	50	30	—	40	40	40	40	50	—	10	10	10	10	20	—
DISCORDANT																								
1. Breccia Pipes: Metals	0	0	X	—	—	—	X	X	X	—	—	—	X	X	X	—	—	—	X	X	X	—	—	—
2. Porphyries: Copper, Moly.	0	0	0	0	—	—	0	0	0	0	—	—	0	0	0	0	—	—	X	X	X	X	—	—
3. Replacement Deposit: Sulfur	0	0	0	0	0	—	10	10	0	0	0	—	30	30	40	40	30	—	60	60	60	60	70	—
4. Vein-Replacement: Silver-Cu	25	25	26	0	0	—	25	25	28	10	10	—	25	25	23	45	45	—	25	25	23	45	45	—
5. Mass. Sulfide Pipes: Metals	5	4	1	1	—	—	10	16	10	10	—	—	30	30	25	30	—	—	55	50	64	59	—	—
6. Mafic-Ultramafic: Ni-Cu	0	0	0	0	0	—	20	20	20	10	0	—	40	40	40	40	30	—	40	40	40	50	70	—
7. Anorthosite: Iron, Vanadium	0	0	0	0	0	—	20	20	10	0	0	—	30	30	30	25	10	—	50	50	60	75	90	—
8. Vein Ultramafic: Asbestos	0	0	0	0	0	—	5	4	5	0	0	—	10	9	10	10	10	—	85	87	85	90	90	—
9. Vein Meta. Dolomite: Talc	40	45	20	5	0	0	40	40	50	45	40	40	20	15	30	50	60	60	0	0	0	0	0	0
10. Carbonatite-Alkalic	0	0	0	0	0	—	20	10	10	5	0	—	40	45	45	40	50	—	40	45	45	55	50	—

X = participates, but no attempt to quantify percentage.
— = no data given in response to questionnaire,

The estimates in table 2.11 are for participation; they do not reflect the success of the various-sized groups. The other statistics cited in this section, as well as discussions with industry exploration executives, indicate that, with rare exceptions, individual prospectors and even small firms do not make actual discoveries of significant commercial mineral deposits. Nor, less clearly but still apparently true, do they often identify or delineate the targets that the larger firms then investigate for an economic deposit. Rather, it seems that the two smaller groups establish land-tenure positions on any land that is even faintly mineralized and probe the surface more or less diligently within the limits of their funding and expertise, trying to develop information that will interest the medium-sized or large firms. They serve essentially as a chamber of commerce for their piece of land and its bit of geologic and mineral information, making sure that the information is fully fed into the models and files of the larger firms, along with all the other information compiled by the larger firms from published sources and their own regional reconnaissance.’)’

The larger firms form the models and identify the targets, which may include a property submitted by, perhaps even as a result of information supplied by, an individual prospector or small firm, who may nevertheless be completely unaware of the particular mineral or information that made the property a target.

This would appear to be the primary role of individual prospectors and small firms—a role quite similar to that of the U.S. Geological Survey in its geologic mapping and survey programs, although more specific and proprietary as a result of the tie to particular tracts: namely, the development and dissemination of basic geologic and mineral information to serve as a base for the more extensive and sophisticated exploration efforts of the larger firms,[62]

Occasionally, as with the Geological Survey,[63] this basic information activity will result in identification of targets, development of models, or even actual physical discovery by an individual prospector or small mining firm, more often by those with training in modern geology and the less expensive applications of the modern techniques .“[64]

The more successful individuals and small firms in the mineral exploration business today no longer fit the image of the penniless and self-reliant prospector. They have evolved into a role similar to that of the “independents” in the oil and gas business, described below, They provide technical and consultant services to the larger exploration firms, do work on contract or “farm out” from the larger firms, or occasionally initiate their own projects with financing from the larger firms or from local investors (who are often motivated by tax writeoff possibilities as well as the prospect of success). These independent explorationists usually concentrate, for their own projects, on the smaller targets which, because of structure, overhead, raw materials requirements, and so forth, would not be of interest to the large-r firms.’)’ Their activity,

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[61] Payne, *Nevada Mineral Exploration and Mine Development 1950-1972*, at 12-16 (1976) (unpublished report prepared for the U.S. President's Council on Environmental Quality).

[62] See "AMC Small Miner Survey," note 57, at 4, 5-6; cf. Albers, note 32, at 71.

[63] See, e.g., Miller, note 17, at 843 (North Carolina phosphate); *Mining Congress J.*, May 1977, at 13 (Utah uranium); Payne, note 61, at 36 (Nevada barite).

[64] *Anatomy of a Mine*, note 16, at 22-23; Payne, note 61, at 12-18; Bateman, note 55, at 46-47; "AMC Small Miner Survey," note 57, at 6-7.

[65] Bailly, note 59, at 8; *Anatomy of a Mine*, note 16, at 23; Payne, note 61, at 18.

however, is constrained by the extent of outside financing they can obtain during any given period,[66]

The sharp decline of the professional (full-time) individual prospector has been accompanied by a mushrooming of recreational or weekend prospectors who contribute very little to mineral discoveries but, as described in recent reports, may be a boon to the local economy at the expense of the surface environment:

> In recent years, as full-time professional prospectors have almost disappeared from the scene, amateur prospectors have become far more numerous. To many outside of the mining business it is difficult to distinguish between the two.
>
> The publicity, sometimes highly distorted, given to rushes such as the uranium boom of the 1950's, the convenience of modern off-road vehicles, and the increasing amount of leisure time available to so many, have combined to produce tens of thousands of amateur prospectors. Some of these individuals make great efforts to equip and train themselves, and they are capable of finding prospects worthy of exploration and development. However, the majority of the amateurs are poorly motivated and so lacking in the most rudimentary knowledge that they create difficulties for those seriously engaged in prospecting and exploration.
>
> The amateur's common lack of consideration for the rights of land owners, his abuse of laws and regulations, and his ill-conceived bulldozing of the surface have become so offensive that there is mounting pressure for drastic restrictions on all prospecting and exploration activities,'>'
>
> The amateur prospector does not, of course, depend upon mining as his means of livelihood, He makes a significant contribution to the local economy in his purchase of off-road vehicles, maps, supplies, and inexpensive metal detection devices of various sorts, No important mineral discovery has been made in Nevada by an amateur prospector in the post-World War II period. [('H]

The role of the small production firm, like that of the individual prospector, is apparently in a state of decline, although less precipitate.[69] The AMC small-miner survey states that small miners (as defined by the AMC) contributed only 4,5 percent of the total value of U.S. hardrock mineral production during 1975, even though they operated over 75 percent of all mines, Small miners, however, account for all or much of the production of some of the more common minerals such as dimension stone, perlite, barite, feldspar, mica, gypsum, crude asbestos, graphite, kyanite, talc, and industrial garnets. Moreover, there are many more small mines than large mines, and the small mines may account for a large part of total mine employment, As in exploration, the small mining firm concentrates on deposits too small to be of interest to the larger firms, and thus produces minerals that otherwise might not be produced,[70]

One area where the small firm, though not the individual prospector, may play a substantial role is the exploration, development, and production of onshore U.S. oil and gas. Published data indicate that "independents" made 75 percent of the new-field onshore and offshore wildcat discoveries between 1969 and 1974, inclusive, whereas major companies made only 25 percent of the discoveries. The bulk of the majors' exploration occurred in the offshore Arctic and ultradeep inland drilling, where the

"Payne, note61, at 72-75,
'Anatomy (If a Mine. note 16, at 23.
'1'' Payne, note 61, at 12; see Anatomy of a Mine, note 16, at 59,
"Lacy, note 56, at 161-164,
"AMC Small Miner Survey, " note 57, at 3, 7-9,

average discovery is substantially larger and more expensive than the average independent's discovery. (The major company discoveries, even counting only the first 100 million barrels of major discoveries such as Prudhoe Bay, accounted for almost half of the oil and gas reserves, and resulted from drilling only 10 percent of the total new-field wildcat wells.) But it is impossible to draw from such data any conclusion as to the actual role of small oil and gas firms, because "independents" were defined as all but the 16 largest oil and gas companies. "

Jackson, "Independents/Majors: Their Exploratory Role," *Oil and Gas J.*, Feb. 7, 1977, at 95. See also *Oil and Gas J.*, June 14, 1976, at 34.

3.

History and Main Elements of the Federal Onshore Mineral Land Management Systems

History and Main Elements of the Federal Onshore Mineral Land Management Systems

In the 19th century, settlement of the vast Federal public domain was encouraged by enactment of laws providing for free or almost-free disposal of public domain land. One of these laws was the Mining Law of 1872, which originally governed the disposal of all minerals other than coal, and still authorizes the disposal of public domain land containing a valuable deposit of almost any nonfuel mineral.

Early in the 20th century, the fossil fuel and fertilizer minerals and lands containing them were reserved from disposal under the Mining Law and were made subject to leasing at the discretion of the Secretary of the Interior under the Mineral Leasing Act of 1920 and related statutes. As the concern over conservation and proper management of mineral and nonmineral resources on Federal land grew, special laws were passed reserving more minerals and lands from disposal under the Mining Law, and making the minerals subject to lease or sale.

Over the years, little consideration was given to the net effect on Federal land management of the numerous distinct mineral and nonmineral resource disposal and management laws. Recent statutes have greatly improved management of nonmineral resources on Federal land. But mineral activities under the various mineral laws are not yet coordinated effectively among themselves or with non mineral activities.

A. Initial Policy: Revenue Generation

The earliest Federal landholdings consisted of land west of the Allegheny Mountains and east of the Mississippi River obtained through cession of territorial claims by the original colonies, followed in 1803 by the huge Louisiana Purchase from France of the territory in the center of the continent roughly east of the Rocky Mountains and north of what is now the State of Texas.

The primary goal of Federal land law in the first few decades of the Nation's existence appears to have been maximization of the revenue flowing to the Federal Gov-

[1] The sources for much of the historical data in this and the following sections are P. Gates, *History of Public Land Law Development* (1968), especially ch. 7 by R. Swenson; Twitty, Sievwright, and Mills, 1 *Nonfuel Mineral Resources of the Public Lands: Legal Study* (1970); Federal Trade Commission, Bureaus of Competition and Economics, *Report to the Federal Trade Commission on Federal Energy Land Policy: Efficiency, Revenue, and Competition*, Ser. No. 94-18 (92-118), ch. 2, Senate Comm. on Int. & Ins. Affairs, 94th Cong., 2d sess. (Comm. Print 1976).

ernment, which had incurred substantial debts as a result of the War of Independence. Land was surveyed and opened to sale by auction with set minimum prices. Mineral lands, however, after an initial auction of copper lands near the Great Lakes at the prompting of Alexander Hamilton, were reserved from sale, and known deposits were made available through lease, so that the Government could retain continuing revenue through royalties on production.

Nonmineral lands were opened to sale as far west as the Mississippi River area, where sizable deposits of lead existed. In 1807, Congress authorized the leasing of the reserved lead mines in this territory with mixed results, The leasing program in the Missouri area produced widespread resentment because of inadequate administration and the existence of conflicting or adjacent early French and Spanish land grants. Congress authorized the sale of these mines in 1829. In the Upper Mississippi Valley, however, the leasing program benefited from strong administration and was successful until 1829, when it began to deteriorate because of a shift to very lax administration, overproduction, fraudulent acquisition of mineral land under nonmineral land statutes, increasing pressure for more agricultural land, and a long period of uncertainty over the legality of the leasing system. In 1846, Congress authorized the sale of the mines at public auction.

The Preemption Act of 1841 was the first law to authorize entry on Federal land in order to obtain a preemptive right to buy a tract for a set price without having to bid against others at public auction. The Act applied only to agricultural land. But, the 1846 Lead Mines Sale statute, mentioned above, authorized similar preemptive rights for any mines not sold at public auction within a year. Two 1847 statutes created immediate preemptive rights for mineral land in northern Michigan and northern Wisconsin authorized to be sold at public auction.

Land classified as mineral land was generally sold at a higher minimum price than land classified as agricultural, However, much mineral land passed into private ownership under the agricultural laws rather than the mineral sale provisions, owing to lack of classification, fraudulent entries, and Government decisions that certain land (for example, land containing “merely” iron ore) was not mineral land.

B. Mid= to Late-19th Century: Rapid Development and Disposal

1. Rapid Development

The territorial holdings of the Federal Government on the American continent were completed by several treaties and purchases in the 1840’s and 1850’s, which extended Federal ownership to the Far West and the Southwest, and by the purchase of Alaska from Russia in 1867. Earlier, in 1819, the Florida territory was obtained from Spain.

The great size of the Federal holdings, combined with the pressure from Western States and settlers to have them rapidly settled and developed, led to the lowering of minimum sale prices, the expansion of preemptive rights, and eventually the free disposal of land to settlers under the agricultural Homestead Act of 1862. There were no general provisions for the disposal of mineral land, though sales of mineral land with preemptive rights were authorized in certain areas, and much mineral land was acquired fraudulently under the agricultural land disposal laws.

2. California Gold and the Mining Codes

In 1848, gold was discovered in California, and the fabled gold rushes in the Far West began. In the absence of Federal law providing for the disposal of mineral land, prospectors and miners, who were technically trespassers on Federal land, relied on State property laws and the rules each mining camp developed for itself. The mining codes generally provided that the discoverer of a mineral deposit was entitled to exclusive possession, limited the size of the tract that could be held as the result of a single discovery, specified procedures for marking and claiming the tract, and required a certain amount of development work to be performed annually to hold the tract.

Congress debated Federal mineral land policy during the 1850's and into the 1860's. Eastern members generally advocated a disposal policy that would generate Federal revenue, and western members advocated free exploration and occupation of mineral land with preemptive rights to obtain title for a nominal fee. No one strongly advocated leasing, apparently because the earlier lead mine leasing program was perceived as a failure.

The Members of Congress urging rapid settlement and development of the West through free exploration and disposal of Federal land prevailed (as they had in 1862, with passage of the Homestead Law for agricultural land). In 1866, a mining law was enacted, declaring "the mineral lands of the public domain , . . to be free and open to exploration and occupation" subject to governmental regulation and to the local customs or rules of the mining districts not in conflict with the laws of the United States.

The 1866 law provided for acquisition of title only for "lode" deposits, which are veins or lodes of rock in place bearing valuable minerals. The Placer Act of 1870 amended the 1866 law to provide for acquisition of title to "placer" deposits, which are mineral deposits other than lode deposits. Generally, lode deposits are those confined by rock in the place where they were originally formed, while placer deposits are former lode deposits that have been broken down, transported, and redeposited in alluvial sediment as a result of being exposed to flowing water or ice.

3. The Mining Law of 1872

In 1872, the 1866 and 1870 mining acts were substantially revised to produce the Mining Law of 1872;[2] (or simply "the Mining Law") which ever since has governed the disposal of all valuable mineral deposits on the Federal public domain except for minerals whose disposal is explicitly provided for by other statutes. (The public domain consists of all land retained in Federal ownership since its original acquisition by treaty, cession, or purchase as part of the general territory of the United States, in-

[2] 17 Stat. 91 (1872), *as amended and supplemented*, 30 U.S.C. § 21 et seq. (1976).

eluding such land that temporarily passed out of but subsequently reverted to Federal ownership through operation of the public land laws, and any land obtained in exchange for such land or for timber on such land. It does not include land that has been acquired from a State or a private owner through purchase, gift, or condemnation for particular Federal purposes rather than as part of the general territory of the United States.)

The Mining Law of 1872 retains the policy of free exploration and occupation of mineral land initiated by the 1866 and 1870 mining acts, Prospecting for minerals covered by the Mining Law is a statutory right on any public domain land[3] that has not been removed from the operation of the Mining Law by congressional or executive action.

Upon discovery of a "valuable mineral deposit" and physical "location" (staking) of a mining claim encompassing the deposit, a prospector has the statutory right to develop, mine, and sell the mineral without obtaining approval from or paying fees to the Federal Government. Complete fee title to the surface and subsurface can be obtained by paying $2.50 or $5.00 per acre, depending on the type of claim, for a title document known as a "patent." Prior to issuance of a patent, use of the surface and of surface resources is limited to those uses required for the mining claimant's prospecting, mining, or processing operations, or uses reasonably incident thereto. The right to mine and make use of the surface does not depend on acquisition of a patent.

Technically, discovery of a valuable mineral deposit is required before a claim can be located, However, early in the history of the Mining Law, it became apparent that some sort of prediscovery protection was needed for prospecting activities that required substantial sampling or excavation. Accordingly, the Supreme Court created the doctrine of pedis possessio, which permits location of a claim prior to discovery, and protects the locator against encroachment by other prospectors as long as the locator is in actual possession of the claim and diligently exploring for minerals. This doctrine protects the locator against other prospectors, but not against nonmineral entrants or the Federal Government, until a valid discovery has been made.

There is no legal limit to the number of claims anyone can locate. However, a valid discovery must be made on each claim in order to acquire a vested right against the Government. Similarly, the doctrine of pedis possessio protects only those claims actually being occupied and worked.

An unpatented mining claim must be maintained by the performance of at least $100 worth of "assessment" (development) work each year. Assessment work can be combined for groups of claims in common ownership. There are no assessment work requirements for patented claims. There is no requirement that mineral production ever be commenced, nor any restriction on the timing or pattern of development, on either patented or unpatented claims. Claims continue indefinitely with or without mineral production,

[3]Although the Mining Law refers to "lands belonging to the United States," it has been interpreted as applying, as did the 1866 law, only to public domain land and not to acquired land

Mineral activities on a claim can preempt all nonmineral resource uses and values, The Mining Law states that Federal land is open to exploration, occupation, and purchase "under regulations prescribed by law, " but Federal regulations covering surface resources on mining claims have been promulgated or proposed only within the last few years. These regulations recognize the priority given to mineral activities over nonmineral resource uses and values. The regulations apply only to unpatented claims, except in special areas such as national parks or wilderness areas.

The Mining Law authorizes the States to prescribe procedures for locating and recording mining claims (including requirements governing discovery work and, within limits, the width of claims), to specify the amount of annual assessment work required above the $100 per claim minimum, and even to provide rules for working mines on patented claims necessary for their complete development. Generally, the States have only specified procedures for locating and recording claims, including discovery work requirements. The regulations vary considerably from State to State. The Federal Land Policy and Management Act, enacted in 1976, for the first time required recordation of claims and assessment work with the Federal land management agencies.

The Mining Law contains several distinctions and provisions that have caused substantial uncertainty and litigation. Among these are the distinction between lode and placer claims, the provision of extralateral or apex rights for lode deposits, the tunnel site provision, and the requirement of discovery of a valuable mineral deposit on each claim in order to obtain tenure from the Government. These problems and others are discussed in subsequent chapters,

4. Extensive Ad Hoc Disposal of Mineral and Nonmineral Land

The Mining Law of 1872 established a policy for the disposal of Federal mineral land analogous to the policies for nonmineral land in the 19th century. Like the Homestead Act of 1862 for agricultural land, it provided for free entry onto and exclusive use of small tracts of unappropriated Federal land. Like the nonmineral land preemption acts (which continued alongside the Homestead Act until almost the end of the 19th century), it provided for purchase of such tracts at fixed prices of a few dollars per acre.

From the beginning, certain mineral lands were excluded from the Mining Law. Coal lands, like many types of nonmineral land, were subject to sale at public auction, or to private entry at minimum prices under an 1864 statute. A new Coal Lands Act of 1873, which governed the disposal of Federal coal land until passage of the Mineral Leasing Act of 1920, authorized entry and purchase of coal land at a minimum price of $10 or $20 per acre, depending on distance from a completed railroad line. Similarly, the disposal of mineral land in Michigan, Minnesota, Wisconsin, Missouri, Kansas, and Alabama was allowed to continue under the general public land preemption and sale statutes. Federal land in those States was excluded from the operation of the Mining Law by three statutes enacted between 1873 and 1883. The same exclusion was applied to Oklahoma in 1891, although certain land ceded to the United States by Indian tribes was opened to entry under the Mining Law in 1895 and 1900.

The management of Federal land during this period consisted largely of ad hoc decisions on the disposal of numerous tracts under a bewildering set of specific-use disposal statutes. Nonmineral land was disposed of under separate statutes governing agricultural, pastoral, desert, timber, building stone, swamp, railroad, and other lands.

Theoretically, entries and sales under the nonmineral land laws could not be made on mineral land, except in the seven States (listed above] where such entries and sales were expressly authorized. Conversely, administrative and court decisions under the Mining Law held that the "valuable discovery" of minerals required for a valid mining claim must include a showing, at least where there was a contest between mineral and nonmineral claimants, that the land was more valuable for mineral than for nonmineral purposes.[9] Thus, the congressional intent of disposal for "highest use" provided the only organizing thread through the morass of laws.

It was recognized that proper disposal for highest use under this mass of laws required thorough investigation and classification of the public domain. In 1879 the U.S. Geological Survey was authorized to undertake such investigations and classifications. Unfortunately, however, the first Director of the Survey interpreted the classification directive narrowly, as seeking only general scientific knowledge of the public domain rather than classification for purposes of disposal under the land laws, As a result, millions of acres of Federal land intended for various mineral and nonmineral uses were obtained fraudulently under statutes providing for disposal for other uses. Not until the beginning of the 20th century were specific land classifications undertaken, and then only for reclamation (irrigation) projects, water powersites, public waterholes, and land considered favorable for the occurrence of coal, oil, oil shale, phosphate, or potash.[10]

C. Early 20th Century: Resource Conservation

1. Reservations and Withdrawals

The massive disposals of Federal land under the nonmineral land laws, including fraudulent disposals of coal and oil land, led to increasing concern over the depletion of what had earlier seemed the endless U.S. bounty of natural resources. The concern was primarily over the dwindling stock of land, timber, water, and minerals for commercial uses, although as early as 1872 land that was not considered valuable for other purposes had been set aside for Yellowstone National Park,

With respect to mineral resources, the concern over depletion was amplified by wasteful exploration and production practices (due in part to the provisions of the Mining Law) and by the existence of monopolistic practices for both oil (the Standard Oil Company) and coal (the railroads).

[9] Brice, "Law of Discovery: Prudent Man and Marketability," in University of Arizona, College of Mines, *Symposium on American Mineral Law Relating to Public Land Use* 19 (J.C. Dotson ed. 1966); G.O. Smith, et al., *The Classification of the Public Lands*, U.S. Geological Survey Bull. 537, at 25-26 (1913).

[10] U.S. Geological Survey Bull. 537, note 4, at 7-8, 11-13, 18-20, 32-33, 35-43; Bass, Smith, and Horn, *Standards for the Classification of Public Coal Lands*, U.S Geological Survey Circ. 633, at 2 (1970).

Congress authorized the establishment of forest reserves in 1891. Administrative machinery for such reserves was created by the National Forest System Organic Act of 1897, which specified that all public domain national forests continued to be open to entry under the Mining Law for prospecting for and 1ocation and development of their mineral resources, subject to the rules and regulations governing such national forests. Millions of acres of national forests (apparently more than Congress desired) were created pursuant to this congressional authorization at the beginning of the 20th century, marking the first major closure of the public domain to nonmineral (but not mineral) private entry and settlement.

There was no comparable law authorizing reservation of public domain mineral resources. However, since early in the 19th century the President had asserted and utilized an inherent or implied power to withdraw or reserve the public domain from private entry in order to permit a particular public use.’[1] Responding to the concern over the depletion, waste, and monopoly of the Nation’s fuel mineral resources, Presidents Roosevelt and Taft withdrew millions of acres of coal and oil land during the first decade of the 20th century from entry under the agricultural land laws and, later, from entry under all the mineral and nonmineral land laws. These withdrawals touched off a storm of protest in Congress and the Western States, but they were upheld in 1915 by the Supreme Court in the Midwest Oil Co. case. ’

At the request of President Taft and prior to the Midwest Oil Co. decision, Congress in 1910 had enacted the Pickett Act, authorizing Presidential withdrawal of Federal land (for classification and ‘‘other public purposes’ from entry under the nonmineral land laws and from entry for coal, oil, gas, and phosphate (later expanded to include all nonmetalliferous minerals) under the Mining Law, The earlier pre-Pickett Act withdrawals were reissued by the President as withdrawals under the Pickett Act. During the following decade, substantially all the unappropriated public domain mineral land was withdrawn from nonmetalliferous entry and location under the Mining Law.

The withdrawals were made to permit investigation and classification of land on which there was a reasonable probability of the occurrence of certain mineral resources. The largest withdrawals were of coal and oil lands, although withdrawals were also made of phosphate and potash lands. Phosphate and potash are the principal fertilizer minerals, and there was concern over conservation of domestic resources in light of substantial exports of phosphate and dependence on Germany for imports of potash. If the withdrawals and classifications were not made, mineral land would continue to pass into private (and often monopolistic) control either inadvertently or fraudulently under the nonmineral land laws.

The withdrawals of mineral land were also intended to segregate such land from disposal under the Mining Law and the Coal Act of 1873, pending adoption of more ap-

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"Technically, land is segregated from entry under one or more of the public land laws in three distinct ways: *classification* designates land as suitable for disposition under a particular statute and hence may limit its disposition under other statutes: *withdrawal* removes land from disposition under one or more statutes without necessarily designating any particular preferred use: *reservation* dedicates land to a particular *public* purpose or use. None of the three methods necessarily involves restrictions on mineral entry. U.S. Department of the Interior, 1 *Final Report of the Task Force on the Availability of Federally Owned Mineral Lands* 10-11 (1977).

236 U.S. 459 (1915). The Court bypassed the issue of the President's inherent withdrawal authority and held that Congress had impliedly granted withdrawal power to the President through its long history of acquiescence in the Presidential withdrawals and reservations for public purposes.

propriate legislation. The Mining Law, drafted primarily with the metallic minerals in mind, was considered to be unsuitable for the disposal of oil, phosphate, and potash, and the Coal Act was considered to be no longer suitable for the disposal of coal.

2. Separation of Surface and Subsurface

The withdrawals prevented agricultural and other nonmineral entries on vast tracts of western land. In order to free this land for nonmineral entry, laws were enacted separating ownership of the surface from ownership of the subsurface. The first of these laws, passed in 1909 and I910, permitted agricultural entries on land withdrawn or classified as valuable for coal. However, the United States reserved ownership of the coal in any land classified as valuable for coal prior to issuance of a nonmineral patent (title). Limited indemnification was provided to the surface owner for any damages caused by exploration for or development and production of the coal. A similar law was enacted in 1914, providing for agricultural entry on land withdrawn, classified, or reported as containing phosphate, nitrate, potash, oil, gas, or asphaltic minerals. In 1916, the Stockraising Homestead Act dispensed with the need for mineral land classifications for stockraising (grazing) entries by reserving all minerals to the United States whether or not the land was considered to be valuable for any mineral, For agricultural entries, however, mineral reservations continued to be made only for those fossil fuel and fertilizer minerals for which the land was considered to be valuable at the time of issuance of the patent.

This collection of separation or severance laws relieved the impact of mineral land withdrawals on nonmineral entries, but it also created a situation of separated ownership of the surface and subsurface that has caused considerable problems to the present day.

3. The Mineral Leasing Act of 1920

The mineral land withdrawals remained effective to prevent disposal of the fossil fuel and fertilizer minerals under the Mining Law and the Coal Act, During the decade following 1910, the conservationists pressed continuously for a leasing system for these minerals, and bills for that purpose were introduced in each session of Congress, Finally, in 1919, even the most adamant opponents of mineral leasing recognized the political necessity of a leasing system in order to make the withdrawn land available again for exploration for and development and production of the fuel and fertilizer minerals, The Mineral Leasing Act of 1920[6] reopened the public domain, with certain exceptions (national parks and land withdrawn or reserved for military or naval uses or purposes), to such exploration, development, and production.

The Act removed all deposits of coal, phosphate, sodium, oil, oil shale, or gas, and public domain land containing such deposits (including public domain land for which some or all mineral rights had been reserved by the United States upon patenting of such land under the nonmineral entry laws) from disposal under the Mining Law or the Coal Act of 1873, and made such deposits and land subject to disposal only through

41 Stat. 437 (1920), as *amended and supplemented*, 30 U.S.C. § 181 et seq. (1976).

prospecting permits and leases. The United States henceforth would retain title to the deposits and the surface (the latter only for so long as the surface was not disposed of under the nonmineral entry laws).

Earlier, in 1917, a hybrid patent-leasing law had been enacted as a wartime measure for potash, which was important for explosives as well as fertilizer. Under the 1917 law, a successful mineral explorer could obtain a patent (full title) to one-fourth of the land embraced in his prospecting permit, and the remaining three-fourths could be leased by advertisement, competitive bidding, or such other methods as might be adopted in general regulations by the Secretary of the Interior. These provisions were lifted from the 1917 version of the general leasing bill, and were similar to the provisions for oil and sodium, By 1920, however, a full leasing policy had been adopted, and in 1927 potash itself was made completely leasable and incorporated into the general provisions of the Mineral Leasing Act.

Similarly, in 1926, sulfur in Louisiana was placed under the Mineral Leasing Act. In 1932, sulfur in New Mexico was added. The most recent additions, in 1960, were native asphalt, solid and semisolid bitumen, and bituminous rock.

The Mineral Leasing Act of 1920 was a major departure from the earlier policy for disposaI of Federal minerals. The absolute right to enter, locate, develop, and (if desired) purchase mineral land under the Mining Law and the Coal Act of 1873 was replaced, for the fossil fuel, fertilizer, and chemical minerals only, with a discretionary permit and leasing system, The Secretary of the Interior was authorized to issue prospecting permits and leases for the exploration, development, and production of such minerals and, within broad statutory limits, to establish rentals, royalties, and other conditions to ensure competition, diligent development, highest use of the land, and a fair return to the public for the use of its mineral resources.

The Mineral Leasing Act has been amended often since its initial passage in 1920, especially with respect to oil and gas. However, its fundamental structure and purpose remain unaltered, Certain general provisions apply to all the minerals covered by the Act, while specific lease periods, rentals, royalties, and other terms and conditions for each mineral follow the same general format. The pervasive theme of the Act is protection of the public interest through grants of broad discretion to the Secretary of the Interior. As shall be seen, however, defects in the Act itself and in its administration have impeded achievement of the intended purposes.

All permits and leases under the Act are discretionary. The Secretary may grant prospecting permits for phosphate, potash, sodium, or sulfur for a specified maximum acreage and time to the first qualified applicant. Similar prospecting permit provisions for oil and gas were eliminated in 1935 and replaced by a provision authorizing issuance of noncompetitive leases to the first qualified applicant. Prospecting permit provisions for coal were eliminated in 1976.

Prospecting permits for phosphate, potash, sodium, or sulfur (or, prior to 1976, coal) can be issued for land where the existence or workability of the mineral in question is not already known. If the permittee discovers a valuable deposit of the mineral for which the permit was issued, and (for sodium, sulfur, and potash permits) if the

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land is chiefly valuable for the mineral thus discovered, the permittee is entitled to a preference-right lease for development and production of the mineral, Similarly, for oil and gas, noncompetitive leases may be issued to the first qualified applicant for land outside the known geologic structure of a producing oilfield or gasfield,

Land known to be valuable for sodium, sulfur, or potash, known to contain workable deposits of phosphate, or desired for development of oil shale, native asphalt, solid and semisolid bitumen, or bituminous rock, may be leased by the Secretary of the Interior through advertisement, competitive bidding, or such other methods as the Secretary by general regulation may adopt. Land within the known geologic structure of a producing oilfield or gasfield or (after 1976) desired for development of coal may be leased only through competitive bidding,

For each mineral, maximum acreages are specified for each permit or lease and for aggregate State or National holdings by a single individual or company. Rentals and royalties are also specified, with minimum rentals and/or royalties being established for some minerals, fixed rentals and/or royalties being established for others, and open-ended rentals and/or royalties being established for a few minerals. Prospecting permits are generally limited to 2 years' duration, although permits for potash (and coal prior to 1976) and phosphate may be renewed by the Secretary for an additional 2 or 4 years, respectively, Leases are generally limited to 20 years (10 years for noncompetitive oil and gas leases and 5 years for competitive oil and gas leases), but continue after the initial period as long as commercial production continues or as long as the terms of the lease are complied with, depending on the mineral. Oil shale and, apparently, sulfur leases may be issued for indeterminate periods, and coal leases issued prior to 1976 had to be issued for indeterminate periods. Lease terms for minerals other than sulfur or oil and gas can be readjusted after 20 years and periodically thereafter,

The acreage limits, combined with specific antitrust provisions, were intended to ensure competition in the exploration for and development and production of federally owned leasable minerals. The rentals, coupled with other lease terms and conditions, were intended to ensure that land would not be held under the Mineral Leasing Act when it was more valuable for other purposes. The royalties were intended to ensure a fair return to the Government for the use of its mineral resources. The rentals and limits on permit and lease durations, together with minimum production requirements and general and specific diligence requirements, were intended to ensure timely exploration, development, and production.

The Secretary was given broad discretion to establish lease terms and conditions and, for most of the minerals, rentals and royalties to fulfill these purposes. More specifically, the Act requires that:

> The Secretary of the Interior shall reserve and may exercise the authority to cancel any prospecting permit upon failure by the permittee to exercise due diligence in the prosecution of the prospecting work in accordance with the terms and conditions stated in the permit, . . .[9]

[9]30 U.S.C. § 183 (1976)

> Each lease shall contain provisions for the purpose of ensuring the exercise of reasonable diligence, skill, and care in the operation of [the] property; a provision that such rules for the safety and welfare of the miners and for the prevention of undue waste as may be prescribed by said Secretary shall be observed . . .; . . . and such other provisions as he may deem necessary to insure the sale of the production of such leased lands to the United States and to the public at reasonable prices, for the protection of the interests of the United States, for the prevention of monopoly, and for the safeguarding of the public welfare. 10
>
> The Secretary of the Interior is authorized to prescribe necessary and proper rules and regulations and to do any and all things necessary to carry out and accomplish the purposes of this Act. . . .[11]

The scope of discretion afforded the Secretary is extensive, particularly with respect to preference-right leases resulting from discoveries under prospecting permits. The terms and conditions of such leases, including rentals and royalties for most of the minerals, can be established at the time of lease issuance, after exploration has been completed. If justified in the public interest, they apparently can be so severe as to render development and production uneconomic. [12] The "valuable discovery" rule for acquiring entitlement to a preference-right lease is subject to the same uncertainties and difficulties that exist for the same rule under the Mining Law. Even the "right" to a preference-right lease may be only a right of first refusal. The Secretary may, in his complete discretion, refuse to issue any prospecting permit or nonpreference-right lease, He also may issue regulations to protect the public welfare binding on all existing as well as new leases.

The Act explicitly preserves the rights of the States to exercise their police and taxing powers over Federal mineral lessees, so that controls and burdens stricter than the Federal terms and payments may be imposed by the States and, through delegation from the States, local governing bodies.

Almost all the revenue collected by the Federal Government under the Act is returned to the producing States either directly or for irrigation projects.

D. Middle Third of the 20th Century: Retention of Land Under Single-Purpose, Commercially Oriented, Ad Hoc Management

1. Termination of Disposal Policy for Nonmineral Land

By the **1930's the best agricultural** and grazing land had been disposed of to private entrants under the 1862 Homestead Law, the 1909 Enlarged Homestead Act, and the 1916 Stockraising Homestead Act. The remaining public domain, chiefly suitable for grazing only, was being destroyed by overgrazing and was being broken up by homesteading of the choicer parcels, leaving useful grasslands without water. To halt the destruction of the rangelands and provide for their management and improvement, Congress passed the Taylor Grazing Act of 1934, under which, as amended, practical-

[10] 30 U.S.C. § 187 (1976).
[11] 30 U.S.C. § 189 (1976).
[12] See ch. 5, subsecs. E(3) and E(4)

ly all the remaining vacant and unreserved public domain in the lower 48 States was withdrawn from further homesteading entries. The Act provided for continuing entry and sale of land found after classification to be suitable and more valuable for raising agricultural crops than native grasses, of isolated or disconnected tracts, and of small tracts in mountainous or rough terrain. Also, entries initiated prior to the withdrawals could continue to be prosecuted to patent. Thus, homestead and other nonmineral land entries and issuance of patents continued, although in a steadily decreasing amount, with entries after 1955 being made almost entirely in Alaska.

The Taylor Grazing Act marked the end of the Federal policy of disposal of its nonmineral land, although it was worded as an interim management measure "[p]ending its [the public domain's] final disposal. " The policy of bountiful ad hoc disposal, first eroded by the creation of the National Forest System in **1897** and the National Park Service in **1916, was** dealt its final blow by the closure of the remaining vacant public domain under the Taylor Grazing Act in 1934.

2. **Ad Hoc Land Management**

Although, except for the Mining Law, the disposal policy for the Federal public domain had been phased out, ad hoc single-purpose management took its place under the (by then) bewildering array of mineral and nonmineral land laws. As problems and conflicts arose, case-specific legislative or administrative adjustments were made. Grazing lands were administered for (and practically by) the ranchers. Forest land was administered for its timber, and secondarily for its watershed and grazing values. The uncoordinated initiation of mineral activities under the mining and mineral leasing laws added to the ad hoc nature of land decisions.

When particular areas of the public domain were desired for specific nonmineral resource uses, they were often withdrawn completely from availability under the Mining Law and the Mineral Leasing Act, Since the President's statutory withdrawal authority under the Pickett Act did not permit withdrawals of land from location of metalliferous minerals under the Mining Law, such withdrawals were usually made under the President's inherent or implied authority (held by the Attorney General in 1941 to continue to exist independently of the Pickett Act).

Adjustments were made to the provisions of the Mining Law and the Mineral Leasing Act, mostly the latter, without changing their basic purposes or structures. As was indicated earlier, a few minerals were added to the list of Leasing Act minerals, and acreage limits and other provisions were revised, usually at industry initiative. Oil and gas prospecting permits were replaced by noncompetitive leases in 1935, when there was great concern about overproduction. Prospecting permits for phosphate were authorized in 1960.

As for the Mining Law, the courts had adopted the pedis possessio doctrine, which protects a prospector who is in actual occupation of a claim and diligently searching for minerals, against fraudulent, forcible, or clandestine entry by other prospectors. Legislative adjustments were minor, consisting primarily of clarifying the periods during which assessment (development) work had to be performed, the allowable types of assessment work, the suspension of assessment work requirements for certain (usually wartime) periods, the procedures for processing adverse claims, and the description of patented ground. Almost all these adjustments were made at industry initiative.

3. Mineral Leasing on Acquired Land: The Mineral Leasing Act for Acquired Lands of 1947 and Reorganization Plan No. 3 of 1946

The Mining Law and the Mineral Leasing Act of 1920 apply only to the Federal public domain. As was stated above, this is land that has been retained in Federal ownership since its original acquisition by treaty, cession, or purchase as part of the general territory of the United States, including such land that has temporarily passed out of but subsequently reverted to Federal ownership through operation of the public land laws, or any land obtained in exchange for such land or for timber on such land. The two laws do not apply to so-called "acquired land," which is land obtained from a State or a private owner through purchase, gift, or condemnation for particular Federal purposes rather than as part of the general territory of the United States.

Land was acquired for Federal offices and similar purposes from the beginning of the Republic, particularly in the States carved from the 13 original colonies in which the Federal Government never had any territorial property. The first acquisition of major land areas, however, was undertaken under the Weeks (Appalachian Forest) Act of 1911, which authorized the purchase of forested, cutover, or denuded land within the watershed of navigable streams to be placed in national forests. Subsequent acts provided more general land acquisition authority for the National Forest System and for other Federal land systems.

In 1917, the Secretary of Agriculture was authorized to permit mineral exploration, development, and production on lands acquired under the Weeks Act. Similar authority was granted under certain other national forest and national grassland acquisition statutes. This authority extended to all minerals, and it was exercised through a permit and leasing system, since ownership of the land was to be retained by the Federal Government.

In 1947, Congress passed the Mineral Leasing Act for Acquired Lands.[13] In substance, the Act made the fossil fuel, fertilizer, and chemical minerals on all acquired land (including acquired land in the National Forest System) subject to permit and lease by the Secretary of the Interior under the provisions of the Mineral Leasing Act of 1920, which was already applicable to such minerals on the public domain. However, permits and leases on acquired land can be issued only with the consent of the surface management agency and subject to such conditions as it may prescribe to ensure the adequate utilization of the land for the primary purposes for which it was acquired or is being administered. Similar consent requirements have recently been legislated for coal and geothermal steam on the public domain. Sulfur can be leased on acquired land in any State, but on the public domain in Louisiana and New Mexico only. Native asphalt, solid and semisolid bitumen, and bituminous rock, which were

[13] 61 Stat. 913 (1947), 30 U.S.C. §§ 351-359 (1976).

added in 1960 to the list of leasable minerals on the public domain under the 1920 Mineral Leasing Act, were not at the same time made leasable on acquired land.

A year prior to enactment of the Mineral Leasing Act for Acquired Lands, the mineral leasing authority of the Secretary of Agriculture for acquired national forest land and grassland was transferred to the Secretary of the Interior by Reorganization Plan No. 3 of 1946. ” Mineral development on such lands, however, could be authorized only upon the Secretary of Agriculture's certification that it would not interfere with the primary purposes for which the land was acquired, and only in accordance with conditions specified by the Secretary of Agriculture to protect such purposes.

This transfer of authority was superseded in 1947 for the fossil fuel, fertilizer, and chemical minerals (other than native asphalt, solid and semisolid bitumen, and bituminous rock) by the Mineral Leasing Act for Acquired Lands; but it continues to be the basis for the Secretary of the Interior's authority to lease all other minerals (that is, the minerals disposed of under the Mining Law on the public domain) on much of the acquired national forest land. The Secretary of the Interior has made the leasing of these minerals subject to the regulations that govern the leasing of the fossil fuel, fertilizer, and chemical minerals on acquired land.

4. Special Leasing Acts

As has been mentioned earlier, the Mining Law does not apply to the public domain in certain States. In 1950, Congress authorized the Secretary of the Interior to lease mineral resources in public domain national forest in one of those States, Minnesota, subject to the consent of the Secretary of Agriculture.[15] Although the National Commission on Materials Policy stated in its 1973 report that hardrock minerals are leased on public domain land in Kansas, Missouri, Minnesota, Nebraska, and Wisconsin, [16] there is apparently no other statute authorizing such leasing.

Other acts provide for leasing mineral resources (a) reserved from certain private Spanish land grants or Federal grants to the States of California and Nevada and (b) in certain other areas (for example, some national recreation areas). 17

Regulations under these special acts have generally followed or been incorporated in the general leasing regulations of the Department of the Interior.

5. Sale of Common-Variety Minerals

To reduce abuse of the Mining Law by those using it to gain ownership of Federal land for nonmineral purposes, common varieties of sand, stone, gravel, pumice, pumicite, or cinders were removed from location under the Mining Law and, together with common varieties of clay and other mineral materials, made subject to disposal (the minerals only, not the surface) through competitive bidding by the Surface Resources Act of 1955. '8 The Secretary of Agriculture disposes of such common-variety minerals

“60 Stat. 1097 (1946).

“30 USC, $ 508b (1976).

“National Commission on Materials Policy, Material Needs and the Environment Today and Tomorrow 7-10 (1973).

“See 43 CFR $3500.0-3 (1976); app. B, sec. F(2); Twitty, Sievwright, and Mills, 1 Nonfuel Mineral Resources of the Public; Lands: LegaI Study 56-57(1970).

“69 Stat. 367 (1955], as amended, 30 U.S.C, $$601, 611 (1976]. An amendment to the Act in 1962 also removed petrified wood from location under the Mining Law.

on land under his jurisdiction. Those on all other Federal land, except national parks and moments and Indian land, are disposed of by the Secretary of the Interior. If the land involved has been withdrawn for the use of a department or agency other than the Departments of Agriculture or the Interior, or for the use of a State or local government, no disposal may be made without the consent of that department, agency, State, or local government.

6. **Resolving Intersystem Conflicts: The Multiple Mineral Development Act of 1954**

Because claims under the Mining Law can develop into full title to the surface and subsurface, including fossil fuel, fertilizer, and chemical minerals in the subsurface that are normally covered by the mineral leasing acts, the Mining Law and the mineral leasing acts were construed as being mutually exclusive with respect to the same tract of land, Hence a prospecting permit or lease could not include land encompassed by a mining claim. Conversely, a mining claim could not be located on land that was leased, covered by a permit or an application for a permit or lease, or known to be valuable for a mineral covered by the mineral leasing acts (“the conflict-producing conditions”).

This mutual exclusivity did not cause substantial problems until the development of uranium as a (nonfossil) fuel mineral in the 1940’s, because Mining Law and Mineral Leasing Act minerals generally occurred in geographically distinct locations. Uranium, however, which is located under the Mining Law, occurs in sedimentary regions also favorable for the occurrence of oil, gas, and coal, which are leased under the Mineral Leasing Acts.

The conflict was removed in part by the Multiple Mineral Development Act of 1954,[19] which (a) provides procedures for validating mining claims subject to the conflict-producing conditions and located after July 31, 1939, (b) reserves to the United States the Leasing Act minerals (and the right to enter and remove such minerals) in all such claims and in every claim located after August 13, 1954, (c) preserves the reservation into the patent for any claim still subject to the conflict-producing conditions when the patent is issued, and (d) authorizes location of mining claims after August 13, 1954, on land subject to the conflict-producing conditions.

The intermixture of coal and uranium deposits (found in North Dakota, South Dakota, and Montana) was given specific treatment in the Uraniferous Lignite Act of 1955.[20] Mining of the uranium would necessarily cause considerable disturbance to the lignite coal deposits. Uncertainty about the legal status of the deposits caused a slowdown of private research on the processing of uranium from the mixed minerals, The 1955 Act provided that valid locations under the Mining Law could be made on the intermixed minerals as long as they were not covered by a coal prospecting permit or lease. Leasing Act minerals were reserved, except for any lignite which it was necessary to mine in order to develop the uraniferous materials. A royalty of $0.10 per ton was levied on all such lignite mined. The 1955 Act was valid for only 20 years, and it expired on August 11, 1975. Any claims not patented by, or for which no patent application was pending on, the date of expiration automatically terminated.

[19] 68 Stat. 708 (1954), 30 U.S.C. §§ 521-531 (1976).

[20] 69 Stat. 679 (1955), *expired* August 1975

These **acts** resolved some of the conflicts created by the existence of two major distinct mineral disposal systems. Problems still remain, however, and are discussed in chapter 4.

7. Lax Administration of the Mineral Laws

Although the legislative history and provisions of the Mineral Leasing Acts clearly indicate that the Secretary of the Interior **was to use** the broad discretion given **to** him in the Acts to ensure diligent and competitive exploration for and development and production of the Leasing Act minerals on Federal land, a fair return to the public for the appropriation of those minerals, and proper conservation of mineral and non-mineral resources, administration of the Acts was exceedingly lax. Permits and leases were issued to any applicant, at the minimum rentals and royalties specified in the Act. Diligence provisions were not enforced. Mere geologic evidence of mineralization was accepted as proof of valuable discoveries. Provisions to safeguard the public welfare (including nonmineral resource values) were practically nonexistent. This situation persisted until very recently, except for moratoriums on the issuance of oil and gas prospecting permits and leases in the late 1920's and early 1930's and coal prospecting permits and leases in the 1970's. Even today, rentals and royalties for most of the Leasing Act minerals are set at or near the statutory minimums prescribed more than 50 years ago.

Similarly, the "valuable discovery" **test was** applied loosely under the Mining Law, and almost no effort **was** made to control or mitigate the adverse impacts that resulted from mineral activity under the law.

E. Present Trends: Protection, Preservation, and Coordinated Management of Nonmineral Resources; Uncertain Policy for Mineral Resources

1. Preliminary Steps: The Surface Resources Act of 1955, the Forest Service Multiple Use Act of 1960, and the Classification and Multiple Use Act of 1964

The ad hoc single-purpose management and use of Federal land resulted in needless damage to and waste of surface resources. Dissatisfaction with these results led to enactment between 1955 and 1965 of three statutes that took preliminary steps toward coordinated and planned multiple-resource management.

The Surface Resources Act of 1955,[21] in addition to providing for sale of common-variety minerals rather than their disposal together with the surface under the Mining Law (see subsection D(5)), restricted surface uses of mining claims, prior to issuance of a patent, to those uses required for mineral exploration, development, or production or reasonably incident thereto, and declared the right of the United States to manage and dispose of the surface resources not so required. Although the Act itself applies only to

[21] 69 Stat. 368 (1955), 30 U.S.C. § 612 (1976).

claims located after July 23, 1955, it has been held that a similar surface use restriction has always been applicable to unpatented claims under the Mining Law. [22]

The Multiple Use-Sustained Yield Act of 1960[23] directed the Secretary of Agriculture to develop and administer the renewable surface resources of the national forests for multiple use and sustained yield, giving due consideration to the relative values of the various resources in particular areas, but not necessarily adopting that combination of uses that would give the greatest dollar return or the greatest unit output. Resources specifically listed in the Act include outdoor recreation, range, timber, watershed, wildlife, and fish; and the establishment and maintenance of areas of wilderness are declared to be consistent with the purposes and provisions of the Act.

The Classification and Multiple Use Act of 1964[24] temporarily provided similar direction to the Bureau of Land Management (BLM) for the bulk of the vacant and unreserved public domain (mainly in grazing districts) under its jurisdiction. The Act, which expired in December 1970 after submission of the report of the Public Land Law Review Commission established by the Act, authorized the Secretary of the Interior to classify and manage BLM land for multiple use, including specification of dominant uses and preclusion of uses inconsistent with the dominant use specified for any particular area.

As a result of these Acts, the Forest Service and BLM initiated or expanded multiple-use land classification and management efforts based on inventory and analysis of the surface resources on Federal land. Mineral resources continued to be treated as an entirely distinct factor outside the inventory and planning process.

2. Coordinated and Planned Management of Nonmineral Resources: The Forest and Rangeland Renewable Resources Planning Act of 1974 and the Federal Land Policy and Management Act of 1976

Building on earlier experience with multiple-use management, Congress has recently enacted comprehensive statutes requiring detailed inventorying, analysis, planning, and management of the nonmineral resources on Federal onshore land. The Forest and Rangeland Renewable Resources Planning Act of 1974, as amended,” governs management activities on Forest Service land, while the Federal Land Policy and Management Act of 1976[26] governs management activities on BLM land. Both Acts provide for extensive public participation.

Both Acts continue to treat mineral activities as activities independent of and outside the basic land use planning and management process. The BLM Act requires recordation of mining claims, specifies more carefully controlled withdrawal procedures, and reaffirms the authority of the Secretary of the Interior to “take any action necessary to prevent unnecessary or undue degradation of the lands. ” These provisions, as discussed in chapter 5, do not accomplish balanced coordination of mineral and nonmineral uses and activities on Federal land.

[22] *United States v. Etcheverry*, 230 F.2d 193 (10th Cir. 1956).
[23] 74 Stat. 215 (1960), 16 U.S.C. §§ 528-531 (1976).
[24] 78 Stat. 986 (1964), *expired* December 1970.
[25] 88 Stat. 476, *as amended*, 16 U.S.C. §§ 1600-1614 (1976)
[26] 90 Stat. 2743 (1976), 43 U.S.C. §§ 1701-1782 (1976).

3. Environmental Concerns About Mineral Activity

During the last decade, the dramatic rise in public awareness of and concern about environmental quality focused attention on mineral activity. In the space of a few years, the almost automatic distribution of mineral permits and leases to applicants and the slight attention paid to surface impacts have been almost reversed. The discretion formerly exercised routinely in favor of mineral activity under the mineral leasing acts is now often used to block such activity or to delay it pending reassessment of resource values and options. The issuance of permits and leases has practically ceased for several of the leasable minerals.

The previous lax enforcement of the valuable discovery rule under both the Mining Law and the mineral leasing acts has been tightened. Environmental regulations, although fairly rudimentary, have been promulgated under the mineral leasing **acts** and for mineral activities in the national forests and certain other areas under the Mining Law.

However, there is great uncertainty as to the actual extent of authority that can be exercised under the various mineral laws, and no procedures have been devised for the integration of mineral and nonmineral resource management. The prevailing procedures rely on case-by-case negotiation of mitigating measures in reaction to the plans of mineral explorers and producers. The result is substantial uncertainty for the mineral industry and frustration on the part of the surface management agencies,

The National Environmental Policy Act of 1969,[27] which requires environmental impact statements to be prepared for any major Federal action that may have a significant impact on the human environment, has been applied to issuance of permits and leases under the mineral leasing acts but usually not to exploration activities or acquisition of tenure under the Mining Law. Environmental impact statements are prepared for incidental aspects of major mine developments under the Mining Law—for example, land exchanges, rights-of-way, or stream-crossing permits.

4. Natural Area Preservation

The public concern over environmental degradation supplements a longer history of concern over the preservation of unique scenic and natural areas, evidenced as early as 1872 (the same year the Mining Law was enacted) with the reservation from entry under the Federal land laws of Yellowstone Park "as a public park or pleasuring ground for the benefit and enjoyment of the people." Earlier, in 1832, the Hot Springs in Arkansas had been set aside for "future disposal," and by 1900 additional acreage considered to have superlative natural beauty or uniqueness had been reserved and set aside in what are now Yosemite, Kings Canyon, Sequoia, and Mount Rainier National Parks.

The parks, however, were valued mainly for their scenic characteristics rather than their basic ecology, natural diversity, or primitive character. Not until well into the 20th century did the Forest Service begin to designate and manage certain national

[27] 83 Stat. 852 (1970), as amended, 42 U.S.C. §§ 4321 et seq. (1976).

forest areas as wilderness or primitive areas. But mineral activity under the Mining Law remained a preemptive use in such areas. In 1964, the preservationists obtained congressional acceptance of the wilderness concept through passage of the Wilderness Act of 1964. The national forest wilderness areas were designated as the first units of a National Wilderness System. Wilderness areas are to be closed to new entries under the Mining Law and new permits or leases under the mineral leasing acts in 1984.

Similarly, the earlier interest in fish and wildlife as game, evidenced by establishment of national wildlife refuges across the country, has developed into concern over entire biological and ecological communities and in the preservation of endangered species. The result has been the closing of almost all existing refuges to mineral activity, the creation of new refuges, and the passage of the Endangered Species Act of 1973, which prohibits the taking of any endangered plant or animal species and forbids any Federal action modifying a critical habitat of any such species (unless approved by a special Cabinet-level committee).

Withdrawals and reservations under these and other acts, and potential future withdrawals and reservations under the Alaska Native Claims Settlement Act and the wilderness study provisions for BLM land under the Federal Land Policy and Management Act of 1976, are often in geologic areas favorable for the occurrence of mineral resources. In general, these areas were not developed in the past because of their complex geology and the hidden nature of their deposits, but they are now being looked to as areas with major potential for future mineral supply.

5. Mineral and Nonmineral Coordination: Recent History

Some recent efforts have been made to coordinate mineral and nonmineral resource management. Principal examples are the prototype oil shale leasing program, the Federal Coal Leasing Amendments Act of 1976,[28] and the Surface [Coal] Mining Control and Reclamation Act of 1977.[29] Coal and oil shale resources, however, are fairly unique in that their location and characteristics are generally known, so that trade-offs between mineral and nonmineral values can be made more reliably than is the case with other mineral resources, and can be based on existing land use plans. Even for coal and oil shale, there are few explicit ties between specific nonmineral resource characteristics and conditions on mineral activity.

Moreover, the Department of Energy Organization Act[30] increases the difficulty of coordinating mineral and nonmineral resource management. It artificially separates the economic and land management aspects of fuel mineral leasing and places them in two different departments.

[28] 90 Stat. 1083 (1976), amending 30 U.S.C. §§ 201 et seq. (1976).
[29] 91 Stat. 445 (1977), 30 U.S.C. §§ 1201-1328 (Supp. I 1977).
[30] 91 Stat. 565 (1977), 42 U.S.C. §§ 7101-7352 (Supp. I 1977)

6. Mineral Conservation and Multimineral Development: The Geothermal Steam Act of 1970

The Geothermal Steam Act of 1970[3] provides for the leasing of geothermal steam and associated resources in public domain and acquired land administered by the Secretary of the Interior or the Forest Service and in areas where such resources have been reserved by the United States. The provisions of the Act are similar to those for oil and gas under the Mineral Leasing Act of 1920, but include more detailed provisions relating to required and allowed multimineral development, prevention of waste, and protection of surface resources. Leases can be issued for land withdrawn or acquired in aid of the functions of the Department of Agriculture, or subject to powersite applications before the Federal Power Commission, only with the consent of the head of the respective department or agency, and subject to such conditions as he or she may prescribe to ensure adequate utilization of the land for the purposes for which it was withdrawn, acquired, or applied for.

F. Conclusion

Legislation concerning the disposal of minerals and mineral land owned by the Federal Government has been shaped by the predominant national concerns at various periods of the Nation's development. Until the beginning of the 20th century, the predominant concerns affecting Federal mineral and nonmineral land law were generation of revenue and settlement of the western frontier. During the 20th century, concern developed initially over the conservation of commercially valuable mineral and nonmineral resources on Federal land, and subsequently over preservation of noncommercial nonmineral resources.

Laws affecting the disposition of Federal mineral and nonmineral land were enacted from time to time in response to these and other more specific concerns. Separate laws were enacted for various types of resources and lands, usually with little consideration of the net effect on Federal land management. The resultant collection of laws contained duplicative and often conflicting provisions, significant gaps in coverage, and nonuniform treatment of physically identical tracts of land.

Nonmineral resource management on Federal land has been improved significantly by enactment of recent laws such as the Forest and Rangeland Renewable Resources Planning Act of 1974, which applies primarily to Natonal Forest System lands, and the Federal Land Policy and Management Act of 1976, which applies primarily to the great bulk of Federal onshore land managed by BLM and not specifically reserved for national systems such as the parks and forests. Both laws establish procedures for implementing an overall national program to coordinate nonmineral resource management on Federal land. The 1976 Act repealed and replaced almost all of the preexisting laws governing acquisition and disposal of nonmineral rights on Federal land. Neither law, however, provides explicit criteria for the resolution of competing resource uses.

[3] 84 Stat. 1566 (1970), 30 U.S.C. §§1001-1025 (1976).

Procedures have not been legislated for implementing an overall national program of coordinated mineral resource management, or coordinated mineral and nonmineral resource management, on onshore Federal land. Mineral activities continue to be governed by a patchwork system developed over more than a century in response to various goals, problems, and pressures,

For example, sulfur in acquired land in any State is leased. But sulfur in the public domain is leased in Louisiana and New Mexico only; it is disposed of by entry under the Mining Law in almost all other States; and it is not available under any law in a few States (see table 4. I in chapter 4). Similarly, copper is disposed of by lease on most acquired land, and by entry under the Mining Law on most of the public domain. Yet copper on public domain national forest in Minnesota is leased. Copper on acquired land outside the national forests, on the public domain in Wisconsin, Missouri, Michigan, Kansas, Alabama, or Oklahoma, or on the public domain outside the national forests in Minnesota is not available under any law (again see table 4.1).

Consider also the results of the recent transfer of control over the economic (mineral) aspects of fuel mineral leasing from the Secretary of the Interior to the Secretary of Energy. When any agency other than the BLM has jurisdiction over the surface of the land to be leased, the BLM ordinarily will issue the lease only with the consent of, and subject to surface protection conditions specified by, that agency. Consent must be obtained and the conditions must be included if the mineral lease is on acquired rather than public domain land, if it is on land withdrawn or reserved for military purposes, or if it is for geothermal steam or coal. In such situations, the surface management agency would control the surface aspects of the lease and the Secretary of Energy would control the mineral aspects, leaving the BLM with only the paperwork. On the other hand, the BLM could override the surface management agencies with respect to surface stipulations for noncoal, nongeothermal, energy mineral leases on nonmilitary public domain lands, even though it had no interest in either the surface or the energy minerals.

The foregoing examples illustrate the complexity and contradictions of present laws governing the management, use, and disposal of minerals on Federal onshore land.

4.

Coordinating Mineral Activities

4.

Coordinating Mineral Activities

The laws governing mineral exploration, development, and production on **Federal land have significant** gaps in coverage, treat physically similar lands or mineral deposits differently, and contain many provisions that unnecessarily cause considerable uncertain y and cost.

Access to Federal land for mineral activity is uncertain under all the mineral laws. Even after access has been obtained, tenure for exploration is highly insecure under the Mining Law, and tenure for development and production is uncertain for all minerals under the Mining Law and for nonfuel minerals under the mineral leasing laws.

Tenure conditions, including payment requirements, are insufficient in themselves to assure diligent exploration and development or proper conservation of mineral resources. The patchwork system of mineral laws also impedes multiple-mineral exploration, development, and production.

A. Existing Laws for Different Areas and Minerals

1. Overview

Chapter 3 traced the historical development of the principal Federal onshore mineral laws in the context of overall Federal land policy. For more than 100 years, since the middle of the 19th century, mineral laws have been enacted in response to various goals, problems, and pressures. Different provisions within the same law or in different laws were drafted for land in different States, for land acquired by different methods, for different minerals, or for different geologic configurations of the same mineral. The resulting collection of laws contains significant gaps in coverage, treats physically similar lands or mineral deposits differently, and otherwise makes distinctions that are difficult to defend or apply. (See table 4. 1.)

This chapter explores the problems involved in achieving efficient and equitable mineral activities under the existing laws, focusing almost exclusively on the mineral activities themselves. The problems involved in coordinating mineral activities with nonmineral activities will be left, with only a few exceptions, for discussion in chapter 5.

The three principal mineral disposal systems for onshore Federal land are the Mining Law of 1872,[1] the Mineral Leasing Act of 1920[2] and related leasing laws, and

[1] 30 U.S.C. § 21 et seq. (1976).

[2] 30 U.S.C. § 181 et seq. (1976).

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Table 4.1 —Principal Laws Governing Disposal of Minerals on Different Areas of Federal Onshore Land

	Minerals					
Federal onshore land areas	Coal, gas, 011, oil shale, phosphate, potash, sod i urn	Sulfur	Native asphalt, tar sands	Geothermal steam	Common varieties of sand, stone, gravel, pumice pumicite, cinders, clay	All other minerals "hardrock " minerals)
Public domain in						
.la., Kans., Mich., Minn. (except na- onal forests), Mo., Okla. (except eded Indian ınd), Wisc.	*1920* Mineral Leasing Act	No applicable law	1920 Mineral Leasing Act	Geothermal Steam Act	Surface Resources Act	No applicable law
Minn. national ɔrests and cer- ain other areas	1920 Mineral -easing Act	Special leasing laws	1920 Mineral Leasing Act	Geothermal Steam Act	Surface Resources Act	Special leasing laws
ouisiana and lew Mexico	*920* Mineral Leasing Act	1920 Mineral Leasing Act	*1920* Mineral Leasing Act	Geothermal Steam Act	Surface Resources Act	Mining Law
All other areas	1920 Mineral easing Act	Mining Law	1920 Mineral Leasing Act	Geothermal Steam Act	Surface Resources Act	Mining Law
A*cquired land in*						
Most national forests and certain other areas	Mineral Leasing Act for Acquired Land	Mineral Leasing Act for Acquired Land	Reorganlza. tion Plan No, 3 of 1946	Geothermal Steam Act	Surface Resources Act	Reorganization Plan No. 3 of 1946
ll other areas	Mineral Leasing Act for Acquired Land	Mineral Leasing Act for Acquired Land	No applicable law	Geothermal Steam Act	Surface Resources Act	No applicable law

the Surface Resources Act of 1955.[3] The distinctions among the minerals covered by the three systems, and the problems caused by these distinctions, are discussed in the following two subsections and in subsection F(l). The remainder of the chapter focuses in detail on the provisions of the Mining Law and the various mineral leasing laws.

2. **Leasable Versus Locatable Minerals**

One of the major distinctions in the current laws is the division between those minerals that are leased under the mineral leasing laws and those that are located under the Mining Law. Generally,[4] the fossil fuel minerals (oil, gas, coal, oil shale, native asphalt, solid and semisolid bitumen, and bituminous rock), fertilizer and chemical minerals (phosphate, potash, sodium and, in Louisiana and New Mexico only, sulfur), and geothermal resources are leased, while all other uncommon-variety minerals (usually referred to as "hardrock" minerals) are located. Under the leasing laws, the Government retains title to the land and may allow mineral activities by private applicants on payment of rentals and royalties. Under the Mining Law, private parties can ex-

[3]30 U.S.C. §§ 601, 611 (1976).

[4]See table 4.1 for the many exceptions. The major exception is the leasing of hardrock minerals on acquired land.

plore for, develop, and produce minerals on Federal land and acquire title to the land without obtaining permission from the Government and without paying rentals or royalties.

The division between those minerals that are generally leasable and those that are generally locatable is more a matter of history than of geology. At the beginning of the 20th century, all minerals other than coal were locatable under the Mining Law. Coal was in a sense also locatable, because coal land was entered and purchased rather than being leased. The fossil fuel, fertilizer, and chemical minerals were made leasable in the 1920's, primarily because of their critical importance to the Nation for the production of energy, food, and explosives. Conservationists were concerned that these strategic minerals might be monopolized and wasted if they remained subject to uncontrolled disposal under the Mining Law.

Although almost all the newly leasable minerals were then being developed from bedded deposits (e.g., coal) or pools (e.g., oil) and thus were usually easier to find than many of the minerals that remained locatable (e. g., gold or silver in veins), this distinction does not appear to have determined which minerals were made leasable. For example, surficial placer deposits and bedded iron deposits remained locatable.

The types of deposits being explored for and developed today offer even less support for a distinction between locatable and leasable minerals based on geologic characteristics or on any associated difficulty of discovery. Table 2.5 in chapter 2 lists most of the known mineral occurrence types (excluding geothermal steam and common-variety minerals such as limestone, common clay, and sand and gravel). These types are divided into four general categories of geologic configuration—surficial, stratabound-extensive, stratabound-discrete, and discordant. The leasable minerals generally are found in surficial or stratabound-extensive geologic configurations, but also occur in the more-difficult-to-find stratabound-discrete and discordant geologic configurations—e.g., oil and gas, trona (sodium), sulfur, and phosphate. The locatable minerals are scattered throughout all four geologic configurations, with some (e. g., copper and gold) occurring in all four and many others occurring in three of the four.

Thus, the distinction between leasable and locatable minerals is not necessitated by their respective modes of occurrence. The distinction is also difficult to support on other bases. For example, it is sometimes argued that the locatable minerals require expensive processing and fabrication prior to ultimate use, while the leasable fuel and fertilizer minerals do not. But many locatable minerals do not require extensive processing or fabrication, while some of the leasable minerals do for at least some of their major actual or contemplated uses (e. g., plastics from oil and gas, or synthetic fuels from coal and oil shale). Moreover, it is unclear why differences in processing requirements and costs should dictate two separate mineral disposal systems rather than, for example, the use of net rather than gross royalties to account for the differing costs.

If there is no geologic or economic reason for the distinction between leasable and locatable minerals, perhaps they should be combined under a single disposal system, whether that system be a location system, a leasing system, or some other system. Two separate systems inevitably create confusion, require more administrative machinery, and raise coordination problems, even when there is a clear division between them.

The problem is exacerbated when, as is the case with the locatable/leasable distinction, there is no clear division. Minerals generally occur in chemical combination, rather than in pure form. Sodium, for example, never occurs in nature by itself, but always in combination with some other element—e.g., sodium chloride (salt). And minerals, in pure or combined form, rarely occur alone but rather are found associated with other minerals. Thus, it is often doubtful under present law whether a particular mineral or mineral deposit is locatable or leasable. The uncertainty increases as improved mineral technology makes it possible to extract valuable ores from complex compounds and to recover valuable coproducts and byproducts from material formerly treated as waste.

Alunite, a hydrous potassium aluminum sulfate compound, illustrates the problems raised by compounds and associated minerals, Alunite contains both potassium, a leasable mineral, and aluminum, a locatable mineral. Should it be treated as leasable or locatable? The Department of the Interior has held that it is leasable because it contains potassium. And, in fact, the Mineral Leasing Act provides for leasing of all ‘‘chlorides, sulphates, carbonates, berates, silicates, or nitrates” of potassium[5] or sodium. [6] But, granting that alunite by itself is leasable, what is the status of deposits where alunite is associated with locatable minerals—e.g., alunite in porphyry copper deposits, which often contain a higher quantity of potash (in the alunite compound) than copper, but are more valuable for the copper? In a similar situation, a special law, now expired, was needed to permit location of uranium associated with lignite (coal) deposits.[7]

Similar problems have occurred recently with dawsonite, bentonites, zeolites, and feldspars, to name but a few instances.” Such problems, which create considerable uncertainty and litigation, or at best duplicate filings under both the Mining Law and the Leasing Act for the same deposit, can be expected to multiply in the future. The Multiple Mineral Development Act[8] does not solve such problems, as it is inapplicable to leasable and locatable minerals that are so closely intermixed as to make it impossible to extract one without extracting or substantially disturbing the other. ’()

3. Common Versus Uncommon Variety Construction Minerals

In 1955, common varieties of the so-called construction minerals—sand, stone, gravel, pumice, pumicite, cinders, clay, and other mineral materials—were removed from location under the Mining Law and made subject to disposal by competitive sale, primarily to prevent locators under the Mining Law from obtaining title to Federal land for nonmineral purposes. ” However, the distinction between common and uncommon varieties of these minerals has proved difficult to apply in practice and has engendered much confusion and litigation. ’z Moreover, there are times when prospecting is

’30 U.S.C, $281 (1976). The Act also provides for discretionary development of similar associated sodium, magnesium, aluminum, or calcium compounds, but states that mineral deposits in fissure veins ordinarily subject to location under the Mining Law shall continue to be subject to location despite the presence of potash therein. Ibid., § 284.

“Ibid., § 261.

’69 Stat. 679 (1955), *expired* Aug. 11, 1975.

[8] See, e.g., Twitty, Sievwright, and Mills, *Nonfuel Mineral Resources of the Public Lands: Legal Study* 264-265, 972 (1970) (prepared for the Public Land Law Review Commission) (hereinafter cited as *PLLRC Nonfuel Legal Study*); *United States* v. *Union Carbide*, I.B.L.A. 75-29 (1977).

[9] See ch. 3, subsec. D(6).

[10] *PLLRC Nonfuel Legal Study*, at 972, citing U.S. Department of the Interior, Solicitor's Opinion M-36764.4357 (Dec. 4, 1968).

[11] See ch. 3, subsec. D(5).

[12] *PLLRC Nonfuel Legal Study*, at 268-280, 1092, III-36 to 38.

needed to find common-variety minerals, and competitive sale in such instances may be inappropriate. The distinction between common and uncommon varieties would not be necessary if all minerals were disposed of under a system (leasing, location, or whatever) that retained surface title in the Federal Government.

B. Obtaining Access to Federal Onshore Mineral Land

1. Government Control Over Access

One of the basic distinctions, in theory at least, between the Mining Law and the various mineral leasing laws is that any person can at any time enter on Federal land subject to location under the Mining Law and locate a mining claim without obtaining permission from anyone, while access to Federal land subject to mineral leasing is at the discretion of the Secretary of the Interior, who may refuse to issue a permit or lease for practically any reason,[13] or delay a decision on access for an indefinite period.

However, until recently, the Secretary's discretion under the mineral leasing laws was routinely exercised in favor of mineral development. The policy of the Department of the Interior was to issue permits and leases on request, with occasional exceptions such as the moratoriums on issuance of coal and oil and gas permits and leases in the early 1930's.[15]

Because of rising concern about the availability and protection of nonmineral resources on Federal land, the issuance of permits and leases is no longer automatic and, in fact, has nearly ceased for most of the leasable minerals.[16] This problem is discussed more fully in subsection E(2) of chapter 5.

The change in public and agency attitudes and concerns has affected not only discretionary access under the leasing laws, but also the nondiscretionary right of access under the Mining Law. As is shown below, no location under the Mining Law creates any rights against the Government until an actual discovery of a valuable mineral deposit has been made on the located land. Hence, almost any location under the Mining Law can be nullified by withdrawing the land involved from the operation of the Mining Law before the mineral explorer has made the required discovery, even though substantial time and effort may have been expended staking and exploring the land.[17] By 1976, the percentage of Federal land withdrawn from location under the Mining Law was almost double that withdrawn from mineral leasing, if only normal with-

[13] The refusal cannot be arbitrary or capricious. Moreover, the Secretary may have no discretion to refuse to issue prospecting permits for sulfur, since the relevant section of the law, unlike similar provisions for the other leasable minerals, authorizes and directs the Secretary to issue a prospecting permit "under such rules and regulations as he may prescribe" to any qualified applicant. 30 U.S.C. § 263 (1976). But the section applies to the public domain in Louisiana and New Mexico only. Sulfur is locatable under the Mining Law on the public domain in other States, and on acquired land it may be leased only with the consent of the land management agency. 30 U.S.C. § 352 (1976).

[14] *PLLRC Nonfuel Legal Study*, note 8, at 730.

[15] See, e.g., 54 L.D. 350, 351 (1934) (coal moratorium).

[16] *Mining Congress J.*, November 1977, at 99-100.

[17] An example is the withdrawal of 26,927 acres of Federal land in western Utah's Deep Creek Mountains to protect rare wildlife and plants, archeological sites, and the water supply for a farming community from proposed uranium prospecting, for which mining claims had already been located. Sierra Club, *National News Report*, May 27, 1977.

drawals are taken into account (that is, omitting the unique situation posed by the Alaska Native Claims Settlement Act).[18]

Even on land not withdrawn from location under the Mining Law, access may be blocked or subjected to lengthy delays pending environmental studies, or may be so severely restricted as to make access impracticable, under surface use regulations such as those adopted by the Forest Service. For example, the mining industry asserts that the Forest Service mining regulations are so stringently enforced in wilderness and wilderness study areas as to discourage any prospecting or development,[19] By 1976, the amount of land highly restricted with respect to activities under the Mining Law equaled almost 45 million acres, which was more than half the amount similarly restricted with respect to mineral leasing. The total amount of land withdrawn or highly restricted under the Mining Law was slightly more than that withdrawn or highly restricted under the mineral leasing laws[20] (again, omitting the unique Alaska withdrawals). Thus, the distinction between access under the Mining Law and access under the mineral leasing laws is not as clear in practice as it is in theory,[21]

Two significant differences remain, however. First, Government inaction will suffice to deny access under the leasing laws (e.g., "sitting" on an application), whereas positive Government action ordinarily will be required to deny (cut off) access under the Mining Law. Second, access under the Mining Law is often cut off after being initially established, rather than blocked from the start as under the leasing laws. Cutting off access under the Mining Law may result in the waste of substantial exploration expenditures. It may also occur too late to prevent significant damage to surface resources (and to the personal security of private owners if private surface is involved).[22]

2. Treatment of Known Mineral Areas

The Federal mineral disposal laws also differ in their treatment of known mineral areas—areas where the character and extent of mineralization are known or can be estimated with a reasonable degree of confidence. The Mining Law makes no distinction between known and unknown mineral areas. Mineral rights are acquired on either type of area by the first person to locate and perfect a claim to the area. The mineral leasing laws do distinguish between known and unknown mineral areas. Mineral rights for unknown mineral areas are granted to the first qualified applicant, while mineral rights for known mineral areas are assigned through competitive bidding.[23]

The primary reason given for distinguishing between known and unknown mineral areas is revenue. When the mineralization of an area is already known, the Government can auction off the mineral rights in order to receive maximum compensation for the removal of its minerals. If the rights were instead given to the first applicant, he could and often would immediately sell those rights for a windfall gain without any ex-

[18] Ch. 5, sec. G.

[19] App. B, subsec. H(1)(b).

[20] Ch. 5, sec. G.

[21] Access to Federal mineral land for exploitation of the common variety construction minerals is, as with the leasable minerals, subject to the discretion of the Government agencies.

[22] See ch. 5, subsec. D(8).

[23] See subsecs. C(3)(a) and D(3)(a).

All common variety construction minerals are subject to disposal only through competitive bidding or, in certain situations, negotiated sale. 30 U.S.C. § 602 (1976). Free use by public bodies is also authorized. Ibid. § 601.

penditure of funds or effort in exploring or developing the property. Actually, the windfall gain would exist even if he retained the rights himself, but the unfairness of the gain is more apparent when he immediately sells the rights that he has acquired free of charge.

When the mineralization of the area is not known, the only thing the Government can sell is the possibility of a mineral deposit—a possibility, in most instances, comparable, at best, to a 10 or 20 percent chance of successfully discovering a mineral deposit of unknown quality and size. ” The probabilities can be improved by auctioning off very large tracts of land, containing several thousand square miles each, as is done by many foreign countries. But such an approach favors the largest mineral companies and excludes participation by smaller firms and individuals. It would not only run counter to our traditional commitment to equal opportunity for small firms and individuals, but it would also probably result in less intensive exploration of the area, because only one firm would be engaged in exploration rather than many competing firms and individuals searching for different types and sizes of mineral occurrences. On the other hand, without some such arrangement, there often would be few if any bidders at an auction of an unknown mineral area. Any bids that were received ordinarily would be nominal, and they probably would be outweighed by the administrative costs of conducting the auction. Moreover, if the auction process were initiated for unknown mineral areas by private industry nominations, the nominee of an area would risk attracting the interest of other explorers who might outbid him after he had spent thousands or millions of dollars selecting the target area through regional appraisal and reconnaissance.[25]

For these and other reasons, it has generally been thought that known mineral areas should be disposed of through competitive bidding, while unknown mineral areas should be granted to the first explorer willing to undertake detailed exploration.

Nevertheless, there is no such distinction under the Mining Law. Historically, this omission can be explained by the policy of free disposal of Federal land that prevailed at the time the law was enacted.[26] Practically, the omission has not aroused much concern since the passage of the Mineral Leasing Act of 1920, which applied the distinction to the fossil fuel and fertilizer minerals, but left the generally more discrete and harder-to-find hardrock deposits subject to location under the Mining Law. Two factors, however, may combine to make the lack of the distinction in the Mining Law more troublesome today. First, exploration for hardrock minerals is increasingly focusing on low-grade disseminated deposits as a result of improved technology and the growing scarcity of high-grade discrete deposits.[27] Second, expanded and more intensive Government mineral surveys continue to turn up very promising hardrock mineral targets and sometimes even actual mineral discoveries.[28] Unless, as was the case with the mineral discoveries made under the Atomic Energy Commission's uranium exploration program in the 1950's,[29] a special law is passed authorizing competitive disposi-

[24]See ch. 2, sec. E.

[25]See ch. 2, subsec. D(2).

[26]See ch. 3, sec. B.

[27]Lacy, "Technical Developments That Should Be Considered In Drafting Mining Legislation," in University of Arizona, College of Mines, *Symposium on American Mineral Law Relating to Public Land Use* 159 (J.C. Dotson ed. 1966); cf. subsec. A(2).

[28]See, e.g., *Oversight on Access to Minerals on Public Lands*, hearings on H.R. 8435 Before the Subcomm. on Mines and Mining of the House Comm. on Int. & Ins. Affairs, Ser. No. 94-41, 94th Cong., 1st sess. 6 (1975); Kaiser, "Assault on the Wilson Mountains," 10 *Colorado*, No. 1, at 3c, 6c (1974).

[29]See National Academy of Sciences, *Mineral Resources and the Environment, Supplementary Report: Reserves and Resources of Uranium in the United States* 192-202 (1975).

tion of such known hardrock mineral areas,[30] the responsible Federal agencies face the choice of withdrawing them from location under the Mining Law or being charged with favoritism and giving away Federal resources.[31]

Yet, as experience under the mineral leasing laws has demonstrated, the attempt to distinguish between known and unknown mineral areas, like any attempt at drawing a line, involves problems of definition and application. Should “known mineral areas” be defined narrowly, to include only actually discovered deposits capable of being presently extracted, processed, and marketed at a profit; or more broadly, to include any deposit the geology of which is known even if the deposit cannot currently be marketed at a profit; or more broadly still, to include deposits not actually discovered but reasonably believed to exist in view of surrounding geology; or most broadly of all, to include any area where there is substantial competitive interest? How reliably and predictably can each of these definitions, or other possible definitions, be applied?

As with almost every other aspect of the mineral leasing laws, the distinction between known and unknown mineral areas has been defined differently for different minerals, creating unnecessary complexity and confusion for the mineral industry and within the responsible Federal agencies. For example, the test for sodium, sulfur, and potassium is whether the land is “known to contain valuable deposits” of the respective mineral,[32] while the test for phosphate is whether “prospecting or exploratory work is necessary to determine the existence or workability of phosphate deposits in any unclaimed, undeveloped area.”[33] The phosphate language was copied in 1960 from the original 1920 test for coal, which arguably was meant to require competitive leasing in a broader set of situations than the test for sodium, sulfur, and potassium. Congress had been extremely reluctant to authorize noncompetitive prospecting permits for coal, because it believed that the existence of coal on extensive areas of Federal land was known, and that prospecting permits were therefore unnecessary.”[34] However, at the last minute, coal prospecting permits were authorized “to encourage the prospecting of undiscovered coal deposits.”[35] Thus, Congress apparently wanted land to be competitively leased for coal development whenever it was known to contain coal that was technically workable, even if insufficient information was available to demonstrate that the coal could be profitably worked (extracted), transported, and marketed. In contrast, land containing sodium, sulfur, and potassium had to be competitively leased only when sufficient information existed to demonstrate a profitable (valuable) deposit.

Over the years the Department of the Interior has tended to merge and equate the “known to contain valuable deposits” and “existence or workability” tests, requiring competitive leasing whenever a deposit is known (through actual physical discovery or geologic inference) to exist in workable quantity, even if additional exploration is needed to project a program for development or to demonstrate profitability.[36] It re-

[30] See, for the Atomic Energy Commission uranium discoveries, 42 U.S.C. § 2097 (1976); H.R. Rep. No. 2181, 83d Cong., 2d sess. 18 (1954).

[31] Howard E. Banta, Assistant Director for Minerals and Geology, U.S. Forest Service, remarks made at the Office of Technology Assessment Workshop on Legislative Strategies for Mineral Accessibility on Onshore Federal Land, Washington, D.C., July 29, 1976.

[32] 30 U.S. §§ 262, 273, 283 (1976).

[33] Ibid., § 211.

[34] E.g., 51 Cong. Rec. 16575-16576 (daily ed. Sept. 15, 1914) (remarks of Representatives Mondell, Borland, and Ferris); S. Rep. No. 116, 65th Cong., 1st sess. 5 (1917); 56 Cong. Rec. 7600-7601 (daily ed. May 24, 1918) (remarks of Representatives Mondell and Ferris); 58 Cong. Rec. 4876 (daily ed. Aug. 30, 1919) (remarks of Senators Smoot and Nugent).

[35] H.R. Rep. No. 398, 66th Cong., 1st sess. 13-14 (1919) (emphasis added).

[36] *PLLRC Nonfuel Legal Study*, note 8, at 827-834.

mains to be seen whether the merger of these tests can survive the recent emphasis on “present marketability at a profit” as the definition of what constitutes a “valuable mineral deposit” under the mining and mineral leasing laws. [37]

The “existence or workability” test has been applied by regulation to hardrock minerals leased on acquired land or in certain public domain areas.[38] It was replaced for coal in 1976 by a requirement that all coal on Federal land be leased competitively. ” Apparently, native asphalt is also available only through competitive leasing. It is not clear from the regulations whether bitumen and bituminous rock are subject to the “existence or workability” test or are available only through competitive leasing.’[40] There are no general regulations applicable to the disposal of oil shale, but the prototype experimental leases issued in 1973 were leased competitively,”’ and it is likely that future leases will also be issued competitively, because the location and extent of the oil shale deposits are generally known, as with coal.

The test for known oil or gas areas is purely geologic. Competitive bidding is required for lands “within any known geological structure of a producing oil or gas field, [42]

The broadest test of all is that for geothermal steam and associated resources, The Geothermal Steam Act of 1970 requires competitive leasing of all lands within any “known geothermal resources area, ” which is defined to include potentially every tract of land that anyone might be interested in exploring:

> Known geothermal resources area” means an area in which the geology, nearby discoveries, competitive interests, or other indicia would, in the opinion of the Secretary, engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose.’

The regulations of the Department of the Interior define a known geothermal resources area as land known through direct discovery or geologic inference to contain geothermal resources, land within 5 miles of a well capable of producing geothermal resources in commercial quantities unless the land is determined to be on a different geologic structure, land within the structural area contributing geothermal resources to such a producible well (regardless of distance from the well), or land covered by a lease application if at least half of such land has also been applied for in another application filed during the same application filing period.”

The “known geothermal resources area” test obviously goes the furthest in attempting to capture the value of Government mineral land for the Government itself. The most interesting part of the test is the overlapping-applications criterion, The existence of overlapping applications is an objective and easily discernible indication of competitive interest that can be used to prevent mineral-potential value from being siphoned off and burdened by speculators. Whoever can most efficiently explore and

[37] See subsecs. D(2)(a) and D(3)(b); cf. Harris, "The Law of Millsites: History and Application," 9 *Nat. Res. L.* 103, 115-116, 135-136 (1976).

[38] 43 CFR § 3501.2-7, subpts. 3510, 3520, and 3565 (1977).

[39] 30 U.S.C. § 201 (1976), as amended by Federal Coal Leasing Amendments Act of 1975, §§ 2-4, 90 Stat. 1083-1086 (1976).

[40] See 43 CFR §§ 3500.0-3(a)(6), 3500.1-1, 3501.1-4(b)(6), 3521.2-2 (1977).

[41] 38 F.R. 33188 (1973).

[42] 30 U.S.C. § 226 (1976).

[43] Ibid., § 1001(e).

[44] 43 CFR § 3200.0-5 (k) (1977).

develop a tract can obtain it directly from the Government through competitive bidding, rather than purchasing it from a lottery winner (as occurs now for noncompetitive oil and gas leases)[45] or the fastest claimstaker (as occurs now under the Mining Law), who usually will have done little or nothing to develop the property, but will burden its future development by retaining an overriding royalty.[46] The other portions of the test are similar to the geologic and economic criteria used for the other leasable minerals.

Overall, the "known mineral area" provisions demonstrate no uniform approach, although the basic purpose of each presumably is to obtain maximum return to the Government for its minerals and to reduce speculation. Moreover, the provisions create considerable costs and uncertainties. The geologic and economic criteria are fairly subjective, and are often difficult to apply reliably and predictably, A noncompetitive application can be rejected on the basis of information known to the Department of the Interior but not yet published in the tract books or geologic maps,[47] or even on the basis of information received after the application was filed, even though there may be considerable delay in processing an application.[48] The applicant may have expended substantial sums on regional reconnaissance and exploration prior to filing his application for a particular target,[49] The Government must expend substantial time and effort classifying land and determining acceptable bids for known mineral areas (otherwise, known subeconomic deposits, such as oil shale, may be prematurely leased to speculators, as apparently happened with coal in the 1960's). Reliance on pure bonus bidding will favor large firms at the expense of smaller firms and individuals, but this effect can be mitigated or eliminated by using walkaway bonuses, royalties, or profit shares, instead of fixed bonuses, as the bidding variable.[50]

The substantial costs and uncertainties flowing from the distinction between known and unknown mineral areas would seem to justify serious investigation of an alternative approach to maximum revenue generation and avoidance of speculation. One possibility might be a substantial predetermined Government profit share[51] combined with strong diligence requirements and restrictions on overriding royalties on all mineral leases, with competitive bidding used only in cases of overlapping applications for the same tract filed within, for example, 10 days of each other, There might then be no need to define or evaluate known mineral areas.

3. Acreage Limitations

There are two basic types of acreage limitations. One limits the acreage that can be included within a single claim, permit, lease, mining unit, or other form of exclusive mineral right. The other limits the total amount of acreage that can be held by one person or corporation in the Nation, in any one State, or in some other geographic area. The principal purposes of both are to deter speculation and monopolization and to promote diligence and competition.

[45] See 43 CFR subpt. 3112 (1977).
[46] See subsec. F(3).
[47] E.g., 43 CFR § 3100.7-3 (1977).
[48] E.g., ibid., § 3110.1-8.
[49] See ch. 2, subsec. D(2).
[50] See subsec. E(2).
[51] Ibid.

The limitation on the size of an individual claim, permit, lease, mining unit, or other tenure unit serves these purposes in two ways. First, requirements related to discovery and diligent development of mineral deposits generally apply to each tenure unit, so that a limitation on the size of the tenure unit prevents large amounts of acreage from being held by simply performing work on a much smaller number of acres. Second, the limitation on the size of the tenure unit gives smaller firms a better opportunity to participate in the development of known mineral areas, because it prevents putting up tracts for competitive bidding that are so extensive only a large company could afford to bid on or develop them.

On the other hand, if the limitation on individual tenure units is too small, it can cause unnecessary and wasteful work under the mineral discovery and diligence requirements and can prevent assembly of economic mining units for competitive bidding. The problem of unnecessary and wasteful work is acute under the Mining Law, as mining claims are generally limited to 20 acres each,[52] while mineral firms usually need several thousand acres for a single mineral project,[53] A similar problem, although less acute, exists under the mineral leasing laws, which limit the size of individual permits and leases to 640 acres for sulfur permits or leases or competitive oil and gas leases: 2,560 acres for geothermal steam, hardrock, phosphate, potash, or sodium permits or leases or noncompetitive oil and gas leases: and 5,120 acres for oil shale, native asphalt, or tar sand leases.[54] Often several leases must be combined to form an economic mining unit.[55] There is no limit on the size of a coal lease, but leases cannot be combined into a logical mining unit larger than 25,000 acres.[56]

All the limitations on the size of individual tenure units were considered at the time of their adoption to be sufficient to encompass economic mining units. However, the increasing scale of mining has made them too restrictive, especially the oldest limitation—the 20-acre-per-claim limitation under the Mining Law. Even the most generous limitation, the 25,0()()-acre limitation on logical mining units for coal, is considered by some to be insufficient for mining units formed to assemble the massive coal reserves needed for huge mine-mouth power generation plants and coal gasification and liquefaction facilities.

The advantages of a limitation on the size of individual tenure units derive from its use as a foundation for diligence requirements and selection of tracts for competitive bidding, rather than from the limitation itself (as multiple contiguous tenure units generally are allowed). Thus, a more flexible and effective approach might be to replace the acreage limitation on individual tenure units with 1) a limitation, established perhaps by the Secretary of the Interior, on the contiguous acreage that can be treated as a unit for the purpose of satisfying mineral discovery and diligence requirements, subject to enlargement in particular cases upon a satisfactory showing to the Secretary, and 2) a requirement that tracts put up for competitive bidding be no larger than necessary, in the judgment of the Secretary of the Interior, for an economic mining unit.

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[52] See subsec. C(2).

[53] See the acreage figures cited for stages 3 through 6 of mineral activity in ch. 2, table 2.6 and subsecs. D(3) and D(4), and app. C, tables C.2 through C.5.

[54] See subsecs. C(3)(a) and D(3)(a).

[55] See the sources cited in note 53. See also U.S. General Accounting Office, *Acreage Limitations on Mineral Leases Not Effective*, RED-76-117, June 24, 1976, at 12-13 (hereinafter cited as *GAO Acreage Limitations Study*).

[56] See subsec. D(3)(a).

Although there would be no need for maximum acreage limitations on individual tenure units under such an approach, a fairly large minimum acreage limitation on initial acquisition and subsequent assignment of tenure units would avoid the administrative costs, anticonservation effects (due to retention of overriding royalties on assignment),[57] and tract-assembly problems caused by speculation in small parcels of mineral land, which now occurs with respect to oil and gas leasing[58] and acquisition of claims under the Mining Law.[59] Currently, minimum parcel sizes are specified only for assignments of oil or gas leases (40 acres, which is too small) or geothermal steam leases (640 acres).[60]

There is no nationwide, statewide, or other limitation on the total acreage or number of claims that can be held by any one person or firm under the Mining Law. Although originally a prospector was not allowed to locate more than one mining claim on any one lode (mineral deposit),[61] individuals and firms may now locate as many mining claims as they wish.

There are limitations on the total amount of acreage that any individual or corporation can hold under the mineral leasing laws. There is no apparent rationale, however, for the different limitations specified for each leasable mineral: for coal, 46,080 acres per State, but no more than 100,000 acres nationwide; for geothermal steam, 20,480 acres per State (which the Secretary of the Interior can raise after December 24, 1985 to 51,200 acres); for hardrock minerals on acquired land, 20,480 acres (nationwide?), of which no more than 10,240 acres can be held under lease (rather than permit) unless otherwise authorized by the Secretary to promote orderly development of mineral resources (no authorization will be given if it would result in undue control of the mineral to be mined or in the leasing of more than 10,240 acres for mining any dominant single mineral); for native asphalt or the tar sands, 7,680 acres per State; for oil shale, no more than one lease nationwide; for oil and gas, 246,080 acres per State in States other than Alaska, and 300,000 acres in each of the two leasing districts in Alaska; for phosphate, 20,480 acres nationwide; for potassium, 25,600 acres per State in leases and 51,200 acres per State in permits; for sodium, 5,120 acres per State (which the Secretary can raise to 15,360 acres to ensure economic mining in a specific situation); and for sulfur, no more than three permits or leases per State.[62]

These acreage limitations on total holdings, except for the limitations on holdings of hardrock minerals and geothermal steam, are those specified for permits and leases on the public domain under the Mineral Leasing Act of 1920. The Mineral Leasing Act for Acquired Lands of 1947 authorizes the leasing of minerals on acquired land "under the same conditions as contained in the (Mineral Leasing Act of 1920)."[63] The Secretary of the Interior has interpreted this language as creating limitations on acquired landholdings separate from but identical to those specified for public domain holdings, thus doubling the total permissible Federal landholdings.[64]

[57] See subsec. F(3).

[58] *GAO Acreage Limitations Study*, note 55, at 13-14.

[59] See subsec. C(2)(a) and ch. 2, sec. F.

[60] 43 CFR § 3241.1-1 (1977). An exception can be made in the interest of conservation of the resources.

[61] *PLLRC Nonfuel Legal Study*, note 8, at 34, 49.

[62] 43 CFR § 3501.1-4(b)(2) (1977) (potassium); ibid., §3501.2-5(b)(2) (hardrock); 30 U.S.C. § 275 (1976) (sulfur); ibid., § 1006 (geothermal steam); ibid., § 241(a) (oil shale, native asphalt, and tar sands); ibid., § 184 (all other minerals).

[63] 30 U.S.C. § 352 (1976). See ch. 3, subsec. D(3) for the distinction between public domain and acquired land.

[64] 43 CFR § 3501.2-5(a) (1977).

The primary purposes of acreage limitations on total holdings, as was stated previously, are to deter speculation and monopolization and to promote diligent development and competition. The limitations were initially imposed at a time when antitrust laws were weak or nonexistent. There is some question whether the limitations are still necessary or useful to prevent monopoly, given the antitrust laws now in effect. Limitations that are too low will constrain the activities of the more efficient and hence more successful firms, even when there is no monopoly problem. This unnecessarily raises the costs of supplying minerals to the consuming public. Moreover, the current limitations are much too high to deter speculation, especially by the smaller firms and most likely even by the larger firms. The limitations in the mineral leasing laws as originally enacted allowed holding of only one or a few leases per State, but except for sulfur and oil shale those original limits have been raised tremendously by Congress at the urging of the affected mineral producers.” The generosity of the current limitations also erodes their effectiveness in assuring diligent development, which can be approached much more effectively through short lease periods, stiff holding charges, or substantial work requirements. [66]

On the other hand, limitations on total holdings can provide some breathing room for the smaller or less efficient firms, and may thereby serve traditional small business promotion goals. Whether they are actually necessary to provide such breathing room is an open question. [67] Moreover, the difficulties of enforcing the limitations (even though much of the difficulty is attributable to the archaic recordkeeping practices of the responsible Federal agencies)” suggest that more direct approaches to subsidizing small miners on Federal and non-Federal land may be preferable to the Federal acreage limitations.

C. Acquiring and Maintaining Tenure for Exploration

1. Defining Exploration Tenure

“Tenure” refers to the right to make use of land for certain purposes for a definite or indefinite period of time. In the mineral context, tenure involves an exclusive right of use, An exclusive right of use for exploration purposes is necessary or desirable generally when, as a result of regional appraisal and reconnaissance, interest has focused on a specific target that can be further investigated only through detailed surface investigation and three-dimensional physical sampling (stages 3 and 4 of the 6 stages of mineral activity described in chapter 2), Exploration continues until an actual physical discovery has been made of economic grade mineralization in sufficient quantity to support a commercial mining operation. At that point, exploration ceases and development begins. [69]

In this section, exploration tenure is discussed by itself. Development and production tenure will be discussed in the next section. Although exploration tenure is worth-

[65] *GAO Acreage Limitations Study*, note 55, at 5-6, 26-27; *PLLRC Nonfuel Legal Study*, note 8, at 749-750.
[66] See sec. C and D.
[67] *GAO Acreage Limitations Study*, note 55, at 4-12
[68] Ibid., at 18-23.
[69] See ch. 2, subsecs. C(1), C(2), D(2), and D(3).

less in the absence of development and production tenure, or some sufficient substitute reward for successful exploration, there are good reasons for treating them separately. First, the mineral laws themselves generally distinguish between these two tenures. Second, exploration is fundamentally different from development and production, not only in terms of techniques, activities, and land requirements,[70] but also in terms of its inherently greater uncertainty and usually larger risks.[71] This difference is reflected in the separation of exploration activities from development and production activities within most mineral companies, and within the mineral industry as a whole.

2. Exploration Tenure Under the Mining Law

a. Acquiring Exploration Tenure: Pedis Possessio and Claim Location

A mineral explorer under the Mining Law cannot obtain any tenure rights against the United States. He can obtain only limited possessor rights under the pedis possessio doctrine against other mineral explorers.

Tenure rights against the United States under the Mining Law can be obtained only upon discovery of a valuable mineral deposit and location (staking) of a claim encompassing the discovery[72]— that is, only after exploration has been successfully completed. Until such a discovery and location have been made (which under the current interpretation of "valuable mineral deposit" may not be until well into the development stage[73]) the mineral explorer is merely a tenant at the will of the Secretary of the Interior, who can at any time withdraw the land being explored from availability under the Mining Law.

Under the literal language of the Mining Law, there is no tenure even against other explorers prior to discovery of a valuable mineral deposit: "no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located. "[74] However, early in the history of the Mining Law, it became apparent that some sort of prediscovery protection was needed for exploration that required substantial sampling or excavation, Thus the courts created the pedis possessio doctrine, which permits location of a claim prior to discovery and provides limited protection against encroachment on the claim by other prospectors. The requirements and limitations of the doctrine will be discussed in subsection 2(b) immediately below.

Such exploration tenure as exists under the Mining Law can be obtained only through the expenditure of considerable time or money, or both, on unproductive claim location activities. Each claim location must be "distinctly marked on the ground so that its boundaries can be readily traced" and must be maintained each year by the performance of at least $100 worth of labor or the making of at least $100 worth of improvements. The State in which the claim is located can specify additional requirements "governing the location, manner of recording, and amount of work necessary to hold possession" of a claim, "

[70] See ch. 2, sec. D.
[71] See ch. 2, sec. E.
[72] 30 U.S.C. §§ 22, 23, 35 (1976).
[73] See ch. 5, subsec. D(5)
[74] 30 U.S.C. § 23 (1976).
[75] 30 U.S.C. § 28 (1976).

As a consequence of the piecemeal development of the Mining Law between 1860 and 1872, '() a distinction was created between two types of mineral deposits, and separate location procedures were provided for each type. A lode claim must be located for any vein or lode of rock in place that bears a valuable deposit. The location must be made along the strike (length) of the mineral vein, up to a maximum length of 1,500 feet and a maximum width of 300 feet on each side of the vein. A placer claim must be located for any other type of deposit. The location must "conform as near as practicable'" to the rectangular public land surveys and cannot exceed 20 acres for each individual claimant, or 160 acres for an association of eight individuals. Failure to locate a deposit properly as a lode or a placer will invalidate the attempted location. "

The most significant legal aspect of the distinction between a lode claim and a placer claim is that a valid lode claim, but not a placer claim, carries with it certain extralateral rights to any vein the apex of which lies within the boundaries of the claim: the dip of the vein may be followed and mined beyond the sidelines of the claim. "

From the beginning, the distinction between lode and placer claims has been difficult to apply. It has resulted in confusion, litigation, and frustration of miners' expectations. The extralateral rights associated with lode claims have caused even more confusion, litigation, and frustration. The distinction is particularly inappropriate today, when many exploration targets are large disseminated deposits, encompassing hundreds or thousands of acres, which are held in place by rock but have no distinct strike or apex. Such targets are located through multiple contiguous claims oriented to cover the target efficiently, and any possible extralateral rights beyond the blanket of claims are usually waived by agreements between locators of adjacent targets. [79]

Nevertheless, the lode/placer distinction remains in the Mining Law, so that prudent locators must cover a target with duplicate lode and placer claims to eliminate the risk of choosing the wrong type of claim for the deposit. Moreover, the duplicate claims must be filed in the proper sequence to avoid having the placer claim construed as an abandonment of the lode claim. [80]

The requirements for locating claims vary from State to State (thus introducing additional needless inconsistency into the Mining Law), but they generally include detailed instructions for marking a claim with physical monuments, sinking a shaft or drilling a hole to a certain depth to show good faith, and posting and recording notices.' [] The cost of doing all this, most of which is nonproductive and unnecessary,"' has been estimated to range from $25 to more than $500 per claim, depending on the terrain and locale. [83]

The costs involved in acquiring exploration tenure under the Mining Law are not limited to the direct costs of locating the 50 or more claims required to cover a typical single exploration target. (The maximum size of either a lode or placer claim is around

[76] See ch. 3, subsecs. B(2) and B(3).

[77] 30 U.S.C. §§ 23, 35, 36 (1970); *PLLRC Nonfuel Legal Study*, note 8, at 305-318. For a recent congressional attempt to deal with the effects of the lode/placer distinction in the narrow context of the switch from location to leasing of deposits of asphalt and tar sands, see 30 U.S.C. § 241(b) (1976).

[78] 30 U.S.C. § 26 (1976).

[79] *PLLRC Nonfuel Legal Study*, note 8, at 555-577, 1092-1093, 1096, III-44, II-47.

[80] Harris, note 37, at 118-120.

[81] *PLLRC Nonfuel Legal Study*, note 8, at 457-548.

[82] See ch. 5, subsec. D(2)(a).

[83] Peters, "Acquire First, Explore Last, *Mining Eng.*, November 1974, at 78; MacDonnell, *Public Policy for Hard-Rock Minerals Access on Federal Lands: A Legal-Economic Analysis*, 71 Q. Colo. Sch. Mines, No. 2, at 39 (1976); Northwest Mining Association, *Mineral Industry Costs* 22, 55 (1977).

20 acres, except for association placer claims, which can be as large as 160 acres for an association of eight or more individuals,) There are also the costs of finding, buying, leasing, or contesting conflicting claims located by other parties. Such claims have at least a nuisance value, since a mining claim, once located, continues indefinitely and can be given the appearance of validity by a show of minimum work or alleged discovery.

b. Maintaining Exploration Tenure: Pedis Possessio and Assessment Work

The pedis possessio doctrine is subject to restrictions that severely limit the prediscovery protection it affords. A claimholder is protected under the doctrine only as long as he is in actual continuous occupancy of the claim and is diligently and persistently prosecuting work looking to discovery of a valuable mineral deposit in the claim. Even then, he is protected only against "forcible, fraudulent or clandestine intrusion" by another: the doctrine does not protect against an unresisted, peaceable and open entry by another explorer.[84] Nor does it protect against "forcible, fraudulent or clandestine" intrusion upon one who is not in actual occupancy or who is not diligently working toward a discovery. In fact, it is not entirely clear whether the entire claim is protected or only that portion of the claim actually being occupied and worked, or whether the protection expires after a certain (reasonable) amount of time. [85]

The limitations of the pedis possessio doctrine result in weak prediscovery protection even for a single claim, When the doctrine is applied to multiple contiguous claims located to cover today's typically large exploration target, it provides practically no protection at all. Only those claims actually being occupied and worked are protected, even though an efficient exploration plan might call for sequential drilling on only one or a few of the many claims covering the target. The explorer faces the undesirable choice of simultaneously performing work that anticipates discovery on each and every claim, hiring armed guards to protect his claims (illegally) against entry by others,[86] or having some or most of his claims "jumped' by other prospectors. [87]

The obvious inadequacy of the pedis possessio doctrine has led to the development of unwritten customs or "gentlemen's agreements" in active exploration areas whereby prospectors will ordinarily not intrude on a block of claims even though work is being actively prosecuted on only some of them. [88] But these customs are neither universally applied nor uniformly followed, and they create no legal rights.[89] Moreover, like the pedis possessio doctrine itself, they afford no protection against termination of the claim by the Federal Government.

Tenure must be maintained under the Mining Law by at least $100 worth of labor or improvements for each claim each year. This "assessment work" requirement will be discussed more fully in the next section on development and production tenure. It is sufficient to note here that satisfaction of the assessment work requirement will usually not be enough to maintain exploration tenure, which, as was noted above, also depends on satisfaction of the much stricter *pedis possessio* requirements of *continued*

[84] *Cole* v. *Ralph*, 252 U.S. 286, 294 (1920).
[85] *PLLRC Nonfuel Legal Study*, note 8, at 348-360.
[86] As happened recently in Utah. *Ranchers Exploration and Development Co.* v. *Anaconda Co.*, 248 F. Supp. 708 (D. Utah 1965).
[87] See *Adams* v. *Benedict*, 327 P.2d 308 (N.M. 1958).
[88] *PLLRC Nonfuel Legal Study*, note 8, at 362.
[89] See, e.g., *Lombardo Turquoise Milling and Mining Co.* v. *Hermanes*, 430 F.Supp. 429, 443-444 (D. Nev. 1977), and the two cases cited in notes 86 and 87. But compare *MacGuire* v. *Sturgis*, 347 F. Supp. 580 (D. Wyo. 1971); *Columbia Standard Corp* v. *Ranchers Exploration & Development, Inc.*, 468 F.2d 547 (10th Cir. 1972).

actual occupancy and persistent and diligent working of each claim. Assessment work alone will maintain tenure only on a claim on which there has been an actual discovery of a valuable mineral deposit—i.e., a claim that has passed from the exploration to the development stage.[90]

3. Exploration Tenure Under the Mineral Leasing Laws

a. Acquiring Exploration Tenure

Exploration tenure under the mineral leasing laws is acquired by obtaining a prospecting permit or a lease, depending on the mineral. Initial issuance of all prospecting permits and leases is at the discretion of the Secretary of the Interior” (except for uranium permits and leases issued at the discretion of the Secretary of Energy for certain land either not subject to or withdrawn from the operation of the Mining Law),’*

Prospecting permits and leases may be issued for acquired land, for land withdrawn or reserved for military purposes, or for coal or geothermal steam only with the consent of the surface management agency.’1{

Exploration tenure for the nonfuel leasable minerals (sodium, sulfur,’)’ phosphate, potassium, and, on most national forest acquired land and certain public domain areas, the hardrock minerals) is provided by a separate prospecting permit for each mineral, except that a single permit may be issued to cover all the hardrock minerals.[95] A prospecting permit grants an exclusive right to explore the permit area for the mineral specified in the permit but does not authorize mining operations.(”) Successful exploration under the permit may entitle the permittee to issuance of a preference-right development and production lease,{)’

Exploration tenure for oil and gas or geothermal steam is provided by a separate noncompetitive lease for either oil and gas[98] or for geothermal steam.’’” A noncompetitive lease grants an exclusive right to explore for, develop, and produce the minerals specified in the lease,

Prospecting permits and noncompetitive leases are issued to the first applicant,[100] who must submit a $10 filing fee ($50 for a noncompetitive geothermal steam lease) and the first year’s rental ($0.25 per acre, but no less than $20 total, for permits; $1 per acre for a noncompetitive lease) with each application for a permit or lease. [101] All permits and leases must be taken in reasonably compact form according to the legal subdivisions of the public land surveys or, if not surveyed, by a special survey. The

[90] *PLLRC Nonfuel Legal Study*, note 8, at 351-352, 357.

[91] See subsec. B(1).

[92] 42 U.S.C. § 2097 (1976); H.R. Rep. No. 2181, 83d Cong., 2d sess. 18 (1954).

[93] E.g., 30 U.S.C. §§ 201(a)(3)(A)(iii) (coal), 352 (acquired land) & 1014(b) (geothermal steam) (1976); 43 U.S.C. § 158 (military land) (1976).

[94] Sulfur is locatable on the public domain in States other than New Mexico and Louisiana. See note 13.

[95] 30 U.S.C. §§ 211 (phosphate), 261 (sodium), 271 (sulfur), 281 (potassium) (1976); see 43 CFR §§ 3500.0-3(b)(2), 3501.2-5(b)(2), 3511.2-1(b)(2) (1977) (hardrock minerals).

[96] 43 CFR §§ 3510.1-2, 3521.4-1 (1977).

[97] See subsec. D(3)(b).

[98] 30 U.S.C. § 226 (1976).

[99] Ibid., § 1003.

[100] Drawings are used to determine priority when two or more applications have been filed simultaneously. E.g., 43 CFR §§ 1821.2-3, 3000.6-1, 3112, 3511.1-6 (1977).

[101] 43 CFR §§ 3503.2-1, 3503.3-1(a) (1977) (permits); ibid., §§ 3205.2(b), 3205.3-1 (1977) (geothermal steam); ibid., §§ 3103.2-1(a), 3103.3-1, 3103.3-2(a) (1977) (oil or gas).

maximum size of each permit or lease is 2,560 acres, except for sulfur (640 acres).”)[102] Permits and leases are noted on the official land tract books and maps,

Prospecting permits and noncompetitive leases cannot be issued for known mineral areas, which must be competitively leased. Moreover, since the location and extent of Federal coal, oil shale, and native asphalt deposits are generally known, all such deposits are essentially treated as known mineral areas and are competitively leased (the status of bitumen and bituminous rock is not clear).[103] Some predevelopment tract evaluation exploration may occur under competitive leases for any of the minerals, but the riskier deposit-location type of exploration generally will occur only under prospecting permits or noncompetitive leases.[104] Thus, discussion of competitive leases will be postponed until subsection D(3)(a).

b. Maintaining Exploration Tenure

Exploration tenure under prospecting permits is limited to a primary period of 2 years, but potassium permits and hardrock permits may be extended for up to 2 additional years and phosphate permits may be extended for up to 4 additional years, if the Secretary of the Interior believes an extension is warranted. Sodium permits and sulfur permits cannot be extended beyond their 2-year primary period.[105]

The short periods of prospecting permits provide a strong incentive for diligent exploration, because no development or production rights can be obtained for the land covered by a permit unless a valuable deposit of the mineral specified in the permit is discovered in the land during the period of the permit.[106]

Other diligence-related provisions applicable to prospecting permits are relatively insignificant, The regulations require payment of an annual rental of $0,25 per acre, but not less than $20 total, for each permit.[107] Failure to pay the rental when due will result in automatic termination of the permit.[108] The rental is nominal, amounting to only $640 for the maximum permit size (for most minerals) of 2,560 acres. The rental provisions do, however, provide an efficient means of clearing abandoned permits, and they may provide some deterrent against speculation (although the short permit periods would seem to be more effective deterrents in most situations).

Similarly, although any permit may be cancelled “upon failure by the permittee to exercise due diligence in the prosecution of the prospecting work in accordance with the terms and conditions stated in the permit,”[109] the shortness of the permit periods and the lack of any specific requirements or guidelines regarding “due diligence”[110] combine to make the cancellation authority useful only when essentially no work has been performed during the first year or two of a 4-year extension of a phosphate prospecting permit.

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[102] 43 CFR §§ 3101.1-1, 3203.2, 3501.1-4(b) (1977).

[103] See subsec. B(2).

[104] The prominent exception is exploration under geothermal steam leases issued competitively only because of overlapping applications or proximity to nearby discoveries. Ibid.

[105] 30 U.S.C. §§ 211(c), 287 (1976); 43 CFR §§ 3511.1, 3511.3 (1977).

[106] See subsec. D(3)(b).

[107] 43 CFR § 3503.3-1(a) (1977), upheld in *Hannifer v. Morton*, 444 F.2d 200 (5th Cir. 1971).

[108] 43 CFR § 3511.4-2(b) (1977).

[109] 30 U.S.C. § 183 (1976); 43 CFR § 3511.4-3 (1977).

[110] The standard permit form merely requires the permittee “to diligently prospect the lands by core drilling *or other acceptable methods*.” BLM Permit Form 3510-1, Permit Conditions § 1 (1977) (emphasis added).

The duration of and requirements for maintaining noncompetitive oil and gas or geothermal leases are considerably more complicated than the prospecting permit provisions. Much of the complication relates to the development and production stages and is left for discussion in subsection D(3)(c). The discussion here will focus on the aspects most relevant to the exploration phase.

Both noncompetitive oil and gas leases and noncompetitive geothermal leases are issued for a primary period of 10 years, which is extended for an additional 2 years for oil and gas leases or an additional 5 years for geothermal leases if actual drilling operations were commenced on the land under lease prior to the end of the primary period and are being diligently prosecuted at that time. Any further extension of the lease may be had only if oil, gas, or geothermal steam, as the case may be, is being produced in commercial quantities, or if a well has been completed that is capable of producing in commercial quantities.[111]

These periods for noncompetitive leases, unlike those for prospecting permits, provide little or no incentive for diligent exploration, since they allow leases to be held for 10 years without any drilling, grant an additional 2 or 5 years if drilling operations are underway at the end of the 10 years (the operations can be abandoned as soon as the extension has been obtained), and thus allow 12 or 15 years to pass before there is any need to complete a well capable of producing.

These provisions are in marked contrast to the prospecting permit provisions that originally governed oil and gas exploration under the Mineral Leasing Act of 1920, and that produced a glut of oil in the 1930's. The oil and gas prospecting permit, replaced by noncompetitive leases in 1935, was limited to a primary period of 2 years, was conditioned on commencement of drilling operations during the first 6 months and drilling of one or more wells to a depth of at least 500 feet each during the first year and to an aggregate depth of at least 2,000 feet by the end of the second year (unless valuable deposits of oil or gas were discovered at less depth), and allowed extension of the permit for an additional 2 years if the Secretary of the Interior found that the permit tee had been unable, with the exercise of diligence, to test the land.[112]

Minimum annual rentals of $0.50 per acre for oil and gas leases and $1 per acre for geothermal leases are required by law.[113] In 1977, the Secretary of the Interior raised the annual rental for noncompetitive oil and gas leases issued on or after February 1, 1977 to $1 per acre.[114] If the known geologic structure of a producing oilfield or gasfield should be defined to include any part of a noncompetitive oil or gas lease, the annual rental for the entire lease will be raised to $2 per acre.[115] The annual rental for a geothermal lease is raised $1 per acre each year beginning in the sixth year of the lease, but payment of all or any of the additional rental maybe waived upon a showing of sufficient justification.[116] The rental obligation continues for oil and gas leases until there has been a discovery of oil or gas in paying quantities; it continues for geother-

[111] 30 U.S.C. §§ 226(e) (oil or gas), 1005 (geothermal steam) (1976).

[112] Act of Feb. 25, 1920, § 13, P.L. No. 146, 66th Cong., 2d sess., ch. 85, 41 Stat. 437, 441 (1920). Many oil and gas prospecting permits were canceled in the 1930's for failure to comply with the drilling requirements. Swenson, "Of Mountains and Mice," 6 *Land & Water L. Rev.* 135, 141 (1970).

[113] 30 U.S.C. §§ 226(d), 1004(c) (1976).

[114] 42 F.R. 1033 (1977), amending 43 CFR § 3103.3-2(a) (1976).

[115] 43 CFR § 3103.3-2(b)(1) (1977).

[116] 43 CFR § 3205.3-3 (1977).

mal leases until commencement of production in commercial quantities,[117] Failure to pay the rental when due automatically terminates a lease unless there is a well capable of producing in commercial quantities.[118]

These rentals, especially the escalating rentals beginning in the sixth year of a geothermal lease, are much higher than those required for prospecting permits, but it is not clear that they are high enough to act as a strong incentive for diligent exploration. The $1 per acre rental for a noncompetitive oil or gas lease amounts to a holding charge of only $2,560 per year for the maximum 2,560-acre lease. The holding charge for a 2,560-acre geothermal lease would also be only $2,560 for each of the first 5 years, but would reach $15,360 for the l0th year and $28,160 for the 15th and final year of an extended lease, unless waived. These charges are small compared with the hundreds of thousands of dollars that would have to be spent on actual detailed exploration of a lease,[119] and they thus will have little effect on the decision whether or when to explore. Yet rentals set at a level comparable to the costs of actual exploration would greatly increase total costs during the exploration stage without any associated increase in exploration data (rentals are a nonproductive holding charge).[120]

Although the noncompetitive **lease** rentals do not ensure diligent exploration, they may deter acquisition of leases for purely speculative purposes, at least by less wealthy individuals and firms, But even this is doubtful for rentals of only one or a few dollars per acre. The $0.50 per acre rental for noncompetitive oil and gas leases issued after 1960 but prior to 1977 did not prevent rampant speculation in such leases. Oil and gas leases on onshore public land at the end of 1972 encompassed 72 million acres, but more than 90 percent of the leases were not producing, and most of these were not believed to be worth drilling.[121] More than 85 million acres were encompassed by noncompetitive oil and gas leases in 1976.[122] Speculation about a possible oil strike in eastern Nevada in late 1976 resulted in issuance of up to 100 noncompetitive leases a day for several months.[123] No drilling was expected on 90 percent of the leases, which were issued to individuals as well as major companies at rentals of $1 per acre.[124]

All things considered, rentals may be useful only as charges for the value of surface uses lost as a result of mineral activities (that is, as typical land-rent or opportunity-cost charges),[125] rather than as incentives for diligent exploration or development, Diligence may be more reasonably and effectively enforced through other mechanisms such as short exploration periods, specific work requirements (e. g., drilling requirements), or exploration expenditure requirements.

There are no work, expenditure, or other specific diligence requirements for exploration under noncompetitive oil and gas leases, except the requirements for extended tenure discussed above. The law requires oil and gas leases to contain provisions "for the purpose of insuring the exercise of reasonable diligence, skill, and care

[117] 30 U.S.C. §§ 226(d), 1004(d) (1976).

[118] 30 U.S.C. §§ 188(b), 1004(c) (1976).

[119] See ch. 2, table 2.6 and subsec. D(3), and app. C, tables C.2 through C.5.

[120] This cost inflation effect would be avoided if actual exploration expenditures could be credited against rentals, as is permitted for exploration expenditures on geothermal leases in excess of a required minimum. See the discussion in the text at note 131.

[121] U.S. General Accounting Office, Letter B-178205, July 12, 1974.

[122] See U.S. Bureau of Land Management, *Public Land Statistics, 1976*, tables 77-80 (1977).

[123] *Land Use Planning Reports*, Dec. 13, 1976, at 7.

[124] Roger McCormack, Associate State Director for Nevada, U.S. Bureau of Land Management, oral communication, December 1976.

[125] See ch. 5, subsec. E(6).

in the operation of [the] property, ''[126] but the noncompetitive lease forms merely require the lessee to "exercise reasonable diligence in drilling and producing the wells herein provided for, " to either drill and produce all wells necessary to protect the leased land from drainage by wells on adjacent land or pay the estimated royalty lost through such drainage, and to promptly "drill and produce such other wells as the Secretary of the Interior may reasonably require in order that the leased premises may be properly and timely developed in accordance with good operating practice,'"[127] The Secretary has never attempted to force diligent exploration by implementing the last quoted provision.[128]

The regulations for geothermal leases, on the other hand, contain an interesting approach to fairly specific requirements for diligent exploration, under authority granted to the Secretary to prescribe rules and regulations for, among other things, "the maintenance by the lessee of an active development program. ''129 The regulations build on and essentially replace the rental requirements with exploration expenditure requirements. As was discussed above, the Geothermal Steam Act establishes a minimum annual rental of $1 per acre, and the regulations raise the rental $1 per acre each year beginning in the sixth year of the lease. The diligence regulations state that, also beginning in the sixth year of the lease, exploration operations each year must cost at least twice the rental required for that year in order to qualify as diligent exploration for the year, except that the required exploration expenditures shall in no event exceed twice the rental required for the l0th year.[130] Thus, escalating exploration expenditure requirements are piggybacked on the escalating rental requirements. Moreover, the regulations allow any expenditures for diligent exploration operations during the first 5 years of the lease, and any such expenditures in excess of the minimum required expenditures in the sixth and succeeding years, to be credited, in such proportions as the lessee may designate, against 1) required expenditures for future years or 2) required rentals for the current or future years in excess of the basic fixed rental established for the first 5 years of the lease.[131] In essence, without affecting the basic fixed rental, which is not subject to credit and must be paid each and every year, an additional escalating rental has been created that can be satisfied by exploration expenditures in excess of the minimum required exploration expenditures. The situation creates a very strong incentive to incur such excess expenditures in an amount exactly equivalent to the additional escalating rental. The money must come out of the lessee's pocket in any event, and he would ordinarily rather spend it on useful exploration work than on rentals.

The net effect for the sixth and each succeeding year of a geothermal lease is the retention of a small fixed statutory rental and the creation of an annual work requirement similar to the payable, bankable, escalating assessment work requirement advocated by the mineral industry for mineral activities under the Mining Law, including almost equivalent expenditure figures.[132] Assuming that the basic rental for a geother-

[126] 30 U.S.C. § 187 (1976).

[127] BLM Lease Forms 3110-1 (1977) (public domain) and 3110-3 (1973) (acquired land).

[128] U.S. National Aeronautics and Space Administration, *Onshore Lease Management Program Study for the U.S. Geological Survey* 75 (1974).

[129] 30 U.S.C. § 1023 (1976).

[130] 43 CFR § 3203.5 (1977). The actual formula is a bit more complicated, but the statement in the text is accurate assuming the lease adopts the statutory minimum rental as the actual rental for the first 5 years.

[131] Ibid.

[132] See subsec. D(2)(b).

mal lease is set at the statutory minimum of $1 per acre, there will be a diligent exploration expenditure requirement of $4 per acre plus a very strong incentive for an additional expenditure of $1 per acre (in lieu of the $1 additional rental) during the sixth year of the lease. This can be viewed as a work requirement of $5 per acre with the option to pay $1 of the $5 to the Government rather than spending it on work. The work requirement will escalate $3 per acre each succeeding year until a work requirement of $17 per acre, of which $5 can be paid to the Government rather than spent on work, is reached in the l0th year. The requirement will then escalate only $1 per year (the amount of annual increase in the rental) until a maximum work requirement of $22 per acre, of which $10 can be paid to the Government rather than spent on work, is reached in the 15th year. Any exploration expenditures in the first 5 years of the lease or in excess of the work requirement for the sixth and each succeeding year can be "banked" and applied to work requirements in future years.

Unfortunately, the work requirement so laboriously constructed on top of the basic rental requirement is apparently not worth the effort in terms of its effect on diligent exploration. There is no requirement that any exploration work be performed during the first 5 years of the lease, and the expenditure required for the sixth and each succeeding year does not come close to the hundreds of dollars per acre per year spent, on the average, for actual detailed exploration. Using the figures cited in the previous paragraph, only $140,800 would be required to be spent on exploration during the first 10 years of a geothermal lease, a sum several times less than the cost of drilling even one well.[133] Thus, commencement of drilling or any other substantial exploration activity prior to the end of the l0th year is more likely to result from the independent requirement that such drilling be commenced in order for a lease to be extended beyond 10 years, than from the "diligent exploration" work requirements,

D. Acquiring and Maintaining Tenure for Development and Production

1. Defining Development and Production Tenure

Development begins after an actual physical discovery has been made of economic grade mineralization in sufficient quantity to support a commercial mining operation. During the development stage, the quantity, quality, and geology of the mineral deposit are ascertained in the detail required for production planning; production wells or mine workings are developed; and mining-related facilities are constructed in preparation for production.[134]

Production consists of the actual extraction of mineral or ore from the mineral deposit in commercial quantities. It usually includes some onsite milling or processing prior to shipment of the mineral elsewhere for further processing or use. Production continues as long as mineral is extracted in commercial quantities.[135]

[133] U.S. General Accounting Office, *Problems in Identifying, Developing, and Using Geothermal Resources*, RED-75-330, Mar. 6, 1975, at 41-42.

[134] See ch. 2, subsecs. C(1), C(2) and D(4).

[135] Ibid., subsecs. C(1), C(2) and D(5).

In practice, development often continues well into the production stage of mineral activity, as additional portions of the deposit are blocked out for production, or secondary or tertiary recovery techniques are initiated. Thus, development and production are lumped together for tenure purposes under the Federal mineral laws and are discussed together in this section,

2. **Development and Production Tenure Under the Mining Law**

a. Acquiring Development and Production Tenure: Patents and Claims

Development and production tenure under the Mining Law is only slightly less uncertain then exploration tenure. The indispensable element for acquiring and maintaining tenure is the actual discovery and continuing existence of a "valuable mineral deposit" within the boundary of each claim, The "valuable mineral deposit" criterion has been subject to varying interpretation over the last 100 years, but it is currently read as requiring proof that the deposit could be presently mined and marketed at a profit, using available technology, and taking all costs (extraction, processing, transportation, environmental protection, marketing, etc.) and even financing arrangements into account.[136] Such a criterion creates considerable uncertainty as to tenure, since costs and mineral prices often fluctuate. Moreover, tenure cannot be assured under such a criterion for deposits that are expected to be produced in 10 or 20 years but are not now marketable.

Tenure would be even more uncertain if the "comparative value" interpretation of the criterion, which requires proof that the land is more valuable for mineral production than for nonmineral purposes,[137] were given renewed emphasis.

If the valuable mineral deposit criterion has been satisfied for a specific mining claim, and if at least **$500** worth of labor has been performed or improvements made on the claim, complete fee title to the surface and the subsurface of the claim may be obtained by paying a nominal $2.50 or **$5.00** per acre (depending on whether the claim is for a placer or a lode, respectively) for a title document known as a "patent."[138] A patent provides tenure as secure as title to any other piece of private property. Once a deposit has been patented, it can no longer be contested under the valuable mineral deposit criterion, unless the patent was fraudulently obtained.

However, patent proceedings can be lengthy and expensive, and there is always the danger that, given the strictness of the valuable mineral deposit criterion and the unpredictable fluctuation of costs and mineral prices, a patent will be denied and the claim will be invalidated. Many claimholders prefer not to assume the expense and risk of a patent application, since the deposit can be developed and mined without obtaining a patent, in which case the burden will be on the Government to bring a contest proceeding to prove lack of a valuable discovery. On the other hand, if a patent is not obtained, there is always the risk of having the claim challenged by the Government or adverse claimants, either because a satisfactory discovery under the increasingly

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[136] *Coleman* v. *United States*, 390 U.S. 599 (1968); *United States* v. *New Jersey Zinc Co.*, 74 I.D. 191 (1967); *United States* v. *Pittsburgh Pacific Co.*, 84 I.D. 282 (1977). See generally ch. 5, subsec. D(5).

[137] See ch. 5, subsec. D(5).

[138] 30 U.S.C. §§ 29, 35, 37 (1976)

stringent valuable mineral deposit criterion was never made or because changing technology, costs, or mineral prices have made a deposit no longer "valuable."

Three archaic provisions of the Mining Law add to the uncertainty with respect to tenure created by the valuable mineral deposit criterion. Each of the three provisions can create situations in which a good faith effort leading to discovery of a valuable mineral deposit can be completely nullified.

First, the Mining Law needlessly distinguishes between lode and placer deposits, and failure to locate a deposit properly as a lode or a placer will invalidate the attempted location.

Second, a valid lode claim, but not a placer claim, carries with it certain extralateral rights to any vein the apex of which lies within the boundaries of the claim: the dip of the vein maybe followed and mined beyond the sidelines of the claim. The extralateral rights flowing from location of the apex of the vein will take precedence over any claim located along the dip of the vein, even if the claim along the dip was located and proved by discovery of the vein prior to the time the apex claim was located.

Both of these provisions, and their inappropriateness under modern conditions, are discussed in subsection C(2)(a).

The third provision, which is also an anachronism,[139] is the tunnel site provision, which gives a person who diligently digs a mining tunnel the right to possess and work 1,500 feet of all veins discovered in the first 3,000 feet of the tunnel, as long as such veins were not previously known to exist, The possessor right to 1,500 feet of the vein will take precedence over any claim located by another person after the commencement of the digging of the tunnel unless the vein appears on the surface.[140]

One of the most serious problems involved in acquiring development and production tenure under the Mining Law is the lack of adequate provisions for obtaining use of or title to land for various surface uses and facilities related to the mining operation. Lode claims cannot extend more than 300 feet in width on either side of the vein, and placer claims are limited to 20 acres for an individual claimant. There must be an actual discovery of a valuable mineral deposit on each lode or placer claim, so that little room is left for any surface facilities on the mining claim itself.

The Mining Law does authorize location and patent of a maximum of 5 acres of nonmineral land in connection with a lode or placer claim if such land is used or occupied by the proprietor of the claim for mining or milling purposes.[141] "Mining or milling purposes" generally include any function or use directly connected with or facilitating the removal and processing of the ore— for example, pumping works, miners' accommodations, mine offices or shops, ore storage, or waste and tailings disposal. The area located and used for mining and milling purposes is called a millsite.[142]

There are substantial limitations on the location and use of millsites. First, each millsite is limited to a maximum of 5 acres. Second, the millsite must be on nonmineral ground, yet it is often difficult to establish the nonmineral character of the ground

[139] *PLLRC Nonfuel Legal Study*, note 8, at 1093.
[140] 30 U.S.C. § 27 (1976); 43 CFR subpt. 3843 (1977).
[141] 30 U.S.C. § 42 (1976). The cited provision also authorizes location and patent of a millsite not connected with a mine on which a "quartz mill or reduction works" has been constructed.
[142] Harris, note 37, at 124-126.

located, especially given the sensitivity of the valuable mineral deposit criterion to shifting costs and prices. Third, although a separate millsite may be located for each lode or placer claim, only those millsites that are actually occupied and being used for mining or milling purposes are valid. Land may not be held for prospective use, Fourth, functions and uses must be organized to take up the least amount of space, Fifth, the millsite is only as secure as the claim with which it is associated, If the claim is invalidated, the millsite will fall with it. Finally, the Secretary of the Interior may have discretion to refuse to issue a patent for a millsite.[143]

These limitations were probably not too restrictive in 1872 when mining operations were small, involved high-grade deposits, and were not faced with substantial competition for the use of nonmineral land. Today, however, the typical mine encompasses a large, low-grade ore body that is often mined in an environment of intense competition for the surface use of land. Such a mine produces enormous quantities of waste rock and tailings that must be disposed of. If it is an open pit mine, it will have deep slanting pit walls. There will be crushing and processing plants and other customary facilities. The size of the operation requires careful advance planning for the life of the mine. But advance planning is impossible with millsites because of the requirement of present occupancy and use. And, even if millsites could be held for prospective use, it is highly doubtful that they could satisfy all the demands for surface space. There could be at most as many millsites as there are mining claims, and each millsite would be at most one-fourth the size of the typical 20-acre claim, so that the millsites, in the aggregate, would be one-fourth the size of the ore body encompassed by the claims. Yet the ore body is itself likely to be smaller than the area required either for pit slopes or disposal of waste rock or tailings.

Because the Mining Law does not adequately provide for land needed for surface facilities and uses, the miner must seek to obtain such land independently through purchases and exchanges.[144]

b. Maintaining Development and Production Tenure: Patents and Assessment Work

A patented claim is no longer Federal land: legal ownership of the entire claim is transferred from the Federal Government to the mineral claimant free from any controls or requirements with respect to mineral development or surface use.[145] The holder of an unpatented claim has a possessor right to use the claim and its surface for mining purposes. This possessor right is vested against the Government as well as other miners once a discovery of a valuable mineral deposit has been made, and it continues indefinitely unless it can be proved at some point that the deposit is no longer valuable or that the required assessment work (see below) has not been done.[146]

There is no requirement that mineral production ever be commenced, nor any effective legal incentive for diligent development, on either patented or unpatented

[143] Ibid., at 118-126, 130, 133-135; see *Utah International, Inc.*, 36 I.B.L.A. 219 (1978), discussed in *Mining Cong. J.*, October 1978, at 73, 85.

[144] *PLLRC Nonfuel Legal Study*, note 8, at 1047-1050, 1093.

[145] Title to the leasable minerals will be reserved in the Federal Government if the claim is subject to a mineral permit or lease, or a permit or lease application is pending, or the land is known to be valuable for a leasable mineral at the time the patent is issued. See ch. 3, subsec. D(6).

[146] Although the possessory right is vested, the right to obtain a patent may not be—that is, it may be subject to being cut off by a new law. See *United States* v. *Rizzinelli*, 182 F. 675, 681 (D. Idaho 1910); *United States* v. *Mulligan*, 177 F. Supp. 384 (D. Ore. 1959).

claims. Claims continue indefinitely without payment of any holding charges, and there are no limitations on the total number of claims that can be held by a single person. The closest thing to a diligence requirement is the requirement, for unpatented claims only, that $100 worth of labor be performed or $100 worth of improvements be made annually on each claim. But this so-called ‘‘assessment work’ requirement, as is shown below, is very difficult to enforce in practice and, even when complied with, is insufficient to ensure diligent development.

The $100 figure was established in 1872 as the minimum value of the required assessment work. It has not been increased since. Individual States can require more than the minimum $100 worth of work each year, but apparently none have done so. Assessment work requirements on one claim in excess of the $100 minimum maybe applied to satisfy the work requirement on adjacent claims being developed or worked under a common plan. [147] (Compare the pedis possessio and discovery-of-a-valuable-mineral-deposit requirements, which must be satisfied individually on each claim.)

Failure to perform the required assessment work opens the claim for which such failure occurred to location by others, unless the initial claimholder resumes assessment work first. Until recently, the courts held that failure to perform the work would not subject the claim to cancellation by the Federal Government. In 1970, however, the Supreme Court indicated that such cancellation would be authorized for claims to leasable minerals that were located prior to the time such minerals were made leasable.[148] The Department of the Interior has issued regulations that purport to authorize cancellation of any claim for failure to perform the required work,[149] but it is not clear that the Supreme Court's holding can be extended so far.

Unfortunately, it is difficult to determine in practice whether the required assessment work has been performed. The courts have held that the work need only be performed for the benefit of the claim and not necessarily on the claim, so that work performed some distance from the claim may suffice. Moreover, the particular allowable items of work or improvement are determined on a case-by-case basis and, depending on the court, may include such items as the expense of hiring a watchman for a temporarily idle mine. On-the-ground geological, geochemical, or geophysical surveys are allowable items for no more than 2 consecutive years or a total of 5 years. Almost any work on the claim is arguably allowable, so that a person who wishes to relocate the claim (or the Government if it wishes, and is authorized, to cancel the claim) faces an uncertain and probably lengthy and expensive legal dispute with the claimholder, especially since the claimholder need only prove resumption of work prior to the attempted relocation or cancellation in order to prevail (work missed in previous years need not be made up). [150]

Except for geological, geochemical, or geophysical surveys, there is no Federal or State requirement to file any proof of performance of assessment work. Most States provide for, but do not require, the filing of an affidavit stating that the work has been done. The affidavit need not describe the work or contain any proof that it was done. Filing of the affidavit is “merely a convenient method of preserving prima facie

[147] 30 U.S.C. § 28 (1976).
[148] *Hickel v. Oil Shale Corp.*, 400 U.S. 48 (1970).
[149] 43 CFR §3851.3(a) (1977).
[150] *PLLRC Nonfuel Legal Study*, note 8, at 578-610

evidence of the performance of the assessment work. ” In most States, anyone wishing to relocate the claim bears the burden of proving that the assessment work was not done, even if no affidavit was filed.[151] The Federal Government now requires annual filing of either a notice of intent to hold onto a claim or a copy of any affidavit of assessment work filed with the State. Failure to file one or the other will be deemed conclusively to constitute an abandonment of the claim.[152] This new Federal requirement should eliminate a large number of stale, abandoned claims, but it does not in any way help those who wish to relocate or cancel a claim that has not been abandoned but apparently is being held without performance of the required work.

Given the great difficulty of ascertaining and proving that assessment work has not been done on a claim, particularly in light of the small amount of work ($100 worth per claim) required, neither other miners nor the Government are eager to contest a claim even when it appears not to have been maintained by the required work. Another miner will usually either pass the claim over or seek to lease or purchase it, and the Government will ignore it unless it is a significant obstacle to some Federal program (especially since the Government’s authority to cancel most claims for failure to perform assessment work is unclear).

Even when assessment work is done, so that a claim or group of claims is actually validly maintained, the amount of work required is so small that a claim can be held indefinitely without ever producing from or even significantly developing it. One hundred dollars’ worth of work as late as 1890, when the average wage was 20 cents per hour and average annual earnings were less than $480, amounted to a significant and bona fide contribution to development of a claim. In 1872, when the $100 yearly work requirement was established, it probably represented a good summer’s work, at least.[153] But $100 today is a drop in the bucket.

Some people in the mineral industry argue that $100 worth of work per claim still represents a substantial, bona fide effort. They reason that the mineral targets being explored today generally encompass 50 or more claims, in contrast with the one-or-few claim deposits prevalent in 1872, so that the effort per deposit is roughly the same now as in 1872, at least during the initial stages of exploration.[154] This argument may be correct for the initial reconnaissance stages of exploration of large targets, but those are not the stages for which the assessment work requirement was designed. Rather it was designed to ensure diligent, good faith development after discovery of a valuable mineral deposit. (The literal language of the law requires that discovery precede location of a claim.) Diligent, good faith exploration is a pedis possessio problem,’” Average expenditures per acre per year today during the development stage are estimated to be in the thousands of dollars for almost every type of deposit. Even during the earlier detailed exploration stages, expenditures per acre per year today are estimated to be $10 or more for stage 3 (detailed surface investigation) and hundreds of dollars for stage 4 (detailed three-dimensional physical sampling) for almost every type of depos-

[151] Ibid., at 594-595, 602-604.

[152] 43 U.S.C. § 1744 (Supp. I 1977); 43 CFR pt. 3830, published at 42 F.R. 5298, 5301 (1977).

[153] O'Callaghan, "The Mining Law and Multiple Use," in University of Arizona, College of Mines, *Symposium on American Mineral Law Relating to Public Land Use* 31 (J.C. Dotson ed. 1966).

[154] E.g., Bailly, "Mineral Exploration and Mine Developing Problems," at 37-38, paper presented at the Public Lands Law Conference, University of Idaho, Oct. 10, 1966, and updated June 30, 1967.

[155] See subsec. C(2)(b).

it.[156] In contrast, the $100 per claim per year assessment work requirement translates to only $5 per acre per year for a typical 20-acre claim.

Thus, the assessment work requirement is set far too low to assure diligent detailed exploration or development, except perhaps for the initial surface investigation stage of detailed exploration. Instead, the requirement results in needless annual scarring of the land with bulldozers or dynamite charges by those who wish to hold on to claims but are unable or unwilling to conduct genuine activities during one or more years.[157]

In order for the assessment work requirement to serve as an adequate assurance of diligent development, the value of the annual work required would have to be escalated rapidly after the first 1 or 2 years to approach the hundreds of dollars per acre per year spent, on the average, on actual subsurface exploration and then the thousands of dollars per acre per year spent, on the average, on actual development of a deposit. In that case, "banking" of work should be allowed—that is, expenditures in excess of the requirement for 1 year should be credited against work required in future years— to provide the flexibility in timing needed for efficient exploration and development, and to avoid unnecessary surface damage resulting from makework that would otherwise be required during lulls in mineral activity. Additional flexibility and avoidance of needless work could be attained by allowing the mining claimant to pay some or all of the value of the required work to the Government rather than actually performing the work. Finally, more effective provisions for enforcing the assessment work requirement would have to be adopted. For example, a mining claimant could be required to file annually a document describing the type and value of work done on or for the benefit of the claim (perhaps including proof of the work done) or evidence of payment in lieu of work if such payment is allowed. Failure to file the document would automatically terminate the claim. Both the Government and third parties should be allowed to disprove assertions of performance of work made in such a document.

The mining industry has recommended changes in the assessment work requirement similar to those outlined in the previous paragraph.[158] However, it would only raise the value of work currently required ($5 per acre per year assuming the typical 20-acre claim) to a maximum requirement of $20 per acre per year after 15 years, which seems inadequate to assure diligent detailed exploration or development,

Additional changes in the assessment work provisions might include limitation of the amount of land that could be treated as a unit for assessment work purposes[159] and termination of the assessment work requirement after development has been completed and production has begun.[160]

[156] See ch. 2, table 2.6 and subsec. D(3) and D(4), and app. C, tables C.2 through C.5.

[157] See ch. 5, subsec. D(2)(a).

[158] See "Declaration of Policy of the American Mining Congress," *Mining Cong. J.*, November 1977, at 66, 75; Office of Technology Assessment, U.S. Congress, *Draft Proceedings of the OTA Workshop on Legislative Strategies for Mineral Accessibility on Onshore Federal Land*, July 29, 1976, at 27, 33.

[159] See subsec. B(3).

[160] Compare the work requirements for geothermal steam and oil shale leases discussed in subsecs. C(3)(b) and D(3)(c).

3. Development and Production Tenure Under the Mineral Leasing Laws

a. Acquiring Development and Production Tenure in Known Mineral Areas: Competitive Leases

Mineral rights for known mineral areas are issued through competitive bonus bidding.[161] As was discussed in detail in subsection B(2), the distinction between known and unknown mineral areas has been defined differently for different minerals, creating unnecessary complexity and confusion for the mineral industry and the responsible Federal agencies. Generally, however, a known mineral area must be an area where the character and extent of mineralization are known or can be estimated with a reasonable degree of confidence, so that only limited predevelopment tract evaluation exploration will be necessary prior to commencing development, rather than the riskier deposit-location type of exploration necessary in unknown mineral areas. Competitive leases, therefore, are essentially development and production leases, except for those geothermal leases that are issued competitivelv because of overlapping noncompetitive lease applications or proximity to nearby discoveries.

Competitive leases are issued a t the discretion of the Secretary of the Interior, who may refuse to put a known mineral area up for competitive bidding or may reject all bids. Considerable administrative effort is required to determine whether the highest qualified bid is adequate payment for the mineral resource, especially when demand for the resource currently is low but may increase substantially in the future as a result of improvements in technology (e. g., oil shale, geothermal steam, coal gasification and liquefaction), shifts in environmental and other legal requirements (e.g., low sulfur coal). or decreased availability of substitute minerals (e.g., coal, oil shale, and geothermal steam as substitutes for oil and gas).[162]

Each application for a competitive lease must be accompanied by a $10 filing fee (except that no fee is required for competitive geothermal or oil and gas leases] and the first year's rental. All leases must be taken in reasonably compact form accordinx to the legal subdivisions of the public land surveys or, if not surveyed, by a special survey, The maximum size of each lease is 2,560 acres, except for sulfur or oil and gas leases (640 acres), oil shale, native asphalt, or tar sand leases (5, 120 acres), and coal leases (no maximum size, but each logical mining unit is limited to 25,000 acres).[164] leases are noted on the official land tract books and maps.

b. Acquiring Development and Production Tenure Through Successful Exploration in Areas Where Mineral Deposits Were Not Known to Exist: Preference-Right Leases and Noncompetitive Leases

Development and production tenure is acquired in areas not previously known to contain mineral deposits through successful exploration under a prospecting permit or

[161] Competitive bidding is required by law only for coal or known oil, gas or geothermal mineral areas. 30 U.S.C. §§ 201(a), 226(b), 1003 (1976). Known mineral areas of the other leasable minerals are generally subject to lease through "advertisement, competitive bidding, or such other methods as [the Secretary] may by general regulation adopt." E.g., 30 U.S.C. § 283 (1976). The Secretary has adopted competitive bonus bidding for all known mineral areas.

[162] See subsec. E(2) and app. A.

[163] 43 CFR §§ 3103.2 (oil and gas), 3205.2(a), 3205.3-1 (geothermal steam), 3503.2 (other minerals). The rentals for the various minerals are discussed in subsec. D(3)(c).

[164] 30 U.S.C. §§ 201(a) & (d)(7) (coal), 211(a) (phosphate), 226(b) (oil and gas), 241(a) (oil shale, native asphalt, solid and semisolid bitumen, bituminous rock), 262 (sodium), 273 (sulfur), 283 (potassium), 1006 (geothermal steam) (1976); 43 CFR § 3521.2-2(c)(3) (1977) (hardrock minerals).

noncompetitive lease, depending on the mineral. As was discussed in subsection C(3)(a), a prospecting permit or noncompetitive lease authorizing exclusive exploration of a tract of land for a specified leasable mineral is issued to the first applicant.

The law generally provides that the holder of a prospecting permit "shall be entitled to a lease for any or all of the land embraced in the prospecting permit" upon showing to the satisfaction of the Secretary of the Interior "that valuable deposits of [the mineral covered by the permit] have been discovered by the permittee within the area covered by his permit" and, for sulfur, sodium, or potassium permits, "that such land is chiefly valuable therefor. "[165] The lease that is issued as the result of such a discovery is called a preference-right lease. A preference-right lease will be issued only if there has been a discovery of a valuable deposit of the mineral specified in the permit; discovery of a valuable deposit of some other mineral will not suffice.'") Thus, a preference-right hardrock mineral lease apparently will not be issued unless there has been discovery of a valuable deposit of the dominant hardrock mineral or minerals required to be specified in the permit, [167]

The provision authorizing issuance of coal prospecting permits was repealed in 1976, [168] but there are still many pending applications for preference-right coal leases based on asserted discoveries of valuable deposits of coal under permits issued prior to 1976.1'"

The "valuable deposit" criterion for issuance of a preference-right lease is the same criterion that determines the validity of mining claims located under the Mining Law.[170] Thus, there is no right to a lease unless the permittee can show that the deposit can be presently mined and marketed at a profit, using available technology, and taking all costs (extraction, processing, transportation, environmental protection, rehabilitation, marketing, etc.) and even financing arrangements into account,'" As is the case under the Mining Law, the use of the criterion can create considerable uncertainty with respect to acquisition of development and production tenure, since costs and mineral prices are often unpredictable.

Additional uncertainty is created by the requirement that sulfur, sodium, or potassium permitters show that the land is "chiefly valuable" for the mineral deposit before a preference-right lease can be issued. This requirement apparently expressly incorporates the "comparative value" test for granting development and production rights—that is, the land must be more valuable for mineral production than for nonmineral purposes, [172] It has been suggested that the comparative value test is implicitly applicable to all preference-right lease applications, and that it was explicitly referred to for sulfur, sodium, and potassium only as a result of the history of land classification and withdrawals. [173]

[165] 30 U.S.C. § 211(b) (phosphate), 262 (sodium), 272 (sulfur), 282 (potassium) (1976); 43 CFR § 3521.1-1(f) & (h) (1977) (hardrock minerals).

[166] 43 CFR §§ 3520.1-1(a), 3521.1-1(h) & (i) (1977); BLM Permit Form 3510-1 (1977).

[167] Ibid.; 43 CFR § 3511.2-1(b)(2) (1977) .

[168] Federal Coal Leasing Amendments Act of 1976, § 4, 90 Stat. 1083, 1085 (1976).

[169] The requirement for a coal lease is literally discovery of coal "in commercial quantities," but "commercial quantities" has the same meaning as "valuable deposit." 43 CFR § 3520 1-1(c) (1977).

[170] 41 F.R. 2648, 18845 (1976).

[171] See subsec. D(2)(a).

[172] See ch. 5, subsec. D(5).

[173] Wright, Office of the Solicitor, U.S. Department of the Interior, *Draft Research Memorandum on Preference Right Leasing of Mineral Deposits on Land Owned by the United States*, Jan. 2, 1975, at 50-65, 101-108, 112-119. See also ch. 5, subsecs. D(5) and E(5).

Acquisition of development and production tenure by means of a prospecting permit followed by a preference-right lease is made even more uncertain because the Secretary of the Interior can and does wait until an asserted discovery has been made before deciding what rental, royalty, environmental protection, and other provisions should be inserted in the lease.[174] Except for statutory restrictions on rentals and royalties for certain minerals,[175] the Secretary has wide discretion to insert whatever lease provisions are necessary "for the protection of the interests of the United States, for the prevention of monopoly, and for the safeguarding of the public welfare,"[176] even if such provisions might make it technically or economically impossible to develop and produce the discovered deposit.[177] Theoretically, then, exploration under a prospecting permit must proceed in almost complete ignorance of what the development-and-production-lease provisions will be if a valuable mineral deposit is discovered. In practice, however, the serious uncertainty that could result from such ignorance has been avoided in the past by the use of standard lease forms with rentals and royalties at or near the statutory minimums and weak (if any) surface protection requirements.[178] However, there is no assurance that this practice will continue, particularly with respect to surface protection requirements. The Secretary's ability to manipulate lease provisions also allows him to manipulate the valuable deposit determination, because the cost of complying with lease provisions must be taken into account in determining whether a deposit can be presently mined at a profit.[179]

Lastly, even if the permittee can prove that he has discovered a valuable deposit and, if necessary, that the land is chiefly valuable therefor, he may have only a preferred right to a development-and-production lease, if one is issued, rather than an absolute right to demand a lease, even though the relevant sections state that the permittee "shall be entitled to a lease." The legislative history of these sections is replete with statements that the permittee obtains a "preference right to a lease."[180] The relevant regulations and the standard prospecting permit form have consistently referred to the lease rewarded for discovery under a permit as a "preference right" lease.[181] The Bureau of Land Management, which is responsible for the issuance of mineral leases, defines "preference right" as:

> The right of an individual applicant, or class of applicants, to apply for public lands or resources prior to the general public or to assert claims superior to those of other applicants.[182]

In cases involving preferential rights to mineral leases given to persons other than prospecting permitters, the Department of the Interior has clearly held that a preference right to a lease is not an absolute right, but only a right of first refusal if the Government decides to lease the land.[183] This is the usual interpretation of preference rights under the Federal land laws. There are indications that it is the interpretation

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[174] Montana Eastern Pipeline Co., 55 I.D. 189 (1935).

[175] See subsec. D(3)(c).

[176] 30 U.S.C. § 187 (1976).

[177] See ch. 5, subsecs. E(3) and E(4).

[178] See ibid. and subsec. D(3)(c) of this chapter.

[179] 43 CFR § 3521.1-1(c) (1977).

[180] E.g., H.R. Rep. No. 398, 66th Cong., 1st sess. 13-14 (1919) (coal permittee has "preferential right to a lease"); H.R. Rep. No. 1278, 86th Cong., 2d sess. 2 (1960) (phosphate permittee has "same preference right to a lease that permittees seeking leases for coal, sodium, sulfur, and potash now have"); accord, S. Rep. No. 879, 86th Cong., 1st sess. 2 (1959). See generally *Draft Research Memorandum on Preference Right Leasing*, note 173.

[181] 43 CFR §§ 3520.1-1, 3521.1 (1977) (headings); BLM Permit Form 3510-1 (1977). Prior to 1976, the "preference right" lease reference was in the body of 43 CFR § 3520.1-1, rather than just in the heading.

[182] U.S. Bureau of Land Management, *Glossary of Public-Land Terms* 36 (1949).

[183] E.g., Elwyn C. Hale, 62 I.D. 19 (1955).

that was meant to be applied to preference-right mineral leases resulting from prospecting permits. ’H’ In practice, however, leases have been routinely granted to prospecting permitters who have discovered valuable mineral deposits. Not until recently has this practice been challenged, and the issue is still unresolved. [185]

Development and production tenure under noncompetitive geothermal or oil-and-gas leases is much more certain, since it is granted along with the initial grant of exploration tenure. An explorer who obtains a competitive or noncompetitive geothermal or oil-and-gas lease obtains the right to explore for, develop, and produce any geothermal resource or oil or gas deposit, respectively, during the term of the lease, There is no valuable deposit criterion to be satisfied after exploration and prior to development and production, and the lease provisions governing development and production are established together with those governing exploration at the beginning of the lease term.

Each application for a preference-right lease must be accompanied by the first year’s rental ($1 per acre, but not less than $20 total, for hardrock minerals; $0.50 per acre for sulfur; $0.25 per acre for all other minerals). [186] There is no filing fee. [187]

The maximum size of each preference-right lease or noncompetitive lease for a particular mineral is the same as for competitive leases of the same mineral (see subsection a immediately above), except noncompetitive oil and gas leases are limited to 2,560 acres while competitive oil and gas leases are limited to 640 acres.

c. Maintaining Development and Production Tenure

Lease periods and other provisions relating to maintenance of development and production tenure vary considerably for the different leasable minerals, with no readily apparent reason (other than historical) for most of the differences. For the most part, however, the provisions applicable to leases of a particular mineral are the same whether the leases are competitive, noncompetitive, or preference-right leases.

With only a few exceptions, the lease provisions for each leasable mineral are inadequate to assure diligent development and commencement of production. They also create uncertainty with respect to the long-term continuation of production rights.

(i) **Lease Periods and Adjustment of Lease Provisions.** The lease period for each leasable mineral is presented in table 4,2. The table also indicates whether and under what conditions a renewal or extension may be obtained for leases that have fixed primary periods, and whether and how often the Secretary of the Interior may adjust the lease provisions to accommodate changed circumstances.

Coal leases issued prior to August 4, 1976, and all phosphate and potassium leases are issued for indeterminate periods—that is, they last indefinitely as long as

[184] E.g., 30 U.S.C. § 272 (1976) (sulfur permittee has "privilege" of leasing); see S. Doc. No. 392, 65th Cong., 3d sess. 15 (1919); 58 Cong. Rec. 4873 (daily ed. Aug. 30, 1919) (remarks of Senator Lenroot); *Duesing* v. *Udall*, 350 F.2d 748 (D.C. Cir. 1965), cert. denied, 383 U.S. 912 (1966); *Draft Research Memorandum on Preference Right Leasing*, note 173.

[185] A 1973 decision of the Department of the Interior's Board of Land Appeals raised but refused to decide the issue. Stanford R. Mahoney, 12 I.B.L.A. 382, 388 (1973). See *Natural Resources Defense Council, Inc.* v. *Berklund*, Civ. No. 75-0313 (D D.C. June 30, 1978), appeals docketed, Nos. 78-1757, 78-1787, 78-1842 (D.C. Cir. Aug. 7, 11, 21, 1978).

[186] 43 CFR § 3521.1-1(f) (1977).

[187] Ibid., § 3503.2-2(b).

Table 4.2—Lease Tenure: Lease Period and Adjustability of Lease Provisions

Mineral leased	Initial lease period (primary period)	Extension of initial lease period	Preferential right to renew lease	Adjustment of lease provisions
Phosphate or potassium	Indeterminate (20yrs. and so long thereafter as terms compiled with)			May be adjusted every 20 years
Coal leased				
before 8/4/76	Indeterminate	—	—	Every 20 years
after 8/3/76	20 years, but terminates after 10 years if no production	So long as coal produced annually in commercial quantities		End of primary term and every 10 years thereafter
Oil shale	Can be indeterminate, but 20 years for prototype leases	Prototype leases: so long as production in commercial quantities		Prototype leases every 20 years
Oil or gas	Initial 5 years for competitive or 10 years for noncompetitive, plus 2 years if then drilling	So long as producing or capable of producing in paying quantities or reworking or redrilling	—	
Geothermal steam	Initial 10 years, plus 5 years if drilling at end of initial 10 years	Up to 40 years after initial 10, so long as producing or utilizing in commercial quantities	For another 40 years	Every 10 years (20 for rentals/royalties) beginning 10 yrs. (35 for rentals/royalties) after steam produced
Sulfur	None mentioned in law, but 20 years under regulations	—	For successive 20-year periods	Every 20 years
Sodium	20 years	—	For successive 10 year periods	Upon each renewal
Hard rock minerals	Maximum of 20 years under regulations	Unconditioned right to renew for successive 10-year periods		Upon each renewal

the terms and conditions of the lease are complied with.[188] The terms and conditions of each lease are subject to reasonable readjustment by the Secretary of the Interior at the end of each 20-year period. Recently, the Secretary has promulgated regulations that apparently require that each coal lease adjusted after August 4, 1976, be limited to a 20-year period and so long thereafter as coal is produced annually in commercial quantities.[189]

A coal lease issued on or after August 4, 1976, is limited by law to 20 years and so long thereafter as coal is produced annually in commercial quantities. It will be terminated at the end of 10 years if it is not by then producing coal in commercial quantities, and its terms are subject to readjustment at the end of the initial 20-year period and at the end of each 20-year period thereafter.[190]

[188] Act of February 25, 1920, § 7, P.L. No. 146, 66th Cong., 2d sess., ch. 85, 41 Stat. 439 (1920), amended Aug. 4, 1976 by Federal Coal Leasing Amendments Act of 1976, § 6, P.L. No. 94-377, 90 Stat. 1087 (1976), codified in 30 U.S.C. § 207 (1976) (coal); 30 U.S.C. § 212 (1976) (phosphate); ibid. § 283 (potassium).

[189] 43 CFR § 3520.2-1 (1977), published in 42 F.R. 25470 (1977).

[190] 30 U.S.C. § 207(a) (1976).

Coal leases issued or adjusted after August 4, 1976, are therefore now similar to leases of the other leasable fuel minerals. For example, the prototype oil-shale leases issued in 1974 were issued for 20 years and so long thereafter as production in commercial quantities is maintained, and they are subject to readjustment every 20 years.[191] It is likely that future oil-shale leases will be issued on similar terms, even though the law allows (but does not require) leases of oil shale, native asphalt, solid and semisolid bitumen, and bituminous rock to be issued for indeterminate periods.[192]

Similarly, oil and gas leases are issued for initial periods of 5 years if issued competitively, or 10 years if issued noncompetitively, and so long thereafter as there is a well on the lease producing or capable of producing in paying quantities, or being reworked or redrilled after having produced in paying quantities. The initial period is extended for 2 years if drilling is underway at the end of the period.[193] The law does not provide for adjustment of the lease terms and conditions.

Geothermal leases are issued for an initial period of 10 years and are extended for an additional period of up to 40 years so long as geothermal steam is being produced or utilized in commercial quantities, The initial 10-year period is extended for 5 years if drilling is underway at the end of the period, and a lessee has a preferential right to renew the lease for another 40 years after the end of the first 50 years. Geothermal lease provisions other than rental and royalty rates are subject to readjustment every 10 years beginning 10 years after geothermal steam is produced; rentals and royalties are subject to readjustment every 20 years beginning 35 years after geothermal steam is produced.[194]

By regulation, hardrock minerals are leased for a maximum initial period of 20 years with an unconditional right to renew for successive 10-year periods. In effect, therefore, hardrock leases are issued for indeterminate periods, like phosphate and potassium leases and pre-1976 coal leases. Hardrock leases are subject to readjustment each time they are renewed.[195]

Sodium leases must be issued for an initial period of 20 years with only a preferential right to renew for successive 10-year periods. The length of sulfur leases is not specified in the law, but the regulations apparently require them to be issued for an initial period of 20 years with a preferential right to renew for successive 20-year periods. Sodium and sulfur leases are subject to readjustment each time they are renewed.[196]

None of the lease periods discussed above is by itself sufficient to assure prompt development. Actual mineral deposits, including even hardrock mineral deposits, normally can be developed in a few (1 to 5) years; they rarely require more than 15 years.[197] Yet phosphate, potassium, hardrock, or unadjusted pre-1976 coal leases continue indefinitely with no provision for automatic termination for failure to develop or

[191] 38 F.R. 33189, 33193 (1973).

[192] 30 U.S.C. § 241(a) (1976). There are no regulations applicable to oil shale leases. There are a few regulations applicable to asphalt leases, but it is not clear whether the regulations refer to asphalt in Oklahoma leased under a special law or asphalt in general, including perhaps bitumen and bituminous rock. See, e.g., 43 CFR § 3500.0-3(a)(6) & (c)(2), 3500.1-1, 3500.1-3(b), 3501.1-4(b)(6), 3501.3-2(b)(2)(v), 3503.3-1(b)(5), 3504.1-2(b), 3520.2-1(a)(1), 3521.2-2, 3521.3-1(a), 3521.4-2, 3562 (1977).

[193] 30 U.S.C. § 226(e) & (f) (1976).

[194] Ibid. §§ 1005, 1007.

[195] 43 CFR §§ 3520.2-1(a)(2), 3522.1-2(c) (1977).

[196] 30 U.S.C. § 262 (1976) (sodium); 43 CFR §§ 3520 2-1, 3522.1-2(b) (1977) (sodium and sulfur).

[197] See ch. 2, table 2.6 and subsec. D(4), and app. C, tables C.2 through C.4.

produce within a certain number of years. Similarly, sodium and sulfur leases last for an initial period of 20 years, and the lessee then has a preferential right over all other potential lessees to renew for additional periods whether or not development or production has occurred.

The continuation of fuel mineral leases, including coal leases issued or adjusted on or after August 4, 1976, is conditioned on commencement of production[198] after a certain number of years. But the number of years specified for coal (10 years) or oil and gas (12 years for noncompetitive leases, 7 years for competitive leases) is several times the normal 1- to 3-year period required for development of these minerals.[199] (A few of the years allowed in excess of the normal time required for diligent development may be required for completion of detailed exploration in advance of development, particularly for noncompetitive oil and gas leases.[200]) The 15 years for geothermal steam and 20 years for oil shale may more closely reflect the time currently required for development of these minerals, given the serious technological and environmental problems yet to be solved prior to substantial production of either mineral.[201] But these periods could also be longer than normally required when and if the problems are solved.

Development times in excess of 10 years are almost always the result of delays in starting up or continuing development—delays due to lack of capital, markets, sufficient high-grade ore, technology, production capacity, infrastructure, desired profit margin, or required environmental clearances[202] rather than time actually spent on development. The Secretary of the Interior may authorize suspension of operations and may extend the lease period in many of these instances.[203] It is not clear that delays in some of the remaining instances are in the public interest—for example, delayed development due to lack of capital to finance development, or due to abundant reserves of ore in more profitable mines owned by the same company, when another company would be willing and able to begin development immediately.

Some deposits, however, may require much more than the normal time to develop because of their low grade, geologic complexity, depth, or geographic remoteness. A maximum period of 5 or even 10 years for completion of development and commencement of production could prevent or negate good faith efforts to develop such deposits.

It is not possible to establish a required period for starting mineral production that will assure diligent development of the easier-to-develop deposits without precluding development of the harder-to-develop ones. Nevertheless, some maximum limitation—for example, 15 or 20 years—on the time allowed to complete mineral development and commence (or be capable of commencing) production seems advisable to prevent indefinite holding of Government land without development. At present, only the fuel mineral leases contain such a limitation.[204]

The lease period could be used to assure diligent development if it were conditioned on commencement of substantial development activity within a very few years

[198] Oil and gas leases need only have a well capable of producing, rather than actual production, unless the Secretary of the Interior has ordered that the well be produced.

[199] See ch. 2, subsec. D(4) and app. C, tables C.3 and C.4.

[200] See app. C, tables C.3 and C.4.

[201] See app. A, subsecs. F(4) and F(8).

[202] See ch. 2, subsec. D(4).

[203] E.g., 30 U.S.C. §§ 209, 1023 (1976); BLM Lease Form 3520-6, § 2(a) (1972). See subsec. F(4).

[204] See table 4.2.

after issuance of a lease, and continuation of such activity until production is possible, subject to extensions or suspensions authorized by the Secretary of the Interior. But no mineral leases at present contain such a condition, Geothermal and oil and gas leases require that drilling be underway at the end of a certain number of years unless there is a well on the leased land capable of producing (see table 4.2). But the drilling requirement is more of an exploration requirement than a development requirement; it does not come into play until 5 or 10 years have elapsed and it does not require that the drilling be continued until there is a well capable of producing.

Conditions placed on the lease period to assure diligent production are also a problem, The fuel mineral leases are generally extended after their primary period only as long as the mineral under lease is produced annually in commercial quantities (oil and gas leases are also extended as long as there is a well capable of producing in paying quantities, unless the Secretary orders that the well be produced). The nonfuel mineral leases contain no such condition on the continuation of the lease period. (See table 4.2.)

The requirement of annual production for the fuel mineral leases can result in inefficient production, In any given year, the price of the mineral may be insufficient to cover the production costs, or greater profits may be possible if production is delayed to some future time when the mineral will be more valuable or the cost of producing it will be less. In these and other situations, not involving monopolistic or oligopolistic practices, efficiency and mineral conservation are served by postponing production. The Secretary has the authority to authorize suspension of operations and production under, and extension of the term of, any mineral lease, in the interest of conservation.[205] Thus he can suspend the annual production requirement in the sorts of situations mentioned above. Nevertheless, the procedure is cumbersome, and the lessee can never be sure the Secretary will actually authorize the suspension, especially when the suspension is sought in anticipation of higher profits in the future.

On the other hand, the absence of any production-related condition on the lease periods for the nonfuel minerals[206] may allow Government land to be held for indeterminate periods without production, resulting in indefinite prolongation of unreclaimed damage to nonmineral resources and uncompensated interference with land use and land management planning.[207]

A possible solution might be the uniform adoption of the production-conditioned lease periods currently specified for the fuel minerals, with an added provision allowing the lessee to choose to pay substantial advance royalties in lieu of production during any 1 or more years after development has been completed. The completion of development is usually the best guarantee of timely and efficient mineral production, The substantial costs of preparing the lease for production can be recouped only by starting up and continuing production. Ordinarily, the lessee will want to recoup these costs and turn a profit as soon as possible. But he could choose to delay production in the interest of efficiency by paying the required advance royalty. Since it is an advance

[205] 30 U.S.C. §§ 209, 1010 (1976); BLM Lease Form 3520-6 (1972) (hardrock minerals).

[206] Continuous production may be required for the hardrock minerals. See the language quoted in the text at note 222

[207] See ch. 5, subsec. E(7); cf. ch. 5, subsec. D(8).

royalty and can be credited against future royalties due on actual production, it should not significantly affect the efficient timing of production. It will, however, discourage a lessee from holding on to a lease that will not be produced again for many years, if ever,

Other provisions related to the lease period also create uncertainty with respect to the long-term continuation of production rights. Lessees of geothermal steam, sodium, or sulfur have only a preferential right to renew their leases after the end of the initial lease period. The Secretary may refuse to renew a lease for these minerals if he does not wish mineral operations to continue on the leased land. The resulting uncertainty is not a major problem for geothermal steam leases, since the initial lease period covers up to 50 years, but the sodium and sulfur leases have initial periods of only 20 years (see table 4.2).

Apart from the renewal provisions, uncertainty is created by the provisions for periodic adjustment of lease terms and conditions, Leases for each leasable mineral other than oil or gas[208] are subject to such adjustment, generally at the end of the first 20 years of the lease and every 10 or 20 years thereafter, depending on the mineral (see table 4.2). Geothermal steam leases are not subject to adjustment until 10 years after production has been achieved, and rentals and royalties for such leases cannot be adjusted until 35 years after production has been achieved. The Secretary's power to adjust lease terms and conditions cannot be exercised arbitrarily or capriciously, but it nevertheless creates uncertainty regarding the nature and profitability of future production rights.

(ii) Work Requirements. Leases for some minerals are subject to specific work requirements that can, at the option of the Secretary of the Interior, result in cancellation of a lease if they are not complied with. For example, coal leases have always been subject to the conditions of diligent development and continued operation of the mine or mines, except when such operation is interrupted by strikes, the elements, or casualties not attributable to the lessee.[209] Until very recently, however, the phrases "diligent development" and "continued operation" were not defined or elaborated by the Secretary of the Interior, and in the absence of such definition or elaboration, the Secretary was unwilling to cancel leases for failure to comply with the conditions, even when leases had been held for 10 years or more with neither development nor production.'") Moreover, as is discussed more fully below, the Secretary has permitted payment of advance royalties in lieu of compliance with the requirement of continued operation.

Regulations issued by the Secretary in 1976 define "diligent coal development" as timely preparation for and initiation of production so that commercial quantities of coal are produced within 10 years of issuance of the lease if the lease was issued after August 3, 1976, or within 10 years of June 1, 1976, if the lease was issued prior to August 4, 1976, Substantial extensions of time are permitted for leases issued prior to August 4, 1976.[211] "Commercial quantities" is defined as one-fortieth (2.5 percent) of

[208] Although the law does not explicitly provide for adjustment of oil and gas leases, the Secretary could insert adjustment provisions in oil and gas leases under general authority granted by the law. See 30 U.S.C. §§ 187, 189 (1976).

[209] 30 U.S.C. § 207 (1976).

[210] See the GAO studies cited in notes 244 and 245

[211] 43 CFR §§ 3500.0-5(f) & 3520.2-5 (1977).

the lease (or logical mining unit) reserves for leases issued before August 4, 1976, and as 1 percent of the reserves for leases issued after August 3, 1976.[212] Leases issued on or after August 4, 1976, shall be terminated, as required by recent amendments to the law, if they do not produce within 10 years, but leases issued prior to August 4, 1976, are subject under the regulations only to possible cancellation in whole or part for lack of diligent development.[213]

In effect, the Secretary has nullified the diligent development requirement for coal leases issued after August 3, 1976, by equating it with the independent requirement, under the law, of obtaining production on such leases within 10 years after their issuance, The diligent development requirement for leases issued prior to August 4, 1976, is even weaker, There is no requirement for any coal lease, whenever issued, that any development activity ever be undertaken—a lease can be held for 10 years (or longer if issued prior to August 3, 1976)[214] without doing anything and can then be abandoned. Some incentive for "early" (within 10 years) development or abandonment of coal leases may be provided by the requirement under the law that no new coal lease be issued to anyone who has an outstanding coal lease that has been held for at least 10 years after August 4, 1976, and is not producing coal in commercial quantities.[215] But the restriction apparently does not apply to leases for which advance royalties are being paid.[216]

The 1976 regulations define "continued operation" of a coal lease as the production of 1 percent of the coal reserves in each of the first 2 years after diligent development has been achieved, and an average of 1 percent per year, calculated over 3-year periods, thereafter.[217] However, as discussed more fully below, the Secretary has substituted payment of advance royalties for the continued operation requirement.[218] Nevertheless, as was discussed above, annual production in commercial quantities is necessary to maintain a coal lease issued or adjusted on or after August 4, 1976, once the first 20 years of the lease have elapsed. Payment of advance royalties does not affect this requirement related to the lease period.

Any coal lease, whenever issued, included within a logical mining unit (an area of land in which the coal resources can be developed in an efficient, economical, and orderly manner as a unit, with due regard to conservation of coal reserves and other resources) must be completely mined—that is, all its reserves must be produced—within 40 years after approval of the mining plan for that unit.[219] By regulation, the Secretary has made every coal lease by itself a logical mining unit.[220] But the regulation maybe invalid with respect to leases issued before August 4, 1976, when the statutory provision authorizing creation of logical mining units was enacted.[221]

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[212] Ibid.

[213] Ibid., § 3523.2-1.

[214] A complicating factor for leases issued prior to Aug. 4, 1976 is a requirement in the regulations that such leases subject to readjustment but not actually readjusted before Aug. 4, 1976 shall be readjusted to conform to the requirements for leases issued after that date if the lessee was not told there would be no readjustment. It is not clear that such retroactive adjustment is valid or, if it is, how it would affect the diligence requirements. Ibid., § 3522.2-1(b).

[215] 30 U.S.C. § 201(a)(2)(A) (1976).

[216] Ibid.; see ibid. § 207(b).

[217] 43 CFR § 3500.0-5(g) (1977).

[218] Ibid., § 3520.2-5(b).

[219] 30 U.S.C. § 202a (1976).

[220] 43 CFR §§ 3500.0-5(d), 3520.2-6(a) (1977).

[221] Compare 30 U.S.C. § 202a(5) (1976) with ibid., § 202a(6). The committee report on the legislation which authorized creation of logical mining units seems to support the regulation's inclusion of all coal leases whenever issued: "[This bill] authorizes the Secretary to approve, or by regulation to *require*, the consolidation of Federal coal leases *(including leases in existence at the time of enactment)* . . . so as to form a 'logical mining unit.'" H.R. Rep. No. 94-681, 94th Cong., 1st sess. 21 (1975) (emphasis not in original).

The lease form for hardrock minerals on acquired land has a provision requiring the lessee to "carry on operations under this lease with reasonable diligence and to begin operations within ______ months and to continue production thereafter unless operations are interrupted by strikes, the elements, or casualties not attributable to the lessee. "[222] The form has generally been filled in to require commencement of production within a period of around 96 months (8 years), but the provision also permits the lessor to grant reasonable extensions of time for commencement of production, and such extensions have been granted for at least some of the lead leases in Missouri. [223] As with coal leases, there is no requirement that development be commenced within any specified period of time.

Both geothermal and oil and gas leases are subject to regulations and lease provisions requiring the lessee to drill wells ordered by the Secretary of the Interior to insure proper and timely development and production, but this authority has been used only to prevent waste or drainage of the leased minerals rather than to assure diligent development. [224]

The only leasable minerals for which there are requirements relating to timely commencement and continuation of development activities, and not just completion of development after a longer-than-normally-required period, are geothermal steam and oil shale.

As was discussed more fully in subsection C(3)(b), beginning in the sixth year of a geothermal steam lease, escalating exploration expenditure requirements are tied to escalating rental requirements, and expenditures during the first 5 years of the lease, or in excess of the minimum required expenditures in the sixth and each succeeding year, may be credited against I) required expenditures for future years or 2) the escalating portion of the required rentals. The net effect is a work requirement of approximately $5 per acre (with the option to pay $1 of the $5 to the Government rather than spending it on work) for the sixth year of the lease, which escalates $3 per acre each succeeding year until a work requirement of approximately $17 per acre (of which $5 can be paid to the Government rather than being spent on work) is reached for the 10th year. The requirement then escalates $1 per year until a maximum work requirement of $22 per acre (of which $10 can be paid to the Government rather than being spent on work) is reached for the 15th year. Extra work can be "banked" and applied to work requirements in future years,

Although the escalating work requirement for geothermal leases is stated in terms of exploration expenditures, it applies to all lease operations and continues until production in commercial quantities is attained. It therefore covers the development stage as well as the exploration stage. It was noted in subsection C(3)(b) that the amount of annual work required is quite small compared to the hundreds of dollars per acre per year required on the average for actual detailed exploration. The work requirement is

[222] BLM Lease Form 3520-6 (1972).

[223] Doris Koivula, Chief, Branch of Upland Minerals, U.S. Bureau of Land Management, oral communication, February 1977.

[224] 30 CFR §§ 221.9, 221.15 (1977); BLM Lease Forms 3110-3 (1973), 3110-1 (1977), 3120-7 (1977) (oil and gas); 30 CFR §§ 270.17, 270.33 (1977) (geothermal steam). See U.S. National Aeronautics and Space Administration, *Onshore Lease Management Program Study for the U.S. Geological Survey* 75 (1974).

even more inadequate during the development stage, when costs average thousands of dollars per acre per year.[225]

The prototype oil shale leases issued in 1974 require submission of a detailed development plan by the end of the third year of each lease. The plan must include a schedule of all activities to be conducted under the lease, and a requirement that the lessee use all "due diligence" in the orderly development of the leased deposits. The leasee must attain production at the minimum rate specified for minimum royalty purposes (see below) "at as early a time as is consistent with compliance with all the provisions of this lease. " A plan acceptable to the Secretary must be submitted within 2 years after submission of the original plan, less periods during which a submitted plan is being reviewed by the Secretary. Failure to submit an acceptable plan is grounds for termination of the lease, if the Secretary so elects, On approval of the plan, the lessee "shall proceed to develop the Leased Deposits in accordance with the approved plan. "[226] The Secretary may initiate court proceedings for forfeiture and cancellation of a lease if the lessee fails to comply with any of the terms and conditions of the approved plan, and if such failure continues for **30** days after service of notice by the Secretary.[227] It is not clear, however, whether the lessee's proposed schedule for development is a "term or condition" of the development plan, If it is, then the oil shale lessee's tenure depends not only on completion but also on commencement and continuation of development activities within certain specified times during the initial lease period, subject to waiver or suspension of such requirements by the Secretary of the Interior. (Suspensions were authorized for all the prototype leases in 1977.) The times, however, are specified by the lessee, and they maybe vague or open-ended,

Apparently, the development plan requirement for the prototype oil shale leases was designed mainly to control surface and other environmental impacts rather than to assure diligent development. Primary reliance was placed on certain economic incentives to assure diligent development.[228] Chief among these economic incentives is the lease provision allowing the lessee to credit development expenditures incurred during the first 4 years of the lease against the bonus installments due at the end of the third and fourth years.[229] Bonuses ranging from $45 million to more than $210 million were bid on the prototype leases,[230] payable in five installments due, respectively, at the beginning of the lease and each year thereafter for the first 4 years of the lease. The installments due at the end of the third and fourth years can be avoided if a lease is surrendered or relinquished prior to the end of the third year. Otherwise, the tens of millions of dollars included in these last two installments must either be paid to the Government or expended on development operations. Ordinarily, a lessee will make every effort to spend the money on productive operations rather than pay it to the Government. The bonus credit provision is thus a strong incentive for early, substantial development activity,

Incentives for diligent development after the first 4 years of an oil shale lease are provided by the provision for crediting development expenditures against required

[225]See ch. 2, table 2.6 and subsec. D(4), and app. C, tables C.2 through C.5.
[226]38 F. R. 33191 (1973) (sec. 10).
[227]Ibid., at 33193 (sec. 29).
[228]*Current Mineral Laws of the United States*, House Comm. on Int. & Ins. Affairs, 94th Cong., 1st sess. at 22-24 (Comm. Print No. 13, 1976).
[229]38 F. R. 33189 (1973) (sec. 5).
[230]*Current Mineral Laws*, note 228, at 21.

minimum royalties. A minimum royalty, due whether or not there has been actual production, is specified for the sixth and succeeding years of each lease, based on a predetermined production rate of approximately 1,000 to 2,000 tons for the sixth year, which increases by a like amount each succeeding year through the 15th year, and then remains the same through the 20th year, at which time the lease terms may be readjusted. Development expenditures made between the date of approval of the development plan and the end of the 10th lease year, and not already credited against the last two bonus installments, may be credited against the minimum royalties due in the 6th through 10th lease years.[231] For the 6th through the 10th years, then, the minimum royalty requirement is, in effect, an escalating development expenditure requirement similar to the escalating exploration and development expenditure requirement applicable to geothermal steam leases discussed above. In both cases, there is a very strong incentive to spend the money on development rather than "throw it down the drain" by paying it to the Government. And the sums required for oil shale leases are more substantial than those required for geothermal steam leases. Assuming a predetermined production rate (for minimum royalty purposes) of 1,000 tons of shale oil per day in the sixth year, increasing by 1,000 tons per day each succeeding year through the 15th year, the expenditure requirement (minimum royalty) at the basic lease royalty rate of $0.12 per ton would be $43,800 in the sixth year and $219,000 in the 10th year. However, these sums are still rather small compared to the tens of millions of dollars per year required for normal mineral development.[232] Moreover, there is a countervailing incentive not to complete development and commence production prior to the end of the 10th year, since the lessee cannot credit development expenditures against the first $10,000 of minimum royalty due in the sixth or any subsequent lease year if there is actual production in that year.[233]

Although development expenditures cannot be credited against minimum royalties due in the 11th through 20th years of an oil shale lease, the minimum royalties for these years provide some incentive for prompt development. They will be money "down the drain" unless actual production is commenced so that they can be credited against actual royalties due. Under the minimum production schedule assumed in the previous paragraph, the minimum royalty in the 11th and succeeding years would rise from $262,800 in the 11th year to $438,000 in each of the 15th through 20th years.

(iii) Rentals, Minimum Royalties, and Advance Royalties. Other than the lease periods and the specific production, expenditure, or other work-related requirements discussed so far in this subsection, the only lease provisions directly relevant to maintaining development and production tenure are the rental, minimum royalty, and advance royalty provisions.

Each mineral lease is conditioned on the payment of an annual rental, but the rentals are too low to act as an effective incentive for mineral development and production. Rentals for sodium or potassium leases are fixed by law at $0.25 per acre for the first year of the lease, $0.50 per acre for each of the second through fifth years,

[231] Ibid., at 22-23; 38 F.R. 33190 (1973) (subsec. 7(e)).

[232] See ch. 2, table 2.6 and subsec. D(4), and app. C, tables C.2 through C.5.

[233] 38 F.R. 33190 (1973) (subsec. 7(e)). However, any royalty due on actual production in the sixth, seventh, or eighth lease year will be reduced by half the difference between the actual royalty due and the specified minimum royalty for that year if the actual royalty due exceeds the specified minimum royalty. Ibid. (subsec. 7(f)).

and $1 per acre for each succeeding year.[234] Rentals for sulfur, oil shale, native asphalt, solid or semisolid bitumen, or bituminous rock leases are fixed at $0.50 per acre each year.[235] Rentals for phosphate leases must be at least $0.25 per acre the first year, $0.50 per acre for each of the second and third years, and $1 per acre for each succeeding year.[236] Rentals for coal leases must be at least $0.25 per acre the first year, $0.50 per acre for each of the second through fifth years, and $1 per acre for each succeeding year (no rental is required after the fifth year for coal leases issued after August 3, 1976).[237] Rentals for hardrock mineral leases must be at least $1 per acre, but not less than $20 total, each year.[238] Rentals for oil and gas leases must be at least $0,50 per acre each year.[239] Rentals for geothermal steam leases must be at least $1 per acre each year.[240]

Even for those minerals for which minimum rather than fixed rentals are specified, the Department of the Interior has kept the actual rentals at or near the specified minimums. Rentals for noncompetitive oil and gas leases have only recently been raised to $1 per acre, and rentals for competitive oil and gas leases are set at $2 per acre.[241] Similar rentals are set for geothermal steam leases (taking into account only the basic rental, not the escalating portion that is in effect a work requirement).[242] Rentals for phosphate leases in the fourth and subsequent years have been set at $3.50 per acre in some recent leases.[243] Coal leases issued between 1970 and 1973 generally have rentals of $1 per acre for each of the first 5 years and $2 to $13 per acre for the sixth and each succeeding year, depending on the quantity and quality of the coal.[244] For coal leases issued since April 1973, the Department has essentially replaced the rental for the sixth and each succeeding year with a minimum advance royalty based on the quantity and quality of the coal (see below).[245]

A rental rate of even $4 per acre would amount to a total annual lease rental of just over $10,000 on even the largest (for most minerals) permissible lease of 2,560 acres. Smaller leases would require even less total yearly rental. The fixed or actual rental for most existing leases never exceeds $1 per acre, or $2,560 per year for the largest lease. These rental rates are insignificant compared to the tens of millions of dollars required for actual development of a lease,[246] and they therefore have little or no effect on the decision whether or when to develop, as can be seen by the production history of oil and gas,[247] coal,[248] and other[249] mineral leases.

Yet, as is the case with exploration,[250] rentals set at a level comparable to the costs of actual development would greatly increase total costs to the lessee during the

[234] 30 U.S.C. §§ 262, 283 (1976); 43 CFR § 3503.3-1(b)(3) (1977).

[235] 30 U.S.C. §§ 241(a), 273 (1976); 43 CFR § 3503.3-1(b)(4) (1977).

[236] 30 U.S.C. § 212 (1976).

[237] Act of February 25, 1920, § 7, P.L. No. 146, 66th Cong., 2d sess., ch. 85, 41 Stat. 439 (1920) (leases issued prior to Aug. 4, 1976); 30 U.S.C. § 207 (1976), 43 CFR § 3503.3-1(b)(1) (1977) (leases issued after Aug. 3, 1976).

[238] 43 CFR § 3503.3-1(b)(6) (1977).

[239] 30 U.S.C. § 226(d) (1976).

[240] Ibid., § 1004(c).

[241] 43 CFR § 3103.3-2 (1977).

[242] U.S. General Accounting Office, *Problems in Identifying, Developing, and Using Geothermal Resources*, RED-75-330, Mar. 6, 1975, at 33.

[243] U.S. General Accounting Office, Letter B-118678 (RED-76-70), Feb. 5, 1976.

[244] U.S. General Accounting Office, *Improvements Needed in Administration of Federal Coal-Leasing Program*, B-169124, Mar. 29, 1972, at 24-25.

[245] U.S. General Accounting Office, *Further Action Needed on Recommendations for Improving the Administration of Federal Coal-Leasing Program*, RED-75-346, Apr. 28, 1975, at 7-8; U.S. General Accounting Office, *Role of Federal Coal Resources in Meeting National Energy Goals Needs to be Determined and the Leasing Process Improved*, RED-76-79, Apr. 1, 1976, at 21.

[246] See ch. 2, table 2.6 and subsec. D(4), and app. C, tables C.2 through C.4.

[247] See subsec. C(3)(b).

[248] See the GAO studies cited in notes 244 and 245.

[249] U.S. General Accounting Office, Letter B-118678 (RED-76-70), Feb. 5, 1976.

[250] See subsec. C(3)(b).

development stage without adding to the funds actually used for development. In effect, development costs would be artificially inflated to such an extent as to preclude efficient development. Rentals set too low to significantly affect costs provide no incentive for diligent development, but if they are set high enough to significantly affect costs they will preclude efficient development,

Straight rentals, therefore, seem to be an inappropriate device for assuring diligent mineral development. However, they can be very important for efficient land use and management if they are viewed, as may have been originally intended, as charges for the use of the land rather than as charges to ensure diligent mineral activity.[251]

The primary means for assuring diligent development of and continued production from phosphate, potassium, sodium, and sulfur leases is the requirement of payment of royalty on a minimum annual production beginning in the fourth year of a phosphate lease or the sixth year of a potassium, sodium, or sulfur lease. The requirement is imposed by law for phosphate and potassium leases and by regulation for sodium and sulfur leases.[252] But it has been nullified in practice, because the minimum royalty for a lease is invariably set at the same level as the annual rental, and rentals for a given year can be credited against the royalties due in that year, In effect, therefore, there is only a rental and no minimum royalty.[253]

Rentals on oil and gas leases are replaced by a minimum royalty of $1 per acre per year after there has been a discovery of oil or gas in paying quantities.[254] Similarly, the escalating rental and expenditure requirements in geothermal steam leases are replaced by a minimum royalty of $2 per acre per year after commencement of production in commercial quantities.[255] These charges relate to the production rather than the development stage, and they are too small to act as an incentive for actual production.

Even if minimum royalties were based on calculations of minimum actual reasonable production, as was intended by Congress for phosphate and potassium, rather than designed as rental substitutes, it is not clear that the required payments would be sufficient to assure diligent development. One estimate of the royalty for reasonable minimum annual production from a phosphate lease in 1976 amounted to only about $23 per acre,[256] a figure still well below the thousands of dollars per acre per year required, on the average, for actual mineral development.[257] A lessee would not be likely to commence development or production solely in order to avoid payment of the minimum royalty.

Both rentals and minimum royalties are credited against actual royalties due in the same year. They therefore provide at least some incentive for early commencement of production, because, until production is commenced, rental and minimum royalty payments are "water down the drain" and cannot be credited against future royalties due on actual production. The longer production is delayed, the longer there will be in effect double payments for future actual production. As noted immediately above,

[251] See ch. 5, especially subsec. E(6).

[252] 30 U.S.C. § 212 (1976) (phosphate); ibid., § 283 (potassium); 43 CFR § 3503.3-2(b)(2) & (3) (1977) (all four minerals). The year for commencement of payment is specified by regulation rather than by law for all four minerals.

[253] U.S. General Accounting Office, Letter B-118678 (RED-76-70), Feb. 5, 1976.

[254] 30 U.S.C. § 226(d) (1976).

[255] Ibid., § 1004(d).

[256] U.S. General Accounting Office, Letter B-118678 (RED-76-70), Feb. 5, 1976.

[257] See ch. 2, table 2.6.

however, the dollar amount going "down the drain" may be too small to significantly affect development and production decisions.

The minimum royalties required for the prototype oil shale leases were designed to provide more substantial incentives for development. Due initially in the sixth lease year, the minimum royalty escalates from several tens of thousands of dollars in the sixth year to several hundred thousand dollars in the 15th through 20th years, and development expenditures may be credited against the minimum royalties due in the 6th through 10th years. In effect, the minimum royalties for the 6th through 10th years constitute an escalating development work requirement, while the minimum royalties for the 1th through 20th years are "water down the drain" unless production has been commenced. However, both the work requirement and the straight minimum royalty are fairly small compared to the costs required for actual development.

Minimum royalties are also required for coal leases, not as a primary lease condition but as a substitute, in the Secretary's discretion, for the primary lease condition of continued operation of the mine.[258] The Secretary has consistently issued coal leases permitting payment of minimum royalties in lieu of continued operation and, until recently, had nullified the minimum royalty requirement by, as in the case of the nonfuel leasable minerals, setting the minimum royalty equal to the annual rental. Beginning in 1973, however, the minimum royalty established for new leases has been based on a predetermined rate of production for the sixth and succeeding years of the lease,[259] and an amendment to the law in 1976 explicitly requires that the minimum royalty on coal leases issued after August 3, 1976 "be no less than the production royally which would otherwise be paid and . . . be computed on a fixed reserve to production ratio" determined by the Secretary .2')') Current regulations issued by the Secretary of the Interior require payment of a minimum royalty beginning in the sixth year of a lease on an annual number of tons of coal sufficient to exhaust the leased reserves in 40 years from the date of issuance of the lease, if the lease was issued after May 28, 1976. Leases issued prior to 1976 but after 1973 contain a similar requirement. All leases issued prior to May 29, 1976 will be subject to a similar payment requirement beginning the year after their next readjustment, but no sooner than May 28, 1982. The production schedule underlying the required payments for such leases must be one that would be sufficient to exhaust the leased reserves within 40 years after May 29, 1976 if production had actually commenced on that date. [261]

These minimum royalty requirements will not assure diligent development of coal leases, One calculation for a 241-acre lease issued after 1973 but prior to 1976 estimated minimum royalty payments of $10,000 to $20,000 a year,[262] still considerably less than the tens of millions of dollars required for actual development of a coal mine. [263] Moreover, the minimum royalties for coal leases, unlike those for the nonfuel mineral leases discussed above, are advance royalties: they are credited against actual royalties due on future production and not just against actual royalties due in the same year.[264] Hence, the coal advance royalties are not "water down the drain, " nor do

[258] 30 U.S.C. § 207 (1976).

[259] See the GAO studies cited in notes 244 and 245: B-169124 at 24, RED-75-346 at 7-10, RED-76-79 at 20-21.

[260] 30 U.S.C. § 207(b) (1976).

[261] 43 CFR §§ 3503.3-2(b)(1) & 3522.2-1(b) (1977)

[262] GAO Report RED-75-346, note 245, at 7-8.

[263] See ch. 2, subsec. D(4) and app. C, table C.3.

[264] 30 U.S.C. § 207 (1976).

they result in double payments for future actual production. They are simply payments in advance of actual royalties due on future production. Nothing is lost by paying the advance royalty rather than producing the corresponding amount of coal: in either case the same sum has to be paid, and the sum so paid will count as actual royalty on the corresponding amount of coal whenever that coal is produced. 'b'

Thus, the advance royalty requirement for coal leases provides minimal incentive for speedier development or continuous operation by those who plan on producing coal eventually, and it provides only a slight incentive for surrender of leases by those who do not plan to produce but are rather speculating on profits from sale of their leases. The advance royalty requirement has been strengthened somewhat by Congress for coal leases issued after August 3, 1976. For such leases, advance royalties may be accepted in lieu of continued operation for no more than an aggregate of 10 years, and no advance royalty paid during the initial 20 years of a lease can be credited against royalties due on coal produced in the 21st or succeeding years.[266] But these restrictions provide very little added incentive for diligent development.

E. Payments for Mineral Value

1. Placing Mineral Value Payments in Perspective

Almost invariably, one of the issues considered most important, if not the most important, in any debate on Federal mineral disposal policy is the issue of payments to the Government for the value of the minerals produced from Federal land by private parties. However, from the perspective of efficiency and fairness in the management of Federal land and its mineral and nonmineral resources, the issue of payments for mineral value is much less important than issues involving other types of payments that might be required— for example, payments for loss of or damage to nonmineral values caused by mineral activities, or payments designed to assure diligent mineral activity.

A particular mineral activity is efficient if and only if the value of the produced mineral is at least equal to the costs of exploring for, developing, and producing the mineral. The costs that must be considered include not only the direct costs in salaries and material of finding and producing a mineral deposit, but also the costs imposed on other activities and land uses as a result of the mineral activity. For example, a private farmowner will not undertake mineral activity on his own farm unless the gross income from the mineral activity is expected to cover not only the direct costs of that ac-

[b] The assumption that the same sum will have to be paid is based on the requirement that the advance royalty be paid even if the continuous operation condition is satisfied. 43 CFR §§ 3503.3-2 (b) (1) & 3520.2-5(b) (1977). Otherwise, theoretically at least, *continuous operation might be preferred to payment of advance royalty*, since continous operation requires production of an annual average amount (calculated over 3 years) of only 1 percent of the reserves of the logical mining unit of which the lease is a part (43 CFR § 3500.0-5 (g) (1977)), whereas advance royalties are paid annually on at least 2.5 percent of the reserves in the lease (recall the 40-year maximum payout schedule). The requirement that advance royalties be paid even if the continuous operation condition is satisfied seems valid for leases issued prior to Aug. 3, 1976, since the Secretary was authorized to *require* advance royalties *in lieu of the continuous operation condition*. 41 Stat. 439-440 (1920). However, the 1976 amendment of the law merely authorizes *suspension* of the condition of continued operation *upon the payment of advance royalties;* it does not explicitly authorize *required* advance royalties. 30 U.S.C. § 207(b) (1976). In actual practice, annual production will almost always exceed 2.5 percent of the lease reserves. Moreover, the Secretary has independent authority to insert provisions in leases to insure diligence. 30 U.S.C. §§ 187, 189 (1976).

[266] 30 U.S.C. § 207(b) (Supp. I 1977).

tivity but also the net income from farming that will be lost as a result of the disturbance of the land by the mineral activity. And the farmer's mineral activity will not be efficient unless the gross income from mineral production is sufficient to cover not only his direct mineral costs plus his loss of farm income, but also any neighbor's loss in farm (or other) income due to, for example, destruction, interruption, or degradation of the common water supply. Otherwise, resources are being wasted: a higher net income would be achieved in the area without the mineral activity.

Not only efficiency, but also equity or fairness usually demands that costs imposed on others by a particular activity be paid by the party engaged in and profiting from that activity. Thus, payments by private parties engaged in mineral activities on Federal land for losses of or damage to nonmineral resources, on or off Federal land, caused by their activities are necessary for efficient and equitable resource use and land management.

Similarly, as was discussed in sections C and D, payments or "holding charges" may be required to assure diligent mineral activity and to free Federal mineral land for use by others when the current occupant is "sitting on" the land, although such payments must be structured very carefully to avoid wasteful, overly rapid, or otherwise inefficient mineral activities,

Payments for the value of the mineral itself, however, are not necessarily required to assure efficient and equitable Federal resource management. In fact, they may cause inefficiencies and inequities if they are not properly designed. It is both inefficient and inequitable to require a mineral explorer-producer to share with someone else that portion of the value of the mineral as produced and sold that represents the costs of finding, developing, and producing the mineral—that is, the value added to the mineral in the ground by the expenditures of the mineral explorer-producer rather than the value of the mineral deposit itself. Moreover, mineral activity will not occur unless the mineral explorer-producer is allowed to retain a minimum profit—at least equal to the net income that could have been made from some alternative investment—in addition to recovering his expenditures.

Any value of the mineral, as produced, in excess of the mineral explorer-producer's expenditures (including expenditures on unsuccessful exploration and development efforts) and minimum profit is the value of the mineral deposit in the ground, or "nature's bounty. " The Federal Government, as owner of the land and, more importantly, as representative of the general public, has an equitable claim to a share in the bounty, particularly when the deposit was known or reasonably suspected to exist before any work was undertaken by the mineral explorer-producer. The Federal Government's claim is at least as strong as the claim of a speculator who acquired mineral tenure on a tract of Federal land and then sat on it until a genuine mineral explorer-producer came along and offered to purchase the tenure rights in order to actually explore and develop the tract. Although the Federal Government, and the public, might be willing to let a genuine mineral explorer-producer have all the bounty, they might not be willing to see the bounty pass (through the purchase price) to a speculator who has done nothing to explore or develop a tract.

Production will be initiated and will continue whether the mineral producer keeps the bounty or pays some or all of it to a speculator or the Government, since in each case, by hypothesis, there is no alternative investment that will provide a return to the producer larger than the minimum profit he is allowed to retain. However, efficiency may be affected in two ways, First, if the Government requires the producer to pay over all the bounty and allows him to retain only the minimum profit on expenditures, the producer will have no incentive to hold down those expenditures and perhaps even have a reverse incentive to increase or exaggerate them in order to obtain a larger gross return. Second, if the Government allows the producer to retain a share in the bounty plus his minimum return, which together exceed the normal return available on non-Federal (State and private) mineral properties, mineral explorers and producers theoretically will tend to concentrate their activities on Federal land as much as possible, all other things being equal. They will pass by equal or possibly even higher quality mineral deposits on non-Federal land, thereby causing unnecessary, excessive damage to nonmineral resources on Federal land, which generally contains higher quality nonmineral resources than non-Federal land. [267]

Thus, payments to the Government for the mineral value itself ideally should be structured to allow the mineral producer to obtain his minimum return on expenditures plus a percentage share of profits, if any, in excess of this minimum return, with some provision to ensure that the payments are not substantially lower than those normally required on non-Federal land.

Some people in the mineral industry contend that no payments for mineral value should be required as part of the mineral tenure arrangement, because mineral firms' profits are already taxed at the 48-percent corporate rate under the Federal income tax laws, which should be an adequate payment to the Government for its minerals. In practice, however, many mineral firms pay little or no Federal income tax each year, because of exemptions and deductions in the income tax laws, even when they are earning substantial net income. [268] Moreover, firms with non-Federal landholdings make mineral value payments under their tenure agreements in addition to paying Federal taxes. As was noted immediately above, failure to require similar payments for Federal minerals may result in inefficiency if, as a result, mineral activity is skewed toward Federal land even when equally or more attractive mineral prospects are located on non-Federal land.

However, neither efficiency nor equity will be greatly affected, in most cases, if no payment at all by the mineral producer is required for the value of the mineral itself. On the other hand, both efficiency and equity can be severely undermined if no payments are required for losses of or damage to nonmineral resources resulting from mineral activities (see chapter 5) or if there are not sufficient incentives for diligent exploration and development (see sections C and D in this chapter). 'by

[267] See ch. 5, especially sec. A and B.

[268] See the annual corporate tax studies by U.S. Representative Charles A. Vanik (e.g., *Washington Post*, Oct. 3, 1976, at A24 and Jan. 28, 1978, at A1) and compare the net profits reported in, e.g., *Oil & Gas J.*, Aug. 8, 1977, at 28.

[269] The prototype oil shale leases at least partially recognize the lesser importance of the payments for mineral value by allowing 1) expenditures on diligent exploration and development to be credited against certain bonus and royalty payments (see subsec. D(3)(c)) and 2) extraordinary expenditures on environmental protection to be credited against royalty payments. 38 F. R. 33189-33190 (1973) (sec. 5 and subsecs. 7(d), (e), & (f)).

It should also be noted that the issue of maximum revenue generation for the Federal Government or the general public is at present a false issue with respect to mineral value payments for the leasable minerals on onshore Federal land, since, as is discussed in subsection E(3) of chapter 6, 90 percent of the Federal onshore mineral leasing revenues are not retained by the Federal Government, but rather are required to be returned directly or indirectly to the Western States.

2. The Basic Types of Mineral Value Payments

There are many different types of mineral value payment requirements. Most of them, however, are simply combinations of one or more of the following basic payment requirements:

- Lump-sum front-end payment (fixed bonus)
- Lump-sum staggered payments (walkaway bonuses)
- Payments on gross value of production (royalties)
- Payments on net value of production (profit share)

The advantages and disadvantages of these basic payment requirements and their various combinations are discussed in detail elsewhere.[270] Here only some of the principal advantages and disadvantages are summarized.

One of the principal goals of payments for mineral value has always been to obtain maximum revenue for the Government without distorting mineral decisions, As we saw in the previous subsection, this goal can be achieved if the mineral payments are structured to capture the "natural bounty" portion, and no more, of the gross value of the produced mineral— that is, the portion of the gross value of mineral production in excess of the amount required by the mineral explorer-producer to recover his exploration, development, and production costs plus a minimum profit.

Theoretically, the fixed-bonus payment requirement is ideally suited to capture the "natural bounty" for the Government. The bonus is merely set equal to the present value (the future flow of income discounted to the present time) of the expected bounty for a particular deposit. The bonus is paid in one or a few lump-sum payments at the beginning of the tenure period. The Government immediately receives its maximum revenue, The mineral explorer-producer treats the bonus, once paid, as a "sunk cost" and is free to explore, develop, and produce the mineral deposit in the most timely and efficient manner, free from any continuing ''overhead' payments to the Government.

In practice, however, the fixed bonus approach can result in payment of much less than the full measure of a mineral deposit's "natural bounty" and can discriminate against individual mineral explorers and the smaller mineral firms. The weaknesses of the fixed bonus stem from the considerable uncertainty surrounding mineral

[270] See, e.g., Lindahl and Useem, Congressional Research Service, Library of Congress, *Federal Leasing of Petroleum on the Outer Continental Shelf*, Senate Comm. on Int. & Ins. Affairs, 94th Cong., 2d sess. 33-41 (Comm. Print 1976); J. Whitaker, *Striking a Balance: Environment and Natural Resources Policy in the Nixon-Ford Years* 281-296 (1976); *The Exploration, Development and Production of Naval Petroleum Reserve No. 4*, a report prepared for the Federal Energy Administration under Contract No. CR-05-60579-00, at 3-17 to 3-30, Exhibit 3-8 and B-11 to B-16 (1976); *Mineral Leasing as an Instrument of Public Policy* (M. Crommelin & A.R. Thompson eds. 1977).

prices, mineral exploitation costs, and the location, size, and quality of mineral deposits.

Even when the location, size, and quality of a particular mineral deposit are well known, a fixed bonus may capture much less than the deposit's full eventual bounty value if future mineral prices or mineral activity costs, or both, are uncertain. A prime example is the experience with competitive coal leasing prior to 1970, when hundreds of leases were issued for very small bonus payments or without any bonus payment at all, since there was no sizable market for Western coal (almost all Federal coal is in the West). In recent years, many of these same leases have become much more valuable due to increased demand for coal in general, and low-sulfur coal in particular, as well as a new demand for huge reserves of coal for projected new coal gasification and liquefaction technology.'" The Government will receive very little of the eventual bounty value realized on these leases. A similar situation could easily arise from overly rapid leasing of oil shale or geothermal steam deposits in advance of development of a widely applicable technology for commercial production of those minerals.

The problems are compounded when the location, size, and quality of mineral deposits are uncertain. Mineral explorers will reduce the size of the bonus they are willing to pay for a tract to match the probability of finding a deposit of the expected size and quality on the tract. For example, if there is only a 10-percent chance of finding a deposit with a bounty (return in excess of expenditures plus minimum profit) of $1OO,OOO, they will pay at most $10,000 for mineral rights on the tract. If no deposit is discovered, they are out $10,000 and the Government has a "windfall" of $10,000. If a deposit of the expected size and quality is discovered, they have obtained $90,000 worth of the bounty and the Government has received only $10,000 worth, Over a large number of tracts, however, the odds will balance out and the Government will receive in the aggregate close to the full bounty for each tract. Losses on some tracts will balance out gains on other tracts.

Large mineral firms, like the Government, often can balance gains against losses by spreading their risks across a large number of tracts. But individual explorers, small firms, and medium-sized firms often do not have sufficient capital to acquire and hold a large number of tracts, Even large firms can and occasionally do use up a large portion of their available risk capital on a single venture if they believe that they might discover an extremely valuable deposit. When a large part of an individual's or firm's risk capital is tied up in a single venture, failure of the venture can result in bankruptcy. Individuals and smaller firms, therefore, are viewed as worse risks than larger firms in the capital market. They have a harder time obtaining capital and pay a higher interest than the larger firms. Moreover, the individuals and smaller firms, and often even the larger firms, will be '*risk averse'" and add a risk aversion factor ("risk premium") to the perceived probability of failure in determining what bonus they are willing to pay to acquire a tract. For example, they will pay less than $10,000 for a 10 percent probability of finding a deposit with a bounty of $100,000.

The impact of uncertainty about the existence and nature of the deposit itself is thus twofold. First, the application of the "risk premium" results in the Government's

See the GAO studies cited in notes 244 and 245.

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receiving less than the full bounty even over a large number of tracts, Second, individuals and smaller firms are at a serious disadvantage in competing for tracts, since they have less capital to spend on bonuses, must pay higher interest for the capital they obtain, and cannot easily spread their risks across a large number of tracts. The bonus approach discriminates against individuals and smaller firms and lessens competition, thus reducing even further the likelihood of the Government's receiving the full bounty value of a tract, [272]

Finally, the fixed-bonus payment approach forces the mineral explorer-producer to make large outlays initially on nonproductive payments rather than on actual exploration and development. When capital is tight, exploration and development will have to be postponed until the capital expended on bonuses is replenished from other sources,

Some of the problems of the fixed-bonus approach can be avoided by staggering the payment of the bonus over a considerable number of years, and allowing the mineral explorer-producer to "walk away" from installments yet to come due by surrendering his mineral tenure. This walkaway bonus can be structured in various ways—for example, as three different installments due at the acquisition of tenure, the beginning of development, and the beginning of production, respectively, or as an annual installment due indefinitely or due only until a certain total is reached.

The walkaway bonus reduces the amount of front-end money required and also reduces the risks associated with straight fixed bonuses, because the payments are spread out and need not be paid in full should the project be abandoned at an early stage—for example, during or after exploration. However, the walkaway bonus retains most of the disadvantages of the fixed bonus, although in milder form, and introduces some new problems of its own. It still requires substantial payments in advance of production and thus reduces the amount of capital available for exploration and development. It still gives an advantage to firms that have easier access to lower cost risk capital. It still can cause the Government to lose a large share of the bounty value because of risk premiums and uncertainty over future mineral prices and technology. And it can create new problems of wasteful, overly rapid, and prematurely terminated mineral activity, particularly if the payments are periodic (e. g., annual) and continue indefinitely rather than being limited in number and keyed to successful completion of certain stages in the mineral process. Rather than one "sunk cost" that does not affect mineral decisions, the walkaway bonus constitutes a series of payments, which are sunk costs once they are made but which can greatly influence mineral decisions while they loom as payments due in the future, If the payments are due at fixed intervals, mineral activity may be inefficiently speeded up to reduce the number of payments that will have to be paid. This practice can lead to wasteful mining, such as mining of only the highest grade ore, as well as loss of revenue to the Government. No matter how the payments are scheduled, tenure may be abandoned prematurely, even when

[272] Joint ventures, whereby individuals and smaller firms pool their capital to jointly bid on a tract, reduce the capital requirements and hence the risk for each joint venturee. But the comparative advantage of the larger firms will be preserved if they also form joint ventures. Moreover, joint ventures among the larger firms can substantially reduce competition and hence reduce the revenue received by the Government. For this reason, joint ventures among larger firms have been banned for offshore oil and gas leasing, and a similar ban has been recommended for onshore coal and oil and gas leasing. U.S. Department of the Interior, *Joint Bidding for Federal Onshore Oil and Gas Lands, and Coal and Oil Shale Lands*, Ser. No. 94-40 (92-130), Senate Comm. on Int. & Ins. Affairs, 94th Cong., 2d sess. (Comm. Print 1976).

substantial mineral value exists, if the mineral value that could be recovered during the next tenure period is less than the payment due at the beginning of that period.

Royalty payments avoid the capital-related problems of bonuses by deferring all payments for mineral value until product ion is actually achieved, and then providing for payment out of the gross income received from the mineral production. Thus. no funds are diverted from mineral exploration and development, and individuals and smaller firms have a much better chance to compete for tracts. Moreover, the Government is assured of obtaining its desired share of anv bounty value even if mineral prices should rise or if a much larger deposit than was expected should be developed, but only if a percentages-of-gross royalty is specified rather than a flat-charge-per-unit-of-production royalty (for example, 10 cents per ton of coal].

Unfortunately, since a royalty is an overhead charge that is added to actual operating costs for each unit of production, it can distort development and production decisions. If the royalty is set too high, i t can prevent development of a mineral deposit or cause losses for an unwary firm, even though mineral development and production would be profitable in the absence of the royalty charge: the Government is taxing the portion of the value of mineral production attributable to development costs in addition to capturing 100 percent of the bounty portion of the value.

Even if the royalty is not set so high that it prevents starting up production, it may con tribute to wasteful and prematurely terminated production. Almost all mineral deposits contain ore of varying thickness and quality. A royalty charge, no matter how small, will make i t unprofitable to extract some portion of the lower gracle ore that otherwise could have been extracted profitably. Thus, the royalty encourages ‘‘high-grading’ of mineral deposits while production is underway and premature termination of production when all the higher grade ore has been extracted. Mineral resoures that could have been extracted are left in the ground and will probably never be extracted, given the high costs of recommencing production after it has been terminated. This is not only a waste of mineral resources but also causes more damage to nonmineral resources than would otherwise be incurred, since more deposits will have to be mined to obtain the desired quantity of mineral production. Even when the same mine is reopened, the surface will be disturbed twice rather than only once.

The adverse effects of royalties on efficient mineral production will be most pronounced when the royalty is used as the bidding variable in the competitive allocation of mineral tenure, since a bidder loses nothing by pushing the royalty level up extremely high: he can “high-grade’” the deposit at whatever cutoff grade is necessarv to assure profitable operations, or he can abandon the tract after only minimal exploration if the hoped-for higher grades of ore do not exist.

Premature abandonment can be delayed, if not entirely avoided, by provision for reductions in royalty as production or reserves decline. However, there will still be high-grading problems during production. Moreover, it is practically impossible to devise a declining royalty schedule that will reduce the royalty at precisely the right times. Premature reduction will result in loss of Government revenue. Delayed reduction will result in premature termination of production and consequently also in loss of Government revenue. If there is no provision for raising as well as reducing royalties, the Government will lose revenue when production is significantly increased after a slack period. But royalties designed to slide up and down a scale depending on the rate of production will even further encourage high-grading and will discourage investment in techniques for boosting production through tapping of the lower grade portions of the deposit (e.g., secondary and tertiary recovery techniques for oil and gas deposits).

The theoretically most attractive payments for mineral value in a world of uncertainty are payments tied to the net rather than the gross value of production—a sort of net profit royalty usually described as a profit share. The profit share, like a normal royalty, avoids the potential for revenue loss and the bias against small firms inherent in bonus-payment requirements. And, since it is based on net profit rather than on the gross value or amount of production, it should not affect the efficiency of mineral operations; at least as long as the profit share is less than the bounty value of the mineral deposit.[273]

The major objection to profit-share payments is the practical problem of determining the actual net profit for a particular mineral project—in particular, the problem of determining the costs that should be subtracted from the gross income received from mineral production to arrive at net profit. A profit-share system would require uniform accounting procedures, including procedures for allocating company overhead to particular successful projects. This problem apparently has been considered sufficiently weighty to preclude any use of the profit-share payment system for Federal minerals. However, similar calculations have been required under the Federal income tax and State mineral taxation laws for quite some time. Furthermore, the Energy Policy and Conservation Act of 1975 explicitly requires the Securities and Exchange Commission to develop uniform accounting practices that must be followed by oil and gas producers, and the Department of Energy Organization Act requires that those practices also be followed, where applicable and to the extent practicable, in the annual financial reports required under the Act for any major firm engaged in exploitation of any fuel mineral.[274] As part of the process of developing those practices, the Financial Accounting Standards Board initiated a project to develop uniform accounting practices for all extractive industries.[275] Finally, lessees of some Federal minerals are already required to report exploration and development expenditures incurred to satisfy diligence requirements, and similar requirements exist for the locatable minerals.[276]

3. Mineral Value Payments Under the Mining Law

There are no mineral value payments to the Government under the Mining Law. Payments of $2.50 or $5 per acre are required to obtain full fee title to placer and lode claims, respectively, but mineral production can proceed without obtaining a patent, and the nominal patent fees are not even sufficient to pay for the surface value of the land.[277]

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[273] See subsec. E(1).

[274] 15 U.S.C. § 796(c)(3), 42 U.S.C. §§ 6383, 7135(h) (1976 and Supp. I 1977); see *Oil & Gas J.*, July 25, 1977, at 107.

[275] Financial Accounting Standards Board, *Financial Accounting and Reporting in the Extractive Industries (Discussion Memorandum)* (1976).

[276] See subsecs. D(2)(b) and D(3)(c).

[277] See U.S. General Accounting Office, *Modernization of 1872 Mining Law Needed to Encourage Domestic Mineral Production, Protect the Environment, and Improve Public Land Management*, B-118678, July 25, 1974, at 31-33.

Minerals that are produced free of charge under the Mining Law on Federal public domain are almost invariably subject to disposal only through payment of substantial bonuses or royalties on federally acquired land or State or private land.[278] Other things being equal, the lack of any payment requirement under the Mining Law thus tends to skew mineral production toward the public domain with resultant losses in efficient use and management of the Nation's land and resources,[279] in addition to depriving the Federal Government of the mineral revenue usually obtained by a mineral landowner,

4. Mineral Value Payments Under the Mineral Leasing Laws

The mineral leasing laws require royalty payments for each mineral leased.[280] The regulations and lease form for hardrock minerals on acquired land also require royalty payments[281] For each mineral other than oil shale, native asphalt, and the tar sands, the royalties must be assessed on the gross value of the mineral production. The prototype oil shale leases require a fixed-charge-per-unit-of-production royalty, adjustable up and down as the value of the mineral fluctuates from year to year, although the law would seem to permit a net-profit royalty,[282]

Minimum royalty levels are established by law for surface-mined coal (12.5 percent),[283] geothermal steam (10 percent), oil and gas (12.5 percent), phosphate (5 percent), potash (2 percent), sodium (2 percent), and sulfur (5 percent). Maximum royalty levels are established for preference-right sulfur leases (5 percent), noncompetitive oil and gas leases (12,5 percent), and competitive or noncompetitive geothermal steam leases (15 percent).[284] The Secretary of the Interior has established a minimum royalty of 8 percent for underground-mined coal, unless conditions warrant a lower royalty.[285] Royalties in actual leases are usually kept at or near the minimum levels, except for the sliding-scale royalties specified for competitive oil and gas leases.

The Secretary of the Interior has the authority to reduce the royalty on a lease. or any portion thereof segregated for royalty purposes, whenever in his judgment it is necessary to do so in order to promote development, or whenever in his judgment the lease otherwise cannot be successfully operated.[286] However, it is difficult to judge when a reduction is justified in the absence of extensive data on production costs, which are usually not available and require considerable time to assemble and evaluate when made available. As a result, reductions in royalty are rare.

Competitive leases of onshore Federal mineral land have invariably been issued on the basis of the highest bonus bid, with a royalty fixed in advance of the competitive

[278] See, e.g., *PLLRC Nonfuel Legal Study*, note 8, app. I.

[279] See subsec. E(1).

[280] 30 U.S.C. §§ 207 (coal), 226(b) & (c) (oil and gas), 241(a) (oil shale, native asphalt, tar sands), 262 (sodium), 272 & 273 (sulfur), 282 & 283 (potassium), 1004(a) & 1007(b) (geothermal steam) (1976).

[281] 43 CFR § 3503.3-2(a)(1)(ii) (1977); BLM Lease Form 3520-6 (1972).

[282] 38 F. R. 33189 (1973) (sec. 7).

[283] Prior to Aug. 4, 1976, the minimum royalty for coal, however mined, was 5 cents per ton, and fixed-cents-per-ton royalties continued to be specified in leases until 1971, when a switch to percentage-of-gross-value royalties (but not less than 5 cents per ton) was made administratively. See the GAO study cited in note 244, at 34-35.

[284] Geothermal steam royalties may be raised to a maximum of 22.5 percent through readjustment of the lease terms, but no such readjustment of the royalties may be made until at least 35 years after geothermal steam is first produced and every 20 years thereafter. Moreover, the royalty increase at each readjustment cannot exceed 50 percent of the royalty paid during the preceding period. 30 U.S.C. § 1007(b) (1976).

[285] 43 CFR § 3503.3-3 (1977).

[286] 30 U.S.C. §§ 209, 1012 (1976).

bidding, even though alternative methods of disposal are authorized for many of the leasable minerals.[287] The bonus has always been a fixed rather than a walkaway bonus, except for the prototype oil-shale leases issued in 1974, which allow the lessee to forego payment of the last two of the five annual bonus installments if the lease is surrendered prior to the time the installments are due.[288] The fixed bonus recluired for coal leases is spread across several years, but the entire bonus must be paid whether or not the lease is surrendered before all payments have come due.[289]

The advantages and disadvantages of bonuses and royalties are discussed in subsection E(2).

F. Maximum Mineral Recovery and Resource Conservation

1. Explicit and Implicit Impediments to Multiple Mineral Development

The existence of distinct legal provisions governing disposal of different minerals under the Federal mining and mineral leasing laws creates explicit and implicit impediments to multiple mineral development on any particular tract.

At one time, as was discussed in chapter 3, mineral leases could not be issued on land subject to a mining claim and vice versa, This legal impediment was removed for most situations by the Multiple Mineral Development Act of 1954.[290] The Act, however, did not repeal the explicit provisions in the Mineral Leasing Act of 1920 that prohibit issuance of coal or phosphate prospecting permits for land already covered by a mining claim located under the Mining Law.[291] Moreover, the Act does not affect the prohibition against location of mining claims in situations where leasable and locatable minerals are intermingled in the same deposit, so that extraction of one type of mineral is impossible unless the other is also extracted.[292] A 1955 statute, no longer in force, was deemed necessary to allow concurrent extraction of intermixed coal and uranium deposits.”]

Even when concurrent operations under a mining claim and a mineral lease are legally permissible, they are rarely attempted due to the physical difficulty of having two distinct mining operations going on simultaneously on the same tract. Similarly, although mineral leases for different leasable minerals can be issued for the same tract, ’(” applications to lease a tract already under lease for another mineral are rarely filed; and the Bureau of Land Management, which issues mineral leases, is reluctant to approve applications that are filed, again due to the difficulty of coordinating two distinct mining operations on the same tract. When multiple mineral de-

[287] See subsec. D(3)(a).

[288] 38 F. R. 33189 (1973) (sec. 5)

[289] The law requires that at least 50 percent of the acreage offered for lease each year be leased under a system of deferred bonus payment. 30 U.S.C. § 201(a) (1976). The Secretary of the Interior has issued regulations requiring that *all* coal leases be issued subject to a deferred bonus payment due in five equal installments over the first 4 years of the lease. 43 CFR § 3525.8(e) (1977).

[290] See ch. 3, subsec. D(6).

[291] U.S. Department of the Interior, "The Effect of Mining Claims on Secretarial Authority to Issue Prospecting Permits for Coal and Phosphate," Solicitor's Opinion M-36893, 84 I.D. 442 (1977).

[292] See, e.g., 30 U.S.C. § 1005(f) (1976).

[293] See ch. 3, subsec. D(6).

[294] It seems to be generally assumed that multiple leases can be issued, and the lease forms for the various leasable minerals reserve the right to issue multiple leases. However, Congress felt it was necessary to explicitly reserve the right to issue multiple leases in the statutory provisions authorizing leasing of native asphalt, tar sands, sulfur, and potassium. 30 U.S.C. §§ 241(c), 274, 284 (1976).

velopment by two distinct firms does occur, it almost always involves oil and gas leases, since oil and gas development requires no excavation and can be accomplished through directional drilling, thus providing the most space and flexibility for development of other minerals. But even with oil and gas leases, multiple development will be precluded if oil and gas operations would endanger mining operations, or vice versa.

Thus, either explicit legal restrictions or implicit physical restrictions will usually prevent multiple mineral development by two different firms on the same tract. Mineral explorers will usually bypass land that is already subject to a mining claim or a mineral lease, especially if it is actively being worked, unless they can buy out the claim or lease.

In practice, then, multiple mineral development is likely to occur only when it can be implemented by a single individual or firm, except in some situations where one of the minerals being developed is oil or gas. Unfortunately, however, there are also explicit and implicit impediments to single-firm multiple mineral development,

Even after passage of the Multiple Mineral Development Act, a mining claimant cannot extract leasable minerals from his claim unless the claim is patented and the patent does not contain a reservation to the Government of the leasable minerals. A reservation of the leasable minerals will be made if the land being patented is covered by a permit, lease, or application for a permit or lease under the mineral leasing laws, or is known to be valuable for a leasable mineral, at the time the patent is issued. Similarly, a mineral lessee cannot extract locatable (Mining Law) minerals, or even leasable minerals other than those covered by his lease, from the leased land. [295]

Holders of hardrock mineral leases on acquired land are allowed to mine the dominant hardrock mineral specified in the lease and also "associated minerals and any other hardrock minerals] in, upon, or under the [leased] lands. [296] Thus, hardrock mineral lessees on acquired land are treated the same as mining claimants on public domain. In either case, all hardrock minerals but none of the usual leasable minerals (geothermal steam, the fossil fuel minerals, phosphate, potassium, sodium and, in Louisiana and New Mexico only, sulfur) can be mined.

A holder of a coal, sulfur, oil shale, native asphalt, tar sand, or oil and gas lease is allowed to produce only that mineral for which the lease was issued. Holders of sodium leases are allowed to mine potassium compounds as a byproduct in addition to chlorides, sulphates, carbonates, borates, silicates, or nitrates of sodium.[297] Conversely, potassium leases may include covenants providing for the development by the lessee of chlorides, sulphates, carbonates, borates, silicates, or nitrates not only of potassium but also of sodium, magnesium, aluminum, or calcium associated with the leased potassium deposits.[298] The standard lease form for potassium contains no such covenants but does grant the exclusive right to mine and dispose of all the potassium ''and associated deposits.''[299] Holders of phosphate leases are allowed to mine phosphates and ''associated or related minerals,'' as well as ''so much of any deposit of silica or limestone or any other . . . rock as may be utilized in the processing of the phosphates, phosphate rock, and associated or related minerals.''[300]

[295] See ch. 3, subsec. D(6).
[296] BLM Lease Form 3520-6 (1972).
[297] 30 U.S.C. § 262 (1976).
[298] Ibid., § 284.
[299] BLM Lease Form 3520-2 (1971).
[300] 30 U.S.C. §§ 211(a), 213 (1976).

Holders of geothermal steam leases are allowed to produce geothermal steam and associated geothermal resources, including any byproduct minerals (exclusive of oil, hydrocarbon gas, and helium) that are found in solution or in association with geothermal steam and that have a value of less than 75 percent of the value of the geothermal steam or are not, because of quantity, quality, or technical difficulties in extraction and production, of sufficient value to warrant extraction and production by themselves.[301] In fact, if the production, use, or conversion of geothermal steam is susceptible of producing valuable byproducts, the Secretary of the Interior must require substantial beneficial production or use thereof unless, in individual circumstances, he modifies or waives this requirement in the interest of conservation of natural resources or for other reasons satisfactory to him.[302] The Secretary has issued regulations stating that one of the "other reasons satisfactory to him" is the economic unfeasibility of such beneficial production or use of byproducts.[303]

In sum, under the mineral leasing laws, most lessees may produce only the minerals for which their leases were issued. Sodium lessees may mine potassium compounds intermingled with the sodium. Potassium lessees may mine sodium compounds (ordinarily leasable under a different provision of the Leasing Act) and magnesium, aluminum, or calcium compounds (ordinarily locatable under the Mining Law) intermingled with the potassium. Geothermal lessees may (or must) produce any mineral other than oil, hydrocarbon gas, or helium intermingled with the geothermal steam. Phosphate lessees apparently may produce any mineral intermingled with the phosphate, as well as separate deposits of silica, limestone, or any other rock that can be used in processing operations, Hardrock lessees may produce any hardrock mineral, whether intermingled with or in a separate deposit from the dominant hardrock mineral for which the lease was issued. Mining claimants under the Mining Law may also produce any hardrock mineral found within the claim.

Thus, in no instance can a holder of a single mining claim or mineral lease produce all the valuable minerals that may occur within the claim or lease, Only a phosphate lessee can produce all the minerals intermingled with a deposit of the mineral for which a lease was issued or a claim was located. A mineral lessee, but not a mining claimant, can apply for additional mineral leases to obtain production rights for intermingled leasable minerals, but the costs (including multiple rentals and diligence requirements) and time required will often discourage such applications. Moreover, since the minerals for which the additional leases are sought are known to exist, competitive leasing may be required, although the original lessee would clearly have a substantial advantage in any competitive sale. Rights to nonintermingled minerals can be acquired through claim or lease, as appropriate, although again the costs and time required often may not be worth the effort.

When a mining claimant or mineral lessee is prevented by explicit limitations or costly multiple application requirements from producing all the minerals in his claim or lease, especially those minerals intermingled in the deposit being developed, there is an unnecessary loss in efficiency and most probably a waste of mineral resources, since it is unlikely in most cases that it will be economical for anyone to attempt to mine

[301] 30 U.S.C. §§ 1001(c) & (d), 1002 (1976).
[302] Ibid., § 1008.
[303] 43 CFR § 3242.1 (1977).

the unproduced minerals after the original claim or lease has terminated. In those cases where sequential production is possible, damage to surface resources and interruption of surface uses will be unnecessarily extended,

There seems to be little reason for not allowing [and possibly even requiring) production of all valuable minerals found within any mining claim or lease, as long as the appropriate royalties are paid on each mineral produced (a uniform profit-share perhaps could replace the different royalties). The paperwork and costs required for multiple applications by the same party are clearly unwarranted. And, as was discussed above, multiple mineral development by different parties on the same tract is highly unlikely even when it is allowed, and it is not allowed for intermingled locatable and leasable minerals.

If production of all valuable minerals is allowed, the period of the claim or lease should be extended as long as any mineral is being produced in commercial quantities (with provision for temporary interruptions of production), as is permitted for production of byproduct minerals under a geothermal steam lease. [304]

A more difficult issue is whether a mining claimant or mineral lessee should be allowed to obtain production rights if he finds any valuable mineral deposit, or rather must find a deposit that is valuable for the mineral for which the claim was located or the (permit or) lease was issued. Currently, production rights may be obtained under the mineral leasing laws only if a valuable deposit of the mineral for which the permit or lease was issued is found, even when concurrent production of other minerals is authorized. That is, the right to produce other minerals is dependent on first commencing production of the mineral for which the permit or lease was issued. [305] Under the Mining Law, on the other hand, discovery of a valuable deposit of any hardrock mineral is sufficient, even if the mineral is not the one that was the object of the exploration effort.

If production rights could be obtained on discovery of any valuable mineral deposit, then each mining claim or mineral permit or lease in essence would become a comprehensive permit granting exclusive exploration rights for all minerals in a particular tract of land. The numerous distinct permits under the mineral leasing laws would no longer make sense, because if different permits were available the mineral explorer could choose to use whichever one seemed least burdensome. Similarly, the distinction between mining claims and mineral permits or leases would no longer make sense, Instead, there could be a single type of comprehensive claim, permit or lease (referred to, from now on, as a comprehensive permit) granting exclusive exploration, development, and production rights for all minerals in the land covered by the comprehensive permit.

Whether a comprehensive permit makes sense depends initially on whether uniform provisions can be devised to assure diligent exploration regardless of the minerals being searched for. (Uniform development and production provisions might also be desirable, but would not be necessary since the permit could specify or refer to different development and production provisions that would apply to different minerals or groups of minerals.] A comprehensive "permit" (mining claim) is now available for

[304] 30 U.S.C. § 1005(e) (1976).

[305] See subsec. D(3)(b)

hardrock minerals on public domain, with uniform assessment work requirements. Functionally similar diligence requirements are imposed on geothermal steam leases, Although the requirements for hardrock minerals and geothermal steam are not now sufficient to assure diligent exploration, it appears that they could be made sufficient.[306] Any uniform requirements sufficient to assure diligent exploration for the hardrock minerals and geothermal steam would most likely be sufficient to assure diligent exploration for any mineral.

A second potential problem with a comprehensive permit is the grant of exclusive exploration rights for all minerals in a particular tract. A person exploring for one or a few minerals under a comprehensive permit would prevent others from exploring for different minerals in the same tract. This problem seems most troublesome in the context of current oil- and gas-leasing practices: several tens of millions of acres are being held for speculative purposes and are not believed to be worth drilling.[307] If these acres were held under a comprehensive permit system, exploration for other minerals would be needlessly and substantially limited, But the problem would not exist if adequate diligence requirements existed. Holdings of oil and gas leases would drop dramatically. And, as was noted above, mineral explorers even now will almost always bypass land that is already subject to a mining claim, mineral permit, or mineral lease that is actively being worked, unless they can buy out the claim, permit, or lease.

If, as seems to be the case, active multiple mineral exploration and development by different parties on the same tract is, in fact, highly unlikely because of explicit restrictions and practical difficulties, there would seem to be little reason to provide for issuance of multiple permits for the same tract. In practice if not theory, the single permit is already the rule. A comprehensive permit in such circumstances might provide a better incentive to explore in the first place (since any mineral discovered could be developed], to explore for all minerals, to utilize modern multiple mineral exploration technology, and to engage in multiple mineral mining, which would promote maximum mineral recovery and conservation of mineral and nonmineral resources.

2. Unitization and Cooperative Development Plans

Oil and gas occur in underground reservoirs. If, as is often the case, the same reservoir lies under several oil and gas leases held by different parties, the lessee who pumps the oil out fastest will obtain most of the resource. Timely and efficient mineral activity can give way to overly rapid exploration, development and production. Oil will not be conserved even though it might have a much higher value in the future, Furthermore, overly rapid production decreases the pressure in the reservoir so that ultimate total recovery may be reduced.

There have been two major approaches to resolution of this problem.[308] One has been State laws and Federal lease provisions related to minimum spacing and maxi-

[306] See subsecs. C(2)(b) and C(3)(b). The expenditure requirement approach to diligent exploration may not be the best approach. It is referred to merely to indicate that a uniform approach for all minerals may be possible.

[307] See subsec. C(3)(b).

[308] See McDonald, "The Maximum Efficient Rate (MER) in Oil and Gas Production," in Resources for the Future *The Use of Maximum Efficient Rate (MER) as a Regulatory Tool*, Final Report to the U.S. Department of the Interior, at I-1, I-33 to I-39 (1976) (hereinafter cited as MER Study).

mum rates of production of wells.[309] The other has been the adoption of cooperative or unit plans, communitization or drilling agreements, or operating, drilling, or development contracts for joint development and production of all or part of a reservoir.

The Secretary of the Interior is authorized to approve participation by Federal lessees in cooperative or unit plans and, with the consent of the lessees, to establish. alter, change, or revoke drilling, producing, rental, minimum royalty, and royalty requirements of such leases. The plan may provide for control of the rate of prospecting and development and the quantity and rate of production. The Secretary may insert in every new Federal oil and gas lease a provision requiring the lessee to operate under a reasonable cooperative or unit plan, and he may prescribe a plan under which the lessee shall operate.[310] The Federal oil and gas lease forms contain such a provision. The Secretary may also approve participation by Federal oil and gas lessees in communitization or drilling agreements or operating, drilling, or development contracts.[312] Any Federal oil and gas lease included in a cooperative or unit plan or an operating, drilling, or development contract is not counted in determining acreage holdings, and operations or production under a cooperative or unit plan or a communitization or drilling agreement are deemed to occur on each lease committed thereto for purposes of diligence and tenure requirements.[313]

Almost identical provisions apply to geothermal steam leases.[314]

The Secretary, by regulation, has provided for approval of operating or development contracts, or processing or milling arrangements, made by one or more Federal lessees of hardrock minerals on acquired land to justify operations on a large scale for the discovery, development, production, or transportation of ores.[315] Apparently, however, individual lease terms and conditions remain applicable.

Since 1976, the Secretary has been authorized to approve consolidation of Federal coal leases, including intervening or adjacent non-Federal coal land, into logical mining units, and he may require a lessee of a Federal coal lease issued on or after August 4, 1976, to form a logical mining unit. A logical mining unit is defined as an area of land in which the coal resources can be developed in an efficient, economical, and orderly manner as a unit with due regard to conservation of coal reserves and other resources. A logical mining unit cannot exceed 25,000 acres, including Federal and non-Federal acreage, and Federal leases included in a logical mining unit are not exempted from the limitations on total acreage holdings.[316]

The Secretary may amend the provisions of any Federal coal lease included within a logical mining unit to conform to the requirements imposed on the unit. He may further provide that operations or production on any part of the logical mining unit shall be deemed to occur on all Federal leases in the unit for purposes of diligence and tenure requirements, and he may allow rental, royalty, and advance royalty payments to be combined for the unit.";

[309] See, e.g., 30 CFR §§ 221.10, 221.15, 221.21, 221.35 (1977); BLM Lease Form 3110-1, § 4 (1977).

[310] 30 U.S.C. § 226(j) (1976).

[311] See, e.g., BLM Lease Form 3110-1, § 2(b) (1977).

[312] 30 U.S.C. § 226(j) (1976).

[313] Ibid.

[314] 30 U.S.C. §§ 1005(c), 1017 (1976).

[315] 43 CFR § 3505.3 (1977).

[316] 30 U.S.C. § 202a (1976).

[317] Ibid.

All of these unitization or cooperative development provisions are intended to prevent waste and assure efficient mineral operations by allowing or requiring mineral deposits to be explored, developed, and produced as a unit rather than in fragmented chunks under separate Federal, State, or private leases owned by different parties. They remove many barriers to maximum mineral recovery and resource conservation, but they may themselves be subject to requirements, including payment and diligence requirements, which detract from maximum mineral recovery and resource conservation.

3. Effect of Mineral Value Payment Requirements

The adverse effect of royalties and walkaway bonuses on maximum mineral recovery and resource conservation is discussed in detail in subsection E(2), Both types of payment requirements can cause mining of only the higher grade ore while production is underway and premature termination of production when all the higher grade ore has been mined. Mineral resources that could have been profitably extracted in the absence of the payment requirements are left in the ground and will probably never be produced, given the high costs of resuming production once it has been terminated. This is not only a waste of mineral resources but also causes more damage to nonmineral resources than would otherwise be incurred, since more mineral deposits will have to be mined to obtain the desired quantity of mineral production. Even when the same mine is reopened, the surface will be disturbed twice rather than only once.

All onshore Federal leases require payment of royalties to the Government. The adverse effects of royalties described above could be avoided by a shift to alternative types of mineral value payment requirements, such as the profit share.[318]

Unfortunately, royalty payment requirements are imposed on Federal lessees not only in the lease itself, but also by previous holders of the lease who assigned their rights to the current leaseholder but retained an "overriding royalty, " This is a particularly troublesome problem with oil and gas leases because of the uncontrolled speculation in noncompetitive leases.[319]

The Secretary of the Interior has restricted the use of overriding royalties through regulations and lease provisions. For example, the oil and gas lease forms limit overriding royalties to a maximum of 5 percent except as otherwise authorized by the regulations. The regulations prohibit any overriding royalty on oil (but not gas) that, when added to previously existing overriding royalties and the basic lease royalty, would result in an aggregate royalty obligation in excess of 17.5 percent, unless the agreement creating the excess royalty expressly provides that the obligation to pay such excess overriding royalty will be suspended when average daily production per well is 15 barrels or less.[320] Similar restrictions exist for all the other leasable minerals, Overriding royalties on hardrock, sodium, sulfur, or potassium leases are subject to reduction, in inverse order of creation, to an aggregate of not less than 1 percent, whenever such reduction appears necessary to prevent premature abandonment or to make possible

[318] See subsecs. E(2) and E(3).
[319] See *GAO Acreage Limitations Study*, note 55, at 13-14, 19-20.
[320] 43 CFR § 3103.3-6 (1977); BLM Lease Forms 3110-3 (1973), 3120-3 (1968) & 3120-7 (1977).

the economic mining of marginal or low-grade deposits.[321] Overriding royalties on coal or phosphate leases[322] or the prototype oil shale leases[323] cannot exceed, in the aggregate, 1 percent for coal, 50 percent of the basic lease royalty for phosphate, or 25 percent of the basic lease royalty for oil shale, unless in each case the assignor shows that he has made substantial investments for improvements on the land covered by the assignment. Overriding royalties on geothermal steam leases cannot exceed, in the aggregate, 50 percent of the basic lease royalty.[324]

As was discussed in subsection E(3) above, the Secretary can [but rarely does) reduce the basic lease royalty whenever in his judgment it is necessary to do so in order to promote development, or whenever in his judgment the lease otherwise cannot be successfully operated. The regulations provide that no such reduction will be authorized unless the holders of overriding royalties agree to reduce them to an aggregate not exceeding 50 percent of the reduced basic lease royalty.[325]

The restrictions on overriding royalties listed above are generally quite weak. Most of the restrictions require affirmative Government action, which is rarely forthcoming, before any actual limitation of overriding royalties is imposed. The limitations, when imposed, still permit substantial overriding royalties for oil, phosphate, oil shale, and geothermal steam. There is no aggregate limit on overriding royalties for natural gas.

Considering the substantial adverse effects royalties can have on maximum mineral recovery and resource conservation, a strong argument can be made for banning any reservation of overriding royalties by assignors who have not made substantial good faith expenditures for exploration, development, or production of the assigned land: the speculator who has done nothing to develop the land should not be allowed to burden its future development, but rather should be left to recover his speculative profits through fixed-bonus or profit-share payments.

In these days of concern over the availability and conservation of mineral resources, consideration could also be given to prohibiting retention of overriding royalties even by an assignor who has expended substantial time and effort on developing the assigned land, If his work has been productive, there will probably be sufficient information about the mineral deposit to enable him to capture his fair share of future profits through a fixed-bonus payment. Or, if there is still considerable uncertainty about the value of the tract, a profit share could be negotiated.

State severance, property, and license taxes based on gross income are in effect royalties on production, and have the adverse effects associated with royalties. The State taxes are discussed more fully in chapter 6, subsection E(l).

4. Effect of Performance Requirements and Incentives

Performance requirements and incentives are imposed on mineral tenure holders to prevent them from "sitting" on land and precluding mineral and nonmineral activ-

[321] 43 CFR § 3503.3-2(c) (1977).
[322] Ibid.
[323] 38 F. R. 33193 (1973) (sec. 25).
[324] 43 CFR § 3241.7-2 (1977).
[325] 43 CFR §§ 3103.3-7, 3205.3-7, 3503.3-2(d) (1977). There does not appear to be such an express requirement for oil shale leases.

ities by others, or to correct practices that are wasteful from the standpoint of the Nation as a whole even though such practices may be "efficient" from the standpoint of the individual tenure holder,

Inadequate diligence requirements or incentives allow mineral land to be tied up by speculators, insufficiently financed explorers or developers, or producers with an overabundance of reserves, who can exclude someone willing and able to undertake immediate exploration or development, or who can demand royalties or other payments in return for the transfer of tenure rights, thereby reducing the interest in such transfer or, should the transfer occur, burdening future mineral operations, [326] even though the original tenure holder may have done little or nothing to explore or develop the land.

Furthermore, the uncertainty over whether or when mineral activity will occur, coupled with the preferred position given to mineral activities, discourages nonmineral development on or near a tract subject to mineral tenure rights, It prevents all but the shortest term planning of land use and services for the tract itself and the surrounding area. [327]

The performance requirements and incentives under the Federal mining and mineral leasing laws are discussed in sections C and D. These requirements and incentives are inadequate to assure diligent exploration and development for all or almost all of the minerals. In addition, some of the requirements, such as the Federal and State location, discovery, and work requirements under the Mining Law, result in make-work, which often destroys nonmineral values without making any contribution to the discovery or development of mineral deposits. [328]

On the other hand, overly stringent production requirements, such as those requiring a certain rate or continuity of production, can prevent conservation of mineral resources that would have a greater value to the Nation in the future but are required to be produced now, or can force premature abandonment or forfeiture of the mineral tenure if the required production cannot be sold at a minimum profit. Similarly, if the time allowed for production is too brief to allow complete mining of the deposit, mining of only the higher grade ores will be encouraged, causing the same adverse effects on maximum mineral recovery and mineral and nonmineral resource conservation as is caused by royalties on the gross amount or value of production. [329]

Such production requirements exist for most of the leasable minerals after the primary period of the lease has expired, The fuel mineral leases are continued after their primary period only so long as there is annual production, unless the Secretary of the Interior suspends operations in the interest of conservation (a rare occurrence). Certain other leasable minerals have an assured lease period of only 20 years, since there is only a preferential right to renew the lease after the initial 20-year lease period. [330]

Even more extensive intrusions into the timing and rate of production are authorized but have not yet been implemented for federally leased oil and gas. The Energy

[326] See subsec. F(3).
[327] See ch. 5, subsecs. D(8) and E(7).
[328] Ibid., subsec. D(2).
[329] See subsec. F(3).
[330] See table 4.2 and the following pages in subsec. D(3)(c).

Policy and Conservation Act of 1975 directs the Secretary of the Interior[331] to determine the maximum efficient rate of production (MER)—which is defined as ''the maximum rate of production . . . which may be sustained without loss of ultimate recovery . . . under sound engineering and economic principles' —for each oil field or gas field on Federal land that produces, or is capable of producing, significant volumes of crude oil, natural gas, or both,[332] The Act also authorizes the President to require production from Federal land at the MER.

Historically, the MER concept has been used, as the word "maximum" in "maximum economic recovery" would suggest, as a ceiling on production rates to prevent waste of oil and gas caused by overly rapid pumping of the reservoir. The MER concept and similar schemes were and are necessary to correct mineral production practices that are wasteful from the standpoint of the Nation as a whole even though such practices may be "efficient" from the standpoint of the individual oil producer,[333] However, the use of the MER not simply as a ceiling on permissible production rates, but rather as the required rate of production, raises substantial logical, practical, and efficiency problems.[334]

When MER is used merely as a ceiling, it is a requirement imposed to assure achievement of maximum ultimate recovery. It corrects for a deficiency in the market caused by the common-pool problem of different leases on the same oil or gas reservoir. It is not concerned with the timing or continuity of production, nor is it concerned with the quantity, if any, produced at any particular time as long as the quantity is below the allowable ceiling. It leaves those decisions to the lessee and the market. Thus, it should result in the most efficient (least wasteful) production over time given adequate competition.

MER has been applied almost exclusively to oil and gas. However, in recent years both the Congress and the Department of the Interior have taken the maximum ultimate recovery goal underlying MER, broadened it to encompass maximum economic multimineral recovery and conservation of the full range of mineral and nonmineral resources, and applied it in various ways to development and production under all mineral leases.

For example, the operating regulations for all mineral leases other than coal, geothermal steam, oil and gas, or in situ oil shale leases require that:

> Mining operations shall be conducted in a manner to yield the ultimate maximum recovery of the mineral deposits, consistent with the protection and use of other natural resources and the protection and preservation of the environment—land, water, and air.[335]

However, the regulatory requirement of maximum recovery of the mineral deposits (not just the leased mineral) is significantly undermined by the explicit and implicit impediments to multiple mineral development created by the existing patchwork system of Federal mineral laws.[336]

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[331] The responsibility for establishing the production rates was transferred to the Secretary of Energy in 1977. See ch. 6, subsec. A(2).

[332] 42 U.S.C. § 6214 (1976).

[333] See subsec. F(2).

[334] See MER Study, note 308; Bruce, " 'Maximum Efficient Rate'—Its Use and Misuse in Production Regulation," 9 *Nat. Res. L.* 441 (1976).

[335] 30 CFR § 231.31(a) (1977); see ibid., § 231.1(b).

[336] See subsec. F(1).

The Geothermal Steam Act of 1970 and the regulations implementing it are packed with provisions designed to assure maximum mineral recovery and conservation of mineral and nonmineral resources, including a statutory provision not only allowing but also requiring substantial beneficial production or use of all valuable minerals found in solution or association with geothermal steam and susceptible of being produced along with the production, use, or conversion of the geothermal steam, unless the Secretary of the Interior modifies or waives this requirement in a particular case in the interest of conservation of natural resources or for other reasons satisfactory to him, The only "other reason" specifically mentioned in the regulations is the economic infeasibility (not just reduced profit) of such beneficial production or use of byproducts.[337]

Meanwhile, both economic and environmental components have found their way into actual or proposed definitions of MER for oil and gas leases,[338]

The most recent congressional revision of the Federal mineral leasing laws, the Federal Coal Leasing Amendments Act adopted in 1976, forbids approval of a coal mining operating plan for a Federal lease unless the plan is found to achieve the maximum economic recovery of the coal within the tract.[339] The committee report on the bill that became law explained the meaning of and motivation for the maximum economic recovery requirement as follows:

> A primary concern of any future coal leasing program on public lands should be the maximum economic recovery of the available coal resources. At present, easily reached surface deposits which yield the highest profits are often the only resources developed in an area that contains vast amounts of coal not so easily or profitably extracted. This results in the waste of valuable resources, and the creation of severe environmental impacts, [The bill] seeks to prevent such waste by requiring the Secretary to form leasing tracts which "permit the mining of all coal which can be economically extracted. " In addition, the Secretary is prohibited from approving any mining plan which he finds does not achieve the maximum economic recovery of the coal within the tract.[340]

The Act further specifies that, prior to issuance of any coal lease, the Secretary must prepare a written evaluation and comparison of the effects (including, but not limited to, impacts on the environment, agricultural and other economic activities, and public services) of recovering coal by deep mining, by surface mining, and by any other method to determine which method or methods or sequence of methods achieve the maximum economic recovery of the coal within the lease,

The committee report also stated that the Secretary's concept of a "logical mining unit" was adopted to "further enable the maximum economic recovery from coal deposits. "[341] Under the Act, the Secretary may approve consolidation of coal leases into a logical mining unit only upon determining that "maximum economic recovery of the coal deposit or deposits is served thereby, " A logical mining unit is defined as ''an area of land in which the coal resources can be developed in an efficient, economical, and

[337]Ibid.

[338]42 F. R. 3904, 10744 (1977); MER Study, note 308. Technically, "economic" includes "environmental," but the two are often distinguished in general discussions, as they are in one of the definitions.

[339]30 U.S.C. § 201(a)(3)(C) (1976).

[340]H.R. Rep. No. 94-681, 94th Cong., 1st sess. 20 (1975).

[341]Ibid.

orderly manner as a unit with due regard to conservation of coal reserves and other resources.[342]

Clearly, the maximum economic recovery requirement was designed to conserve mineral and nonmineral resources by restricting, insofar as possible, the practice of mining only the more accessible or higher grade coal seams on Federal land. The implementing regulations for surface coal mines require extraction of the coal resource to the maximum extent possible so that future environmental disturbance caused by the resumption of mining (or having to open an entirely new mine elsewhere) will be minimized.[343] Apparently, however, the maximum economic recovery requirement is not being enforced; mining plans are being approved that do not include all the recoverable coal in a lease.[344]

G. Summary and Options

This section summarizes the material discussed in the previous sections of this chapter by presenting four major options for consideration, The options are presented in ascending degree of the amount and character of change involved when compared with the existing systems—no changes at all, moderate adjustments to the existing systems, major adjustments to the existing systems, and a comprehensive new system (for all minerals or for the nonfuel minerals only) to replace the existing distinct systems, The options, other than the "no change" option, are presented in skeletal form in table 1 at the end of the executive summary.

In each option other than the "no change" option, an attempt is made to eliminate unnecessary or duplicative regulations, to address questions of efficiency and equity in other regulations, and, where it seems appropriate, to replace regulatory restrictions with more flexible payment requirements or incentives. Many of the elements discussed under these four options are controversial; some are highly controversial. This report has not examined in depth the entire range of impacts that would be expected from the implementation of the options presented below.

Option 1. The Existing Systems ("No Change" Option)

The existing laws that govern mineral activities on Federal onshore land were enacted over more than a century. Different provisions within the same law or in different laws were enacted for land in different States, for land acquired by different methods, for different minerals, or for different geologic configurations of the same mineral. The resulting collection of laws contains significant gaps in coverage, treats physically similar lands or mineral deposits differently, and otherwise makes distinctions that often seem arbitrary or are difficult to apply.

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[342] 30 U.S.C. § 202a (1976).

[343] 43 CFR § 3041.2-2(c) (1977), apparently based on Surface Mining Control and Reclamation Act of 1977, § 515(b)(1), 30 U.S.C. § 1265 (b)(1) (Supp. I 1977). The regulation for *underground* coal mines is very similar to the maximum recovery regulation for most of the leasable minerals quoted in the text at note 335, except for the insertion of a "sound economic practice" limitation on the maximum recovery requirement for underground coal. 30 CFR § 211.30 (1977).

[344] U.S. General Accounting Office, *Inaccurate Estimates of Western Coal Reserves Should Be Corrected*, EMD-78-32, July 11, 1978, at iii, 12-15, 22-23, 28, 41.

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The patchwork of existing mineral laws creates legal and practical barriers to multiple-mineral exploration and development on the same tract of Federal land. It also creates considerable uncertainty about the procedures to be followed to find and develop the growing number of mineral resources, such as zeolites, that cannot easily be classified as being subject to one law or another.

Tenure for mineral activities is uncertain and insecure under each of the existing laws. Under the Mining Law, there is no way to obtain exploration rights secure against the Government even after particular targets have been staked, and the pedis possessio doctrine provides only very weak protection against other mineral explorers. Under the leasing and sale laws, exploration rights valid against other mineral explorers and the Government can be obtained, but the granting of such rights is at the complete discretion of the Secretary of the Interior. Development and production rights for all minerals under the Mining Law and for nonfuel minerals under the leasing laws depend on satisfaction of the shifting and uncertain "discovery of a valuable mineral deposit" test.

On the other hand, the existing laws provide very few effective requirements or incentives for diligent exploration, development, or production once mineral rights have been acquired. Speculators or inadequately financed explorers or developers can tie up promising mineral land for many years, often indefinitely, or can burden future mineral activity by retaining overriding royalties although they have done nothing to develop the land. It is difficult, if not impossible, to prove noncompliance with such work requirements as do exist, and the Government may not be able to cancel mineral rights even when noncompliance has been proved. Many of the claim location and work requirements imposed by the Federal and State governments under the Mining Law do not promote the identification and development of economic mineral deposits, but rather result in needless damage to the land and expense to the explorer or developer. However, some States have recently changed their discovery work requirements to reduce such needless damage and expense.

The maximum acreage limits on individual mining claims or mineral leases are, in some cases, insufficient for modern mineral projects and techniques. These limits can prevent formation of economic mining units for competitive leasing and can cause unnecessary and unproductive work when the work requirements specified for each claim or lease cannot be aggregated for contiguous claims or leases. Minimum acreage limits either do not exist or are not set high enough to prevent splintering of economic mining units by speculators, making it more difficult to assemble such units, administer the laws, and reduce the anticonservation effect of overriding royalties.

Expense and uncertainty exist under the leasing laws as a result of the blurred distinctions between known and unknown mineral areas. Competitive bonus bidding for known mineral areas places individuals and smaller firms at a disadvantage. Gross royalties inserted in leases for known and unknown mineral areas can result in failure to produce lower grade minerals that otherwise could be efficiently recovered.

Finally, the Mining Law has some outmoded provisions (such as the provisions for extralateral rights and tunnel sites and the distinctions among lode and placer claims and millsites) that create problems for the mineral industry without serving any useful purpose.

Option 2. Moderate Adjustments to the Existing Distinct Systems

Moderate adjustments could be made to some of the existing distinct systems that would eliminate or reduce a good part of the inefficiency and uncertainty that now exist. These adjustments would be "moderate" in the sense that they would not alter the basic character of any existing system. Consequently, they would not affect aspects of a system that are a key part of its structure, nor would they eliminate the gaps and uncertainties that arise from the existence of a number of distinct systems.

For example, the tunnel site, lode versus placer, and extralateral right provisions in the Mining Law could be eliminated. Maximum limits on the size of individual claims under the Mining Law could be replaced with much larger maximum limits on the area that could be treated as a unit for the purpose of satisfying work requirements. Damaging and unproductive claim marking and location requirements could be replaced with filings in the local land office, as is currently the practice under the leasing laws. The existing annual work requirements could be increased slightly each year a claim is held, and work performed in excess of the requirement for one year could be "banked"" and applied toward requirements in subsequent years. Payments could be allowed in lieu of actual work. Failure to file proof of such work or make payment every year would result in automatic cancellation of the claim. If it is desired to require payments to the Federal Government for production of minerals under the Mining Law. then the payments probably should be structured as a share of net profits (gross income less expenses and a minimum return on investment) in order to avoid inefficiencies that may result from other types of mineral value payment requirements. It should be noted, however, that payments for mineral value are much less important, from the standpoint of either efficiency or equity, than payments in lieu of work requirements or payments for damage to nonmineral resources.

Similarly, maximum acreage limits could be eliminated from the leasing laws. An escalating, payable, bankable work requirement could be introduced similar to the one outlined above for the Mining Law and already in effect for oil shale and geothermal steam leases. Gross royalties could be replaced by profit-share payments,

Minimum sizes could be specified for claims and leases, and overriding royalties could be eliminated, severely limited, or required to be based on net profits rather than on gross income.

Claims and leases could be terminated automatically after 15 to 20 years if development had not yet been completed—that is, unless there were a well or mine producing or capable of producing. The escalating, payable, bankable work requirement could be replaced, after development had been completed, by a requirement of annual commercial volume production, or payment of an advance royalty on such production in lieu of actual production. The Secretary of the Interior could be authorized to suspend any work or production requirement for good cause shown in a particular case, but might not be allowed to extend the 15- to 20-year period allowed for completion of development.

These adjustments could greatly improve the efficiency of mineral activities. However, substantial problems would remain. For example, the work requirements, although improved, would still be insufficient to ensure diligent mineral activity, and tenure for exploration, development, and production, especially for the nonfuel minerals, would continue to be uncertain and insecure.

Option 3. Major Adjustments to the Existing Distinct Systems

Further adjustments, in addition to those outlined in the previous "moderate adjustments" option, would be necessary to provide for secure tenure and diligent activity under the mining and mineral leasing laws. These adjustments would eliminate or revise major elements of each separate system. However, they would still not eliminate the gaps and uncertainties created by the existence of a number of distinct systems.

Secure exploration rights could be created under the Mining Law by granting to each claimant an exclusive right to explore, good against the Government as well as against other explorers, for a 2-year period, perhaps renewable for an additional 2 years for good cause shown. In addition, the "discovery of a valuable mineral deposit" test for acquiring and maintaining development and production tenure could be eliminated, Any explorer willing and able to begin substantial development activity upon termination of the exploration period would automatically be granted tenure for development and production. Alternatively, development and production tenure could be granted initially along with the exploration tenure, subject to the condition that exploration be completed within 2 (perhaps extendable to 4) years. Either way, the tenure package would be subject to the work requirements and time limits on development, and the produce-or-pay conditions on production, outlined above in the "moderate adjustments" option. Moreover, to prevent speculation in and tying up of mineral land, the escalating annual work requirements would be applied to exploration as well as development and increased to a level comparable to actual expenditures on good faith exploration and development. (The annual work requirements could be either uniform requirements revised periodically on the basis of reported expenditures on actual projects, or ad hoc negotiated requirements built into a "development contract.")

Patents (ownership documents) would continue to be granted under the Mining Law, but only after commencement of development. To prevent abuse of the liberalized tenure provisions, a patent would grant ownership of the minerals only, not the surface. Use of the surface, for mining-related purposes only, could be allowed upon payment of an appropriate rental. The mineral ownership would revert to the Government if the annual work or production requirements were not satisfied or if the surface were used for nonmineral purposes,

Similar adjustments could be made under the leasing laws, The "discovery of a valuable mineral deposit" test for acquiring development and production tenure for nonfuel minerals under the leasing laws could be replaced by automatic grants of such tenure, as outlined immediately above for the Mining Law, and subject to the same work requirements, time limits, and conditions. These work requirements, time limits, and conditions could also replace similar but less effective provisions currently applicable to the tenure granted for exploration, development, and production of the fuel minerals under the leasing laws. Again, the escalating work requirements would have to be increased to a level comparable to actual expenditures on good faith exploration and development in order to avoid speculation in and tying up of mineral land.

Finally, the distinction between known and unknown mineral areas could be eliminated from the leasing laws and avoided under the Mining Law, since (a) profit-share mineral value payments should satisfy those who believe that the Government should receive payment for its mineral resources, (b) the substantial escalating work requirements should deter speculation, and (c) the elimination or restriction of overriding royalties should also deter speculation and minimize burdens on production resulting from such speculation. Competitive bidding or a lottery are two options that could be reserved for those situations where more than one person filed a claim or applied for a lease for the same tract of land during, for example, any 10-day period.

As is discussed below and in section H of chapter 5. several of these major adjustments would eliminate some of the strongest protections of nonmineral values that now exist under the mining and mineral leasing laws (e. g., the "discovery of a valuable mineral deposit" test for acquiring development and production tenure under the mining and mineral leasing laws and the ability to withdraw claimed land from continued exploration under the Mining Law). Therefore, it is doubtful that these adjustments could be made without also making other changes to ensure proper balancing of mineral and nonmineral resource values.

Option 4a. Replacement of the Existing Distinct Systems With a Comprehensive System for All Minerals

If all the moderate and major adjustments listed above were made to the existing distinct systems, the various systems would be practically identical in structure, requirements, and effects, and there would be little reason for continuing the distinctions among minerals and lands covered by the systems.

Thus, the confusion and costs involved in applying the lines that separate the systems, and the impediments to efficient multiple-mineral operations inherent in such line-drawing, could be eliminated by combining all minerals and lands under one comprehensive system (either location, leasing, or some other system). A claim or lease under this comprehensive system would grant exclusive rights for all minerals.

The major remaining obstacle to such a comprehensive system would be the theoretical distinction between a miner's absolute right of access under the Mining Law and his access subject to the discretion of the Secretary of the Interior under the leasing and sale laws. But the '*absolute" right of access under the Mining Law can be and increasingly has been blocked or restricted through land withdrawals or through delays or restrictions on rights-of-way or other land use permits. Withdrawals can now be made at any point during exploration under the Mining Law, so that exploration access and tenure are even more uncertain under the Mining Law than they are under the leasing and sale laws. One of the major adjustments to the Mining Law listed above would provide for exploration tenure secure against such land withdrawals. But it is doubtful that such an adjustment could be made without eliminating the absolute right of access, unless better provisions for coordinating mineral and nonmineral activities were also adopted. If such better provisions were available, they could be applied also to the leasing and sale laws in order to reduce the need for Secretarial discretion over access under those laws.

In sum, the need (or lack of need) for Secretarial discretion over access is the same under each of the adjusted distinct systems, and the resolution of the discretion issue should be the same for each distinct system, or for any comprehensive system replacing the distinct systems. In other words, the discretion issue should not deter consideration of adopting a comprehensive new system,

Option 4b. Partial Replacement of the Existing Distinct Systems With a Comprehensive System for Nonfuel Minerals Only

For a number of reasons, it might be considered desirable to exclude the fuel minerals (except perhaps uranium) from a comprehensive system like the one described above.

First, Congress has given considerable attention to the laws governing some of the fuel minerals—oil, gas, geothermal steam, and coal. Congress might not want to alter laws in which it had already invested so much effort, even though those laws contain many defects in common with the systems governing nonfuel minerals. This is actually an argument against making any adjustments at all to the fuel mineral leasing systems, rather than an argument against including them, once adjusted, in a comprehensive system.

Second, it would be difficult to define the Department of Energy's proper role, under its recently granted authority over some aspects of fuel mineral leasing, in a comprehensive system that combined all minerals under each claim or lease. This difficulty would be eliminated if, as is suggested (on other grounds) in one option in section F of chapter 6, the Department of Energy's authority over fuel mineral leasing were revised or revoked.

Third, there are large, known, untapped resources of some fuel minerals—for example, coal and oil shale. It has been argued that greater control should be exercised over these fuel minerals in order to prevent premature or speculative leasing and undesirable cumulative damage to the physical and socioeconomic environments, But such control would clearly be available under a comprehensive all-mineral system that made access subject to the discretion of the Secretary of the Interior. Even under a system of nondiscretionary access, these concerns could be handled adequately by appropriate diligence, payment, nonmineral resource protection, and socioeconomic: impact provisions in an all-mineral system.

5.

Coordinating Mineral and Non mineral Activities

Coordinating Mineral and Non mineral Activities

Federal land contains both important mineral and nonmineral resources. The existing laws treat mineral exploration, development, and production as distinct activities outside the mainstream of the land use planning and management process, although minerals and nonmineral resources are both part of the land, and decisions, policies, and actions affecting each inevitably affect the other.

Historically, mineral uses have been preferred over nonmineral uses of Federal land that is open to mineral activity. Mineral rights, once acquired, override all nonmineral resource values. Neither the mining nor mineral leasing laws contain incentives or other mechanisms adequate to ensure proper balancing of mineral and nonmineral resource values. Many provisions, especially in the Mining Law, result in adverse impacts on nonmineral resources without contributing to efficient or diligent mineral activity.

The lack of adequate nonmineral resource protection requirements has been partially responsible for congressional and executive branch decisions to withdraw increasing amounts of Federal land from the operation of the mining and mineral leasing laws in recent years, thereby precluding even mineral exploration on these lands. On those lands that remain open to mineral activities, administration of the existing broadly worded requirements often creates considerable uncertainty over the acquisition and maintenance of mineral tenure.

A. Mineral and Non mineral Resources on Federal Land

1. The Importance of the Mineral Resources in Federal Land

The importance of Federal onshore land for mineral exploration, development, and product ion was discussed in section B of chapter 2, where i t was noted that Federal onshore land has the potential to continue to be a major source of domestic mineral discoveries. In fact, according to a sampling conducted in 1968, more than **70** percent of the land then controlled by nonfuel mineral producers in the United States that directly overlaid an ore body, or Was necessary for mining an ore body, was originally obtained under the Federal mineral laws.[1] All the data support the conclusion of the Public Land Law Review Commission that the public land areas of the West generally hold greater promise for future mineral discoveries than any other region of the country, and that it is in the public interest to acknowledge and recognize the importance of mineral exploration and development in public land legislation.[2]

2. The Importance of the Nonmineral Resources on Federal Land

Federal onshore land also is a major locus of certain nonmineral resources, including timber, forage, watershed, wilderness, scenic and natural areas, wildlife, and outdoor recreation. Initially, this was the result of historical accident, as the most remote and scenic Federal land areas generally had little commercial value and were passed up by homesteaders, Eventually, as was discussed in chapter 3, many areas of the remaining public domain intentionally were set aside and reserved to protect and preserve such nonmineral resources. The Federal Government came to be recognized as the appropriate trustee of areas containing unique or important nonmineral resources, particularly the noncommercial ones, Areas containing such resources on non-Federal land began to be acquired by the Federal Government through purchase or donation—a process that has continued into the present, and which, together with the public domain areas, make the Government's holdings of such resources among the most significant in the world.

3. Locational Conflicts Between Mineral and Nonmineral Resources

The vast majority of Federal lands, as well as the majority of metal mining districts in the United States, lie west of longitude 100 degrees. Figure 5.1 roughly depicts the location, in 1976, of the mining districts for the six principal base and precious metals (iron, copper, lead, zinc, gold, and silver) and of the principal designated natural, scenic, or recreational areas on Federal onshore land (national parks, national monuments, national seashores, national recreation areas, national preserves, national wildlife refuges, wilderness areas, wilderness study areas, Bureau of Land Management primitive areas, and areas in Alaska withdrawn for possible inclusion in the National Park or Wildlife Refuge Systems). As figure 5.1 shows, the metallic mining districts, which are areas with past or present production or known to contain metallic mineral resources, in many cases are in or adjacent to areas set aside to protect nonmineral resource values. Exploration geologists believe, based on projections from the known areas of mineralization, that mineral belts possibly containing undiscovered mineral deposits exist in the nearby areas set aside or being set aside to protect nonmineral resource values.

This juxtaposition of mineral resources and nonmineral resources on Federal land did not cause much conflict until recently, primarily for two reasons. First, most nonmineral resources, especially the noncommercial ones, were not valued nearly as highly as mineral resources; thus mineral development and production proceeded with

[1] University of Arizona, 6 *Nonfuel Mineral Resources of the Public Lands: Minerals and the Environment* 694-696 (1970) (prepared for the Public Land Law Review Commission).

[2] See ch. 2, sec. B.

Figure 5.1 Base and Precious Metal Mining Districts in Relation to Federal Natural, Scenic and Recreational Areas in 1976

Dots: Metal Districts

SOURCE: U.S. Geological Survey, Special Maps Branch, 1977.

NOTE: Alaska is shown here at a reduced scale.

little or no objection. Second, many of the most significant nonmineral resources, including especially the noncommercial ones, were in geologically complex areas that sometimes were passed over by mineral explorers in favor of more accessible areas containing more easily identifiable mineral deposits. Today, however, nonmineral resources are being valued more highly than before by many citizens (see subsection C(3)), and mineral explorers are turning toward more remote and more complex targets (see chapter 2), Consequently locational conflicts are occurring more frequently between mineral and nonmineral resource activities and uses.

Similar situations exist for the nonmetallic minerals, including the fuel and fertilizer minerals. In places, bedded deposits of these minerals underlie land also valued for its watershed, agricultural, timber, grazing, or recreational uses, Furthermore, the search for these minerals is also moving to more remote and geologically complex targets. A prime example is the major new oil and gas exploration effort in the Overthrust Belt in southeast Idaho, southwest Wyoming, and north-central Utah,[3] in which areas formally or informally set aside or highly protected because of their nonmineral resource values, including commercial as well as scenic values, are estimated to encompass almost one-half of the area with the greatest oil and gas potential. Conversely, oil and gas leases have been issued for millions of acres in the Overthrust Belt that lie within areas being considered for designation as wilderness or wild and scenic river corridors.[4]

The conflict between mineral and nonmineral resource values is apparent in the current debate over the appropriate classification of vast areas of Federal onshore land in Alaska. On the one hand, Alaskan geology is considered to be favorable for the occurrence of various types of high-grade mineral deposits, but Alaska has not been explored as thoroughly as the lower 48 States because of its remoteness and lack of infrastructure. It therefore represents the last frontier for discovery of major new mineral districts in the United States. On the other hand, the same remoteness, vastness, and lack of infrastructure have resulted in the de facto preservation of extremely significant nonmineral resources not duplicated anywhere else in the United States or, in some instances, in the world, such as entire river valleys and ecosystems that remain in their undisturbed primitive state.

B. The Impact of Mineral Activities on Nonmineral Resources and Their Management

1. Factors Affecting the Extent and Duration of Impact

The impact of mineral activities often can be limited in time and severity through proper precautions and careful reclamation. However, some mining methods, such as mountaintop removal or deep-pit or block-caving mining, will inevitably result in per-

[3] McCaslin, "Thirty Wells Drilling in Overthrust Belt," *Oil & Gas J.*, Aug. 1, 1977, at 123.

[4] U.S. Department of the Interior, 1 *Final Report of the Task Force on the Availability of Federally Owned Mineral Lands* 51, 54-59 (1977) (hereinafter cited as *DOI Task Force Report*); Hamilton, "The Overthrust Belt," 63 *Sierra Club Bull.*, No. 8, at 8 (Oct./Nov./Dec. 1978); see *Oil & Gas J.*, Aug. 2, 1976, at 50.

manent alteration of the surface and, particularly with respect to mountaintop removal and deep-pit mining, major shifts or losses in nonmineral resource values. Some nonmineral resource values, such as critical habitat for endangered species, archeologic sites, and unique and highly esthetic landforms, are not subject to reclamation. Wild, primitive areas can sometimes, depending upon the extent of the impacts, be restored by natural processes to their original state, but it may take up to a century or more to recover the full depth and diversity of the previously existing ecosystem stocks and functions. This is particularly true of the ecosystems of the arid regions and alpine terrain of the West and the tundra of Alaska. There are, however, instances where land can be improved by reclamation after mining,

The extent and duration of the impacts caused by mineral activity vary significanttlv depending on the stage of the activity. In general, each stage involves more concentrated and intensive work on successively smaller tracts of land (see chapter 2).

During the initial stages of regional appraisal and aerial reconnaissance, very large areas are covered with practically no impact on the land. Regional reconnaissance involving on-the-ground geologic and geochemical techniques also causes very little disturbance if appropriate care is taken in gaining physical access. Regional reconnaissance involving stratigraphic drilling or seismic surveys, however, can result in significant local impacts if new roads or trails are created, particularly in areas containing the more sensitive nonmineral resources. The drill holes required for seismic surveys and stratigraphic drilling may constitute hazards to animals and people and may result in pollution of water tables if not properly sealed and reclaimed. Drilling and roadbuilding activities can upset domestic stock and wildlife, especially during breeding seasons, and may lower an area's recreational values, especially for the nonintensive forms of recreation. However, with proper precautions and reclamation all these effects tend to be temporary, and they are dispersed over a fairly large area rather then concentrated at a particular site,

When exploration focuses on particular target areas, the exploration techniques are applied more intensively in tighter patterns, and techniques such as drilling and the digging of pits and trenches are utilized, but the area of activity is greatly reduced. This intensive exploration is much more likely to require new roads, which, along with cross-country travel, may form a grid as exploration proceeds. The impacts on nonmineral resources are more severe and more prolonged. Some of the more sensitive nonmineral resources may not recover, or may take a long time to recover despite careful exploration and reclamation.

By the time an economic mineral deposit has been confirmed, surface impacts can be quite substantial, although activity is confined to a fairly small area. Development and production of the deposit can either cause substantial and permanent effects, as in the case of an open-pit mine, or can result in impacts no greater or even less than that which occurred during exploration, as in the case of underground mines with minimal onsite surface facilities or oilfields with buried pipelines. Milling and process-

National Academy of Sciences, *Rehabilitation Potential of Western Coal Lands* (1974); Noble, "Healing the Wounded Tundra," *Forestry Research West*, January 1979, at 7; West, "Environmental Problems Associated With Arctic Development Especially in Alaska," 3 *Environmental Conservation* 218-224 (1976); Waldrop, "Strict Law Challenges Strip Mine Operators," *Chem. & Eng. News*, Aug. 22, 1977, at 18.

ing plants can cause noise, water, and air pollution, Much of this type of pollution has been mitigated in recent years by general environmental laws, Large surface areas, including entire valleys, are often required for disposal of waste rock from mining or waste "tailings" from milling or processing operations.

The impacts of mineral activity on nonmineral resources can be beneficial as well as adverse. In some areas and for some uses, mining and subsequent reclamation can improve the nonmineral resource values of a tract of land. In many areas the same roads that give access to minerals often give access to nonmineral resources, for example, access to outdoor recreation including wilderness. The impacts of roads cannot be generally described, but must be assessed on a site-specific basis, and even then subjective judgments are often called into play. As another example, many of the ancillary land uses connected with mineral activities are for communities and jobs; the tradeoffs among land use, social, and economic impacts are extremely complex, are viewed in different ways by different people, are site-specific, and can vary with time. Thus mineral activities involve both temporary and permanent gains and losses in nonmineral resource values, The mix and extent of these gains and losses depends on the type of nonmineral resources affected, the stage of mineral activity and the type of technology used at that stage, the type of ecosystem, and the care taken in reclamation and mitigation.

2. Total Land Area Affected by Mineral Exploration, Development, and Production

Mineral deposits occur within the crust of the Earth as rare geochemical anomalies concentrated in small portions of the total land areas. For example, the recently discovered deposit of copper and zinc near Crandon, Wis., is one of the largest and richest on Earth (70 million tons of ore indicated to date) and yet lies under a surface area of less than 20 acres.

Data are not available to estimate the total amount or percentage of Federal land affected by mineral activities. A 1974 Bureau of Mines study. based on a survey of the mineral industry, estimated that only 3.65 million acres, or 0.16 percent of the land mass of the United States, inciuding both Federal and non-Federal lands, was utilized by the mining industry in the 42-year period extending from 1930 through 1971, and that 40 percent of this acreage had been reclaimed.[6] However, the study clearly states that its estimate covers only certain types of mineral activities and impacts, and it does not distinguish between impacts on Federal versus non-Federal lands. The following paragraphs list some of the activities and impacts that were not included in the Bureau's study, without attempting to quantify or evaluate the impacts. It should be kept in mind, as discussed above, that impacts maybe deemed beneficial or adverse by different parties in different situations.

First, the 3.65 million figure estimated by the Bureau of Mines does not include land explored and worked for oil and gas (and possibly other minerals), even though oil and gas activities account for a large proportion of land used for mineral activities.[7]

[6] Paone, Morning, and Giorgetti, *Land Utilization and Reclamation in the Mining Industry, 1930-1971*, U.S. Bureau of Mines Inf. Circ. 8642, at 10 (1974).

[7] See U.S. Bureau of Land Management, *Public Land Statistics, 1976*, tables 72, 77 & 78 (1977).

Second, the Bureau of Mines' estimate covers only the development and production stages of mineral activity. As was noted above, the impacts of mineral activity are generally much less intense but much more widely dispersed in the exploration stages. For each operating mine, there are exploration pits, drill sites, roads, and other impacts scattered over an area much larger than the mine area, as well as similar impacts from the 10 to 100 unsuccessful exploration projects that occur for each successful project.

Third, the figure does not include much of the area directly affected by mineral activities even at the development and production stages. It includes only the area actually excavated, the area used for disposal of overburden and other wastes, and the area that has subsided (dropped or caved in) as a result of underground mining. It does not include the area occupied by industrial facilities (e. g., processing plants), utilities (e.g., powerlines), residences, and other onsite facilities directly connected with the mine, even though they will usually affect an area much larger than the mine itself. It does not include the downstream areas affected by runoff of water, which may contain sediment or toxic substances. It does not include the area affected by consumption of water from, or even destruction of, an adjacent or underlying aquifer. And it does not include the buffer areas in which wildlife, scenic viewing, and recreation may be affected as a result of the physical, visual, and aural impacts of the mine, its road network. and other facilities and infrastructure.

Even comprehensive estimates of past effects might not be reliable yardsticks for the future. Mineral production has increasingly moved from underground mining to open-pit and surface mining, especially in recent years. As an indication of this trend, the Bureau of Mines' study states that **206,000** acres were affected in 1971, which is over twice the average yearly rate for the period between 1930 and 1971.

Finally, percentage figures for nationwide land disturbance probably underestimate the effect mineral activities have on Federal land and on the Nation's important nonmineral resource values, because mineral activity generally is concentrated in the more remote areas of the country, which contain the most Federal land and the most significant nonmineral resource values.

C. Mineral Resources and Federal Land Management

1. The Federal Land Management and Planning Systems

Two Federal agencies, the Forest Service in the Department of Agriculture and the Bureau of Land Management (BLM) in the Department of the Interior, together controlled over 85 percent of the Federal onshore land in 1976. The Forest Service controlled almost 188 million acres and BLM controlled more than 470 million acres, including the approximately 23 million acres in the National Petroleum Reserve in Alaska.[8] About 295 million of the BLM acres were in Alaska and subject to the extensive land selection and allocation process initiated under the Alaska Statehood Act

[8]Ibid., tables 9-11

and the A1aska Native Claims Settlement Act, which will eventually result in the transfer of around 105 million acres to the State, 45 million acres to the Natives, and perhaps 100 million acres to the national park, wildlife refuge, and forest systems.[9] This will leave BLM with only 45 million acres in Alaska and 220 million acres in all. The combined Forest Service and BLM acreage would then drop to about two-thirds of the Federal onshore land.

The Forest Service and BLM have relatively sophisticated planning programs for the management of nonmineral resources on land under their jurisdictions. Both agencies are under explicit congressional directives to inventory periodically the nonmineral resources and to establish plans based on the inventories for multiple use of the land and sustained yield of its renewable resources. ’() (There is some question whether the agencies receive sufficient funding to implement these directives,) The terms "multiple use” and “sustained yield” are defined in the Federal Land Policy and Management Act (“BLM Organic Act”) as follows:

> The term “multiple use” means the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; the use of some land for less than all of the resources; a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historical values: and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output.
>
> The term “sustained yield” means the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the public lands consistent with multiple use, [11]

The BLM Organic Act also requires that the Secretary of the Interior, in developing and revising land use plans, “consider the relative scarcity of the values involved and the availability of alternative means (including recycling) and sites for realization of those values” and “weigh long-term benefits to the public against short-term benefits.’’” Similar definitions and requirements are found in the laws governing land management and planning by the Forest Service,]

The Forest Service and BLM differ somewhat in their approaches to land management and planning, but there are more important similarities. Both agencies, faced with wide variations in the types of land under their jurisdictions and in the supply of and demand for the resources on different tracts, place the major responsibility for management and planning at the local level, with guidance and review by State or re-

[9]See app. B, sec. O.

[10]Multiple-Use Sustained Yield Act of 1960, 16 U.S.C. §§ 528-531 (1976) (Forest Service); Forest and Rangeland Renewable Resources Planning Act of 1974, *as amended*, 16 U.S.C. §§ 1600-1614 (1976) (Forest Service); Federal Land Policy and Management Act of 1976 ("BLM Organic Act"), 43 U.S.C. §§ 1701-1782 (1976).

[11]BLM Organic Act, § 103(c) & (h), 43 U.S.C. § 1702(c) & (h) (1976).

[12]Ibid., § 202(c), 43 U.S.C. § 1712(c) (1976).

[13]See the first two statutes cited in note 10.

gional offices and the National headquarters. For BLM, the local level is the district office, which receives limited guidance and review from the State and National offices. For the Forest Service, the local level is the forest office, which receives more specific guidance in terms of overall resource allocation goals from the regional and National offices. Each local-level office subdivides the land under its jurisdiction for management and planning purposes. Each national forest is divided into management areas, and each BLM district is divided into resource areas,

An inventory is made of the resources, including known mineral resources, and ecological characteristics of each management or resource area. Major land types are identified on the basis of significant differences in the ecological characteristics that may affect the land's ability to support or survive various uses. The elements that define a land type include land form, slope, aspect (exposure to Sun or prevailing winds), elevation, soils, wildlife habitat or cover, vegetation, and hydrologic characteristics,

These land types are the basis for estimating land use capabilities and sensitivities. The land use capabilities are combined with an assessment of the demands for the various resources in the area to produce a land use plan for the area. Both the Forest Service and BLM follow a well-defined planning process with considerable public input. ” In most cases, public input is used to critique plans, assumptions, and alternatives developed by the agency's professional staff. In some cases, however, public input is sought earlier to assist in framing issues and identifying alternative solutions.

The land use plans incorporate decisions on permissible resource uses and restrictions on uses. They are often followed by more detailed activity plans for individual resource activities such as timber harvesting or grazing allocations. The activity plans, however, conform to the guidelines and restrictions established in the land use plans. The Forest Service therefore treats the preparation of land use plans as the major decision point in the land management and planning process. Each plan is accompanied by a full environmental impact statement (EIS), complete with examination of alternatives, under the National Environmental Policy Act (NEPA). BLM, on the other hand, has waited until later in the process to prepare an EIS on individual resource activity plans. Its reason is that the land use plans are merely guidelines and that no environmental impact will occur until specific activities are undertaken. For BLM as well as the Forest Service, however, the decisions made in the land use plan on alternative resource uses and restrictions define the bounds of the subsequent specific resource activities. The range of alternatives with respect to a specific resource activity or program is constrained by the decisions made in the land use plan, and consideration is narrowed to alternatives that are primarily concerned with only the specific individual resource. From a policy perspective, the land use plan is thus the major action affecting alternatives or options, From a practical perspective, it seems also the most logical and efficient place to consider alternatives and impacts through an EIS. To the extent that later actions flow naturally from the land use plan, one EIS prepared for the land use plan can dispense with the necessity of preparing a complete separate EIS for each such subsequent action. (At most, a supplemental EIS might have to be pre-

[1] *Forest Service Manual*, pt. 8200; *Bureau of Land Management Manual*, §§ 1601-1609

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pared for subsequent actions that could result in impacts of a type or magnitude not considered in the land use plan EIS.)

Other major Federal land management agencies include the National Park Service, with more than 25 million acres in 1975 and a possible addition of over 40 million acres in Alaska; the Fish and Wildlife Service, with more than 30 million acres in 1975 and a possible addition of more than 50 million acres in Alaska; the Department of Defense, with over 30 million acres in 1975, split among the Army (11 million), the Air Force (8 million), the Navy (4 million), and the Corps of Engineers (8 million); the Bureau of Reclamation, with more than 7 million acres; the Department of Energy, with more than 2 million acres; and the Tennessee Valley Authority, with almost 1 million acres.[15]

Unlike the Forest Service and BLM, each of these other agencies has a legislatively mandated primary use for the land under its jurisdiction. Although much of this land is managed for multiple use, the management and planning process is constrained by the mandated primary use. For example, rules issued by the Secretary of the Army require inventory, classification, and multiple-use management of the renewable natural resources on Army land, but designated uses must be consistent with the military mission.[16]

2. Minerals in the Land Management and Planning Process

With rare exceptions, the Federal land management and planning systems discussed immediately above treat minerals as a distinct category outside the mainstream of the land use planning process.[17] There are two principal reasons for this separation of mineral resource management and nonmineral resource management, one historical and the other practical.

First, throughout history, mineral development generally has been considered the highest use of land. Thus, as was indicated in chapter 3, mineral activities historically have been treated, from a policy and management standpoint, as independent of and preferred to activities related to nonmineral resources on Federal land. The mining and mineral leasing laws make mineral activity the preferred use on any Federal land that is open to such activity. They contain no explicit procedures for coordinating mineral and nonmineral activities. This is true even for those Federal land systems that are managed by agencies other than the Forest Service or BLM and are subject to legislatively mandated primary nonmineral uses. If lands in these systems are open to mineral activity. it will override the designated primary nonmineral uses.

Second, as a practical matter, coordinated planning of the use of mineral and nonmineral resources on any land is complicated considerably by the difficulties of identifying and valuing these resources.

It is usually easier to identify nonmineral resources than mineral resources, as nonmineral resources are usually visible while mineral resources are generally hidden beneath the surface and can be found only through costly and risky exploration. Conse-

[15] U.S. Bureau of Land Management, *Public Land Statistics, 1976*, table 9 (1977).
[16] 36 CFR pt. 642, 59 F.R. 16385 (1977).
[17] E.g., 36 CFR § 642.49, 59 F.R. 16389 (1977) (Department of the Army).

quently, Federal land use planning and land management tend to concentrate, at least until a mineral discovery is made, on the nonmineral resource potential of the land. Mineral resource potential ordinarily is taken into consideration only for known occurrences (as in the case of coal).

On the other hand, it is usually easier to value known mineral resources than certain important types of nonmineral resources, such as scenic beauty, endangered wildlife and plant species, air and water quality, ecosystem functions, wilderness, and quality of life. Our understanding of the range and functions of nonmineral resources is very incomplete, and our ability to value even the better understood ones is quite limited, Thus, land management decisions involving known mineral resources often either slight nonmineral resources or give them an essentially infinite value.

Nevertheless, unless mineral activities are always to be preferred to nonmineral resource uses, or vice versa, decisions by Congress or the Federal land management agencies on the proper use of a particular tract of Federal land will always involve an explicit or implicit balancing of the values of the mineral and nonmineral resources on the tract. This balancing is now being made, in many cases, with inadequate information and analysis.

3. The Relative Availability and Value of Mineral and Nonmineral Resources

The independent and preferred position historically afforded to mineral activities on Federal land has been based largely on two premises: I) that economic concentrations of minerals, **unlike other resources,** are “where you find them,”’ and 2) that these mineral concentraions are **always** the most valuable resource **wherever** they are found. As will be demonstrated below, neither premise is valid today, However, they continue to be the starting point for major studies on Federal mineral land management. Both were substantially adopted by the Public Land Law Review Commission in its 197o report to the President ’t’ and by the Department of the Interior’s Task Force on the Availability of Federally Owned Mineral Lands in its 1977 report to the Secretary of the Interior,[19] although the Commission hedged on the first premise and the Task Force on the second. The Commission explicitly and the Task Force implicitly drew the conclusion that “[mineral] exploration and development should have a preference over some or all other uses on much of our public lands. ” An examination of the two premises follows:

a. Availability

Physically the Earth’s crust consists entirely of mineral elements, with each element constituting varying percentages in the rock and soil. Considering only physical crustal occurrence, minerals are among the most abundant and widely dispersed of all resources.

However, all minerals have different values and economic concentrations of the more valuable minerals are rare and occur in specific identifiable geologic environ-

[18] Public Land Law Review Commission, *One Third of the Nation's Land* 122 (1970).

[19] *DOI Task Force Report*, note 4, at 14, 16, 17

ments.[20] Generally, these economic mineral resources (called "reserves" when discovered and delineated) represent mineral concentrations that are much higher than the crustal average, although for some minerals the lowest grades (degrees of concentration) currently considered economically workable approach the average crustal concentration.[21] Extremely high capital, energy, and environmental costs make it highly unlikely, barring a revolutionary technological breakthrough, that common crustal rock will be mined for its mineral content in the foreseeable future.

Nevertheless, a large supply of mineral resources is physically available in concentrations substantially greater than the crustal average, which, although not currently economical, could conceivably become so with possible increases in price or advances in technology, or both. In the past, such developments have been responsible for the conversion of substantial quantities of previously uneconomic mineral resources into reserves for production. For example, most of the current domestic production of iron and copper comes from previously known low-grade resources that were uneconomical to produce until new mining, processing, and transport technologies were developed.[22] Extensive subeconomic resources of hydrocarbons and aluminum are known to exist in oil shale and clays, respectively, that could be developed given the appropriate economic, technological, and political conditions.

Similarly, increases in price or technological advances could lead to the development of synthetic minerals, the use of less expensive substitute minerals, exploration for deeper hidden deposits, or the mining of mine waste piles or garbage dumps (nonfuel minerals are never destroyed, but rather are recycled or disposed of after use, or dispersed as trace elements in the air, land, or water).

Thus, the location of economic mineral deposits is determined by prices, markets, technology, and time in addition to geologic factors. For society as a whole, the development and production decisions for a particular mineral deposit are not simply "this deposit or none" but rather "this depositor (eventually) a (possibly) more expensive 1) lower grade, more deeply buried, or more geographically remote mineral deposit, 2) synthetic mineral, or 3) substitute mineral. "

The situation for nonmineral resources is in some respects similar to the situation for mineral resources, and in some respects dissimilar. In contrast to the nonfuel minerals, which theoretically at least can be recovered and reused, some (but by no means all) nonmineral resources are subject to permanent loss. Examples include endangered plant and animal species, scenic landforms, and historical and archeological sites and objects. Others, such as wilderness, may take so long to recover, once disturbed, that their destruction is, in a practical sense, irreversible. Still other nonmineral resources recover or can be restored within a reasonable period of time at acceptable cost, analogous to the recovery and reuse of some mineral resources.

Many nonmineral resources are at least as limited in physical supply as most mineral resources, and subject to the same economics of more expensive, lower quality

[20] H.J. Barnett and C. Morse, *Scarcity and Growth: the Economics of Natural Resource Availability* (1963); J.F. McDivitt and G. Manners, *Minerals and Men* 10-12, 72-78 (rev'd ed. 1974); J. Tilton, *The Future of Nonfuel Minerals* 4-23 (1977); Cook, "Limits to Exploitation of Nonrenewable Resources," 191 *Science* 677 (1976).

[21] Cook, note 20, at 678; *DOI Task Force Report*, note 4, at 14-16.

[22] McDivitt and Manners, note 20, at 39-48, 72-78; see ibid., at 128 (sulfur), 148 (nickel).

alternatives. Examples include watersheds and aquifers, potential hydroelectric powersites, old-growth hardwood timber, prime agricultural land, and white-water rivers.

Thus, many nonmineral resources, like currently economic mineral deposits, are ‘‘where you find them only in the sense that alternative sites, although physically available, are of generally lower quality and higher price. Some nonmineral resources, because of uniqueness, are, unlike mineral resources, strictly “where you find them, ” in the sense that alternative sites are not available at any cost. However, no generally accepted formula exists to identify uniqueness.

b. Value

The long-standing premise that mineral activity is **always** the most valuable use of a tract of land is no longer widely accepted. It was based originally on the high net value of high-grade surface or near-surface mineral deposits in relation to the generally low or minimal commercial land values of the arid, remote, and unpopulated western regions. Today. however, two sets of factors undermine this premise.

First, many, if not most, mineral deposits being discovered today are of much lower grade and are located at greater depth than mineral deposits discovered in the past. They are thus more expensive to find and mine than the high-grade surface deposits formerly developed. As a result, the net value of many deposits being discovered today is lower than the net value of deposits worked in the past.

Second, major changes have occurred on the nonmineral side of the balance sheet. For example, today almost all the consumable nonmineral resource stocks (such as timber, forage, game, and water) are scarce as a result of the increase in demand for such resources and the decrease in the land base from which they are obtained, brought on largely by growth in population and the economy.

Furthermore, increased understanding of ecological processes, together with shifts in private and social values, has led to recognition and appreciation of a host of nonconsumable resource uses and values. There is a large and growing demand for various types of outdoor recreation. To illustrate, in 1976, there were close to 10 million visits to the Great Smoky Mountains National Park. Well over 2 million people a year visit Yosemite Valley in Yosemite National Park. These and other national parks clearly have a very high recreational and esthetic value.

Besides recreational and esthetic values, a natural ecosystem provides stocks of fish, animals, and plants for scientific study and research. It was estimated in 1967 that approximately half of the new drugs currently being developed are obtained from botanical specimens.[23] For example, very recently, a wonder drug for viral diseases was developed from the nucleosides of a Caribbean sponge.[24] The genetic diversity provided by ecosystems thus has immediate substantial practical benefits as well as longer range evolutionary importance.

An ecosystem also provides functions or services that produce tangible benefits without any necessity for direct intervention or use:

[23] Krutilla, "Conservation Reconsidered," 57 *Am. Econ. Rev.* 777, 780 (1967).

[24] Cohn, "Drug Treatment for a Virus is Hailed as 'Major Advance,' " *Washington Post*, Aug. 11, 1977, at A1, A25.

> [These functions] include the absorption and breakdown of pollutants, the cycling of nutrients, the binding of soil, the degradation of organic waste, the maintenance of a balance of gases in the air, the regulation of radiation balance and climate, and the fixation of solar energy— the functions, in short, that maintain clean air, pure water, a green earth, and a balance of creatures; the functions that enable humans to obtain the food, fiber, energy, and other material needs for survival.’)

Estimates of the value of just a portion of these functions include $83,000 per acre for the water purification and fisheries functions of a wetland (not taking account of other functions such as sulfate reduction, carbon dioxide fixation, oxygen release, and waterflow support) and a minimum of $784 per acre for the ground water storage, soil binding, water purification, and streamside fertilization functions of a Georgian river-swamp-forest.[26]

Finally, apart from any direct use or tangible benefit, many persons attach a value to the preservation of an option, for themselves or others, to view or use a unique resource in the future, or just to know that it is there. The existence of such an “option demand”’ value is demonstrated by their willingness to give money to nature preservation and conservation organizations, which use the money to protect resources most contributors never expect to see themselves.[27]

When all the mutually consistent consumable and nonconsumable nonmineral resource uses, scientific and evolutionary values, ecological functions, and option preservation values of a tract of land are considered, the value of the mineral resources in the tract may be outweighed by the temporary and permanent losses in nonmineral resource uses and values that would result from developing the mineral resources, even when the social value of a secure domestic mineral supply is added to the private value of the deposit to a mineral producer. An obvious example is a low-grade surface deposit of coal under a skyscraper. A more controversial example is an actual calculation made for a low-grade molybdenum deposit in a highly scenic mountain range.[28] The automatic assumption, in every case, of a higher value for the mineral resource can lead to inefficient resource use, even though a rich mineral resource may outweigh the nonmineral resource values in most areas.

The difficulty of balancing mineral and nonmineral values should not be underestimated. No general formulas can be given. Each case, each site is different. The methodologies for valuing nonmineral resources vary widely in the acceptance they command, Some nonmineral resource values are calculated by established methods with wide acceptance— e.g., those for the commercial value of agricultural and grazing lands and timber resources. Others are valued by methods still being developed but having reasonable scientific and economic bases—e.g., those used to calculate the $83,000-per-acre valuation placed on the water purification and fisheries function of a certain wetland. (See footnote **25.)**

The valuation becomes more difficult and more subjective when the nonmineral value is based more upon recreational use and especially so when esthetic and wilderness considerations are taken into account. Great Smoky Mountain National Park, for

[25] Westman, "How Much Are Nature's Services Worth?" 197 *Science* 960, 961 (1977).
[26] Ibid.
[27] Krutilla, note 23, at 780-781.
[28] Krutilla and Fisher, *The Economics of Natural Environments* 151 (1975).

example, would clearly command a very high value, but the value of a remote scenic area, an area of unconventional beauty, or the preservation of an option cannot, at present, be quantified in a way that wins agreement. Indeed, it is likely that such valuations will remain highly subjective and rooted in much larger value systems.

Nevertheless, it is clear that the values of many people in the United States have been changing in favor of nonmineral resource uses as opposed to particular mineral activities. These changing values are partially responsible for increased withdrawals of Federal land from mineral activity that, together with other restrictions, are making it increasingly difficult to explore for and develop minerals on Federal land (see section G). This trend may have serious adverse consequences on the domestic mineral industry and, after a deceptive lag of 10 to 20 years (during which time currently known and available mineral deposits are brought into production but few new deposits are discovered and developed for eventual production), on the U.S. mineral posture in an increasingly tight international minerals environment.

4. The Land Management Dilemma

Land management and planning must proceed on the basis of existing information. This will almost always be deficient with respect to the mineral resources of a tract, as most mineral deposits, unlike almost all nonmineral resources, are hidden beneath the surface. One of the principal goals of Federal land management, therefore, should be to improve such management by obtaining better mineral resource information.

But mineral resource information can be obtained only through exploration, which is both costly and risky. A single mineral exploration project involving the search for only one mineral occurrence type can cost several tens of millions of dollars and yet stand an **80** percent or greater chance of failure to discover significant mineralization (see chapter 2) Clearly, neither Federal land management agencies nor private industry can afford to obtain mineral information that would be adequate for each once-and-for-all, mineral-versus-nonmineral land use decision.[29] Unless practically every cubic foot of land in a particular tract has been excavated and analyzed, we can never be entirely sure of its mineral content, Land in Arizona once classified by the U.S. Geological Survey as not known to be mineralized was later found by drilling through the overburden to be underlain by major copper deposits, and many ore bodies have been discovered in areas previously explored and rejected by others.[30]

An obvious alternative to possible once-and-for-all, mineral-versus-nonmineral land use decisions based on inadequate knowledge of the mineral resources is to leave the land open to mineral exploration so that the existing land use designations can be constantly reappraised in the light of whatever mineral information is produced. But, given the risks and costs of exploration, private firms will invest in exploration only if they are given reasonable assurance that they will be allowed to develop any mineral deposit they discover. If such assurance is provided, the land use decision has been

[29] See O. C. Herfindahl, *Natural Resource Information for Economic Development* (1969).

[30] Bailly, "The Problems of Converting Resources to Reserves," *Mining Eng.*, January 1976, at 1, 3-4.

made prior to the acquisition of the mineral information, and it has been made in favor of mineral development, even though the mineral deposit (if one is found) may be worth less than the nonmineral resources on the tract. If a deposit were discovered, the Federal land management agency could mitigate the impacts, but it could not prevent the development and production of the deposit. Even if no discovery were made, land use planning might be inhibited by the possibility of a discovery, since an actual discovery could lead to preemption of the planned nonmineral uses.

The land management agency therefore faces a fundamental dilemma in deciding whether to leave an area open to mineral exploration. If the agency wishes to retain control over the later decision on whether mineral development should be allowed, it can do so only by refusing to allow exploration in the first place (e. g., by refusing to issue an exploration permit or by withdrawing the land from the pool of lands available for exploration), in which case it is making a decision without adequate mineral information and precluding the possibility of obtaining such information except through Government exploration. On the other hand, if it wishes to obtain the mineral information through exploration by private industry, it can do so only by turning the later development decision over to the industry, which generally will not fully consider the nonmineral resources values of the tract in deciding whether to proceed to development.

Although the dilemma is persistent and troublesome, it maybe mitigated by establishing, in advance of exploration, conditions and payments applicable to exploration and development that will ensure more complete consideration of nonmineral resource values by private industry, In some areas, the nonmineral resource values may be so low as to make the dilemma of little practical significance.

As we shall see in the following sections, the current Federal mineral laws do little to resolve this dilemma.

D. Coordination of Mineral and Nonmineral Activities Under the Mining Law

1. Relevant Provisions of the Mining Law[31]

During the 19th century, settlement of the public domain was encouraged by enactment of laws providing for free, or almost free, disposal of the public domain to individuals and firms for mining, logging, farming, ranching, irrigation, railroad, and other purposes. The Mining Law of 1872 was enacted during this period.

It authorizes free entry onto and occupation of public domain land for the purposes of exploring for, developing, and producing minerals other than the fossil fuels, certain fertilizer and chemical minerals, and common-variety minerals. There is no requirement for obtaining approval from or paying fees to the Federal landowner.

[31] See ch.3, subsec. B(3), for a more complete discussion

Entry is made by "locating" a mining claim. The claim must be distinctly marked on the ground so that its boundaries can be readily traced. No notice need be given to the Federal land management agency, or to the private or State surface owner if the surface is in non-Federal ownership, before entering on the land. Beginning in 1976, a notice of location, accompanied by a general map and description sufficient to enable someone to find the claim on the ground, must be filed with the appropriate BLM State office within 90 days after making the location, and affidavits of assessment work or notices of intent to maintain the claim must be filed annually.

There is no legal limit to the number of claims anyone can file, However, a discovery (physical exposure] of a valuable mineral deposit must be made on each claim in order to acquire a possessor right valid against the Government.

If it is shown that a valuable mineral deposit has been discovered, complete fee title to the surface and subsurface can be obtained by paying $2.50 or $5.00 per acre, depending on the type of claim, for a title document known as a "patent." In addition, at least $500 worth of mineral development work must have been done. Before issuance of a patent, use of the surface and surface resources is limited to those uses required for the mining claimant's prospecting, mining, or processing operations or uses reasonably incident thereto. After issuance of a patent, any use can be made of the surface. No patent is needed to mine.

2. Unnecessary Adverse Impacts on Nonmineral Resource Values

a. Unnecessary Impacts Due to Federal and State Work and Claim Requirements

Various requirements imposed by or under the Mining Law in an attempt to ensure good-faith mineral activity result in adverse impacts on nonmineral resources without an offsetting furtherance of actual mineral discovery. The requirements and impacts vary from State to State.

The Mining Law allows each State to specify the method of locating claims. Almost all the States have enacted location provisions that include a requirement for sinking a discovery shaft or pit of specified minimum dimensions on each claim within a certain period (at most 120 days) after the initial posting of the location notice on the claimed area. Originally, this requirement made sense as a method of ensuring physical exposure of the mineral deposit for which the claim was located, since almost all claims were based on showings of commercial-grade mineralization at or just below the surface. Today, however, as was discussed in chapter 2, many claims are located for buried deposits, and the shaft dimensions specified in the State discovery work requirements (e.g., 10 feet deep) usually will not expose the mineral deposit. The only outcome of the requirement is surface damage. An example is the situation in a remote wildlife area in northern Washington, described by the Secretary of the Interior in 1969:

[?]Twitty, Sievwright, and Mills, *Nonfuel Mineral Resources of the Public Lands: Legal Study* 476-482, 518-539 (1970) (prepared for the Public Land Law Review Commission) (hereinafter cited as *PLLRC Nonfuel Legal Study*).

> The land covered by the mining claims is rough and mountainous. ., . To dig [the required] pits, which are entirely unrelated to the exposing of mineral deposits which are usually well below the surface, the scrapers and bulldozers cross the country in the most economical way possible for the company, This results in one pit on each claim and roads bulldozed without respect to contours, slopes, water courses, or other resource considerations. The sum total is hundreds of pits and miles of cuts and scars.

Some States have amended their discovery work requirements to permit drilling instead of the sinking of shafts, or to allow one shaft or drill hole to suffice for several contiguous claims, substantially reducing but not eliminating the damage. Only a few States require the work to continue until exposure of commercial-grade mineralization is accomplished, and the time allowed for exposure is so short (at most 120 days after initial location of the claim) that actual exposure becomes improbable—thus the discovery work is unlikely to accomplish its purpose, and the surface is disturbed for no purpose and at expense and trouble to the mineral explorer. Some States, for example, Alaska and Utah, have no discovery work requirements. Colorado has provided for filing of a map of a field survey of the claim as an alternative to the discovery work.[34]

The Mining Law itself requires $100 worth of labor to be performed or improvements made each year from the time a claim is located until a patent is issued conveying title to the claimant. This $100 worth of work, usually referred to as "assessment work," is also meant to demonstrate good faith in developing the claim. The law permits work on one claim to be applied to a group of claims held in common, and most work that would tend to facilitate the development of the claim, including on-the-ground geological, geophysical, or geochemical surveys for a limited number of years, will satisfy the requirement.[35] Nevertheless, the requirement may lead to unnecessary surface damage (including unnecessary use of bulldozers or dynamite[36]) by those unable or unwilling to conduct genuine mineral development activities during 1 or more years. This sort of damage is especially unfortunate because it results from a legal requirement that is administratively unenforceable.[37]

The *pedis possessio* doctrine created by the courts to protect good faith, diligent exploration prior to actual discovery also leads to unnecessary adverse surface impacts. The damage, however, is in more acute form, since this doctrine requires *continued actual occupancy* and persistent and diligent prosecution of work looking to mineral discovery on *each* claim, and perhaps even over the entire claim. The requirement is not satisfied merely by performance of the annual assessment work, which only maintains a claim on which there has been an actual discovery of a valuable mineral deposit.[38] Thus, the explorer who has a target encompassing many claims must maintain "show" work on all the claims even though he expects to discover the underlying ore body by drilling on only one of the claims.[39] The amount of unnecessary surface damage can be substantial.

[33] U.S. Department of the Interior, *The Mining Law—An Antique in Need of Repeal* 9 (1969) (hereinafter cited as *DOI* Mining *Law Report*).

[34] *PLLRC Nonfuel Legal Study*, note 32, at 522-539.

[35] Ibid., at 578-595.

[36] U.S. General Accounting Office, *Modernization of 1872 Mining Law Needed to Encourage Domestic Mineral Production, Protect the Environment, and Improve Public Land Management*, B-118678, at 26 (1974) (hereinafter cited as *GAO Mining Law* Study); see *DOI* Mining *Law Report*, note 33, at 10.

[37] See ch. 4, subsec. D(2)(b).

[38] *PLLRC Nonfuel Legal Study*, note 32, at 351-352, 356-357.

[39] MacDonnell, "Public Policy for Hard-Rock Minerals Access on Federal Lands: A Legal-Economic Analysis," 71 *Q. Colo. Sch. Mines*, no. 2, at 18 (1976).

Finally, the claim marking and posting requirements in the Mining Law and the supplementary State laws also produce unnecessary surface impacts. The Mining Law requires that each claim “be distinctly marked on the ground so that its boundaries can be readily traced.” The supplementary State laws all require placing of substantial posts or mounds of stone at least 3 feet high on at least each corner of the claim. Trees may be used for monuments in at least some of the States if they, for example, are “so hewn as to readily attract attention” (Idaho) or have had their tops removed leaving stumps at least 3 feet high (Nevada).[40] Such claim marking activity has obvious detrimental impacts on plant life and scenery.[41] More extensive surface impacts can result from roads or trails constructed across the countryside in the process of marking a group of claims. All these impacts are unnecessary for placer claims on surveyed land, which must be located according to the subdivisions of the public survey. Yet only California and Oregon dispense with all physical marking requirements for such placer claims.[42] These impacts would also be unnecessary for lode claims if the Mining Law required them to be located according to the subdivisions of the public survey. On unsurveyed land, the impacts could be avoided or minimized by requiring location through a field survey tied to a substantial natural monument and depicted on a map to be filed in the recording office.[43]

All the legal requirements described in this subsection are either outmoded or lack appropriate and adequate criteria for acceptable mineral activities that can be administratively enforced. They therefore result in “practices which often destroy nonmineral values without making a comparable or any real contribution to the discovery or development of mineral deposits.”[44]

b. Unnecessary Impacts Due to Inadequate Government Controls Over Surface Impacts of Mineral Activities

The Mining Law itself contains no provisions for the protection of nonmineral resource values. In 1974, relying on the language in its 1897 Organic Act that requires prospectors and miners in the national forests to “comply with the rules and regulations covering such national forests,”[45] the Forest Service issued regulations designed to minimize the surface impacts of mineral activities on unpatented claims in the national forests.[46] BLM has had under consideration issuance of similar regulations based on language in the Mining Law that makes activities under the law subject to “regulations prescribed by law”[47] and on inherent executive authority to protect Federal land from despoliation or improper use.[48] In 1976, following passage of its own Organic Act that, among other things, directed the Secretary of the Interior “by regulation or otherwise, [to] take any action necessary to prevent unnecessary or undue degradation of the [public] lands,”[49] BLM proposed regulations similar to those issued

[40] *PLLRC Nonfuel Legal Study*, note 32, at 509-513.

[41] *See also* Sumner, “Wilderness and the Mining Law,” *The Living Wilderness*, spring 1973, at 11.

[42] *PLLRC Nonfuel Legal Study*, note 32, at 509-513.

[43] It is doubtful that the costs of such a survey would be any greater than those now incurred in locating a typical group of claims. See ch. 4, subsec. C(2)(c).

[44] I. Senzel, *Revision of the Mining Law of 1872*, Senate Comm. on Energy & Nat. Res. Pub. No. 95-11, 95th Cong., 1st sess. 21 (Comm. Print 1977) (hereinafter cited as Senzel).

[45] 16 U.S.C. § 478 (1976).

[46] 36 CFR pt. 252 (1977).

[47] 30 U.S.C. § 22 (1976). But see Senzel, note 44, at 13.

[48] Senzel, note 44, at 6 n.8.

[49] 43 U.S.C. § 1732(b) (1976).

by the Forest Service, but covering all public domain land.[50] So far, however, the proposed BLM regulations have not been finally adopted.

In the absence of any regulations,[51] BLM is unable to prevent unnecessary surface impacts on the public domain caused by mineral activities under the Mining Law. The activities include dumping waste rock from mines down steep slopes to valley floors, leaving behind abandoned mine equipment, draining possibly toxic or carcinogenic mine water runoff into streams, failing to control soil erosion, drilling in streambeds, constructing duplicative roads and trails, destroying fences and irrigation ditches, failing to plug or fence shafts or drill holes (which constitute safety hazards as well as pollution sources), failing to locate and construct roads and trails so as to minimize surface damage, and failing to reclaim or rehabilitate land affected by mineral activities.[52] From 1930 to 1971, counting only acreage actually excavated for mines or used for disposal of mine wastes (that is, excluding roads and similar ancillary surface uses), only 8 percent of the area in the United States disturbed by metal mining and 26 percent of the area disturbed by nonmetal mining was reclaimed. By 1971, the annual reclamation rate had risen to 35 percent for metal mines and 56 percent for nonmetal mines.[53] Data for more recent years is not available, and there are no mechanisms for gathering such data.

Unnecessary surface impacts also occur, although to a much smaller degree, on national forest land, often as a result of activities undertaken without filing the notice of intent or plan of operations required by the Forest Service's surface use mining regulations.[54] The regulations require that a notice of intent be filed by any person proposing to engage in mineral activities under the Mining Law that might disturb surface resources. They also state that a notice of intent need not be filed for activities for which no plan of operations would be required. Since plans of operations are required only for activities that will cause significant surface resource disturbance, a miner apparently must file a notice of intent only if significant surface resource disturbance is anticipated.

A plan of operations must include information adequate to describe the proposed activities and their location, the size and location of areas where surface resources will be disturbed, existing and proposed roads or access routes, the time period during which the proposed activities will take place, and measures to be taken to meet certain broad requirements for environmental protection. The environmental protection requirements refer to applicable Federal and State air quality, water quality, and solid waste disposal laws. They require, to the extent practicable, elimination or minimization of impacts on the environment and surface resources, including scenic values, fisheries, and wildlife habitats. The surface, including roads, must be reclaimed. Upon

[50] 43 CFR pt. 3800 (proposed), 41 F.R. 53428 (1976). Although the language from the BLM Organic Act quoted in the text is clearly applicable to activities under the Mining Law (see the entire paragraph from which the language is quoted), a question has been raised whether the language would support rehabilitation requirements. Senzel, note 44, at 21. See also 43 CFR subpt. 3802 (proposed), 44 F.R. 2623 (1979) (Mining Law activities in wilderness study areas).

[51] Or of any delegation of the Secretary's authority to act "by regulation or *otherwise*." See text at note 49.

[52] D. Sheridan, *Hard Rock Mining on the Public Land* 14-15 (1977) (report prepared for the U.S. President's Council on Environmental Quality) (hereinafter cited as *CEQ Study*); *DOI Mining Law Report*, note 33, at 9-13; *GAO Mining Law Study*, note 36, at 24-28.

[53] U.S. Bureau of Mines Inf. Circ. 8642, note 6, table 10, at 54.

[54] *CEQ Study*, note 52, at 15-19; letter from John R. McGuire, Chief, Forest Service, to John A. McComb, Southwest Representative, Sierra Club, Mar. 18, 1977, at 5; McGuire, "Forest Service Mining Regulations," remarks at the AMC Mining Convention, Sept. 28, 1976.

cessation of mineral operations, hazards must be marked or fenced and all structures and equipment must be removed. Bonds may be required to ensure reclamation. [55]

In its enforcement of the regulations, the Forest Service makes a particular effort to avoid infringing the miner's (prospector's) absolute right of entry. The Forest Service Manual emphasizes the limited nature of control the regulations afford:[56]

> The prospector and miner have a statutory right , , . to enter upon the National Forests for prospecting and mining. Their rights to do this cannot be unreasonably restricted or made excessively burdensome.
>
> The objectives in administering the . . . regulations are to . . . [a]void materially endangering or interfering with prospecting, exploration, mining and mineral processing operations, as well as uses reasonably incident to such uses . , . .
>
> [T]he economics of operations will be considered in determining what are reasonable environmental protection requirements in operating plans and in special-use permits for road construction, reconstruction or restoration.

No fines or penalties are assessed for failure to comply with the regulations. The Forest Service seeks to negotiate compliance before issuing a notice of noncompliance. In one case it wrote the entire plan of operations for a recalcitrant prospector who still refused to file the plan. [57] In such cases, the Forest Service Manual advises that, "Where reasonable, continued failure to comply should be followed by additional personal contacts. Legal action to force compliance should be a last resort . . . . [58] (In the case mentioned, a lawsuit was finally filed.)[59]

In sum, the Forest Service is cautious about pressing very hard for major mitigating measures, given the prospector's or miner's absolute legal right to proceed under the Mining Law, The Forest Service has been quite strict in insisting on environmental controls in certain areas, but this strictness occurs against a background of uncertainty over exactly how much authority can be exercised.[60] Moreover, the workload involved in trying to track down and keep on top of all the mineral projects in a national forest can preclude detailed attention to all but a few projects. In one ranger district on the Beaverhead National Forest in southwest Montana, notices of intent had been filed for only half of the estimated 80 active projects, and plans of operations had been filed and approved for only 6 or 7. Although there is no requirement to file notices or plans for projects that will not involve significant surface disturbance, it is not clear that half the projects did not involve such disturbance, which includes any disturbance for which natural recovery would not be expected to take place within a reasonable period of time.[61] Nationwide, operating plans have been required for only one out of three notices of intent that are filed.[62]

The absence in the Forest Service and proposed BLM surface use regulations of a requirement that everyone file a notice of intent, rather than only those who believe

[55] 36 CFR pt. 252 (1977).

[56] *Forest Service Manual* pt. 2850, Interim Directive No. 5 (1977); cf. *United States* v. *Bennewitz*, 72 I.D. 183, 187-188 (1965). For two limited categories of Federal land, entry under the Mining Law can be conditioned or regulated to whatever extent is deemed desirable by the Secretary of the Interior. See 30 U.S.C. §§ 621, 622 (1976) (certain powersite withdrawals and reservations) and ibid. § 1281 (Supp. I 1977) (urban or suburban residential areas).

[57] Interview with Buster LaMoure, U.S. Forest Service, September 1976.

[58] *Forest Service Manual* § 2851.2, Interim Directive No. 5 (1977).

[59] Letter to John A. McComb, note 54, at 6.

[60] *CEQ Study*, note 52, at 18, 29.

[61] *Forest Service Manual* § 2851.05a, Interim Directive No. 5 (1977).

[62] McGuire, note 54.

they will cause significant surface disturbance, means that the local agency staff must try to discover and keep track of all those who do not file to make sure there is no significant disturbance. This is, in a practical sense, impossible. Each ranger district or BLM district can encompass millions of acres, and only one or a few persons, if any, will be available and qualified to administer and enforce the regulations, whereas any number of prospectors and miners can come and go at will under the Mining Law and the regulations.

Moreover, the uncertainty of prediscovery tenure under the Mining Law can act as an incentive to ignore the surface use regulations. Because the limited protection afforded by the pedis possessio doctrine applies only to explorers in actual occupation and diligently working, explorers may decide not to wait for approval of operating plans or even to take time to file notices of intent in a competitive situation, especially since failure to comply will not void their claims and will most likely result simply in an admonishment by the Forest Service.[63]

Finally, it should be noted that the Forest Service (or proposed BLM) surface use regulations apply only to unpatented claims. once a claim is patented, it becomes private land, and the Federal land management agencies lose control over the surface as well as the subsurface except in a few special areas. They are not empowered to prevent even the most adverse surface impacts on the patented claim, regardless of any indirect impact on nonmineral resource values on the surrounding Federal land.

3. Preemption of Nonmineral Resource Values

As explained in the preceding subsection, mineral activities legally always take precedence over nonmineral resource uses on land subject to the Mining Law, regardless of the relative values. In particular, the surface use regulations under the Mining Law emphasize that the environmental mitigation measures they authorize cannot materially interfere with the mineral activities. The most that can be done for nonmineral values, under the regulations, is to eliminate unnecessary adverse impacts—i.e., those impacts that can be eliminated without seriously affecting the economics of the mineral activity—and to mitigate, insofar as practicable, necessary adverse impacts.

Activities under the Mining Law are subject to Federal and State air quality, water quality, toxic substances control, and other environmental laws of a general nature, But, as is discussed in section F, these laws provide only for mitigation of impacts resulting from the mineral activity. They do not reach the central issues of land resource allocation and use.

Because the Forest Service cannot through its regulations materially interfere with the rights of the prospector or miner under the Mining Law, and therefore sees itself as having little real control over the basic mining activities, it rarely prepares an EIS for proposed operating plans filed under the regulations. Only four had been, or

[63]See U.S. Department of Agriculture, Forest Service, *Anatomy of a Mine From Prospect to Production*, Gen. Tech. Rep. INT-35, at 14 (1977) (hereinafter cited as *Anatomy of a Mine*)

were being, prepared by early 1977.[64] A similar "lack of discretion'" rationale for declining to prepare an EIS has been adopted by the Department of the Interior's Board of Land Appeals for patent applications under the Mining Law.'[65]

4. Unpredictable Nonmineral Resource Protection Requirements

The surface use and protection requirements that apply to some mineral activities under the Mining Law are applied in an ad hoc and unpredictable manner that sometimes creates great uncertainty for mineral explorers and developers. For example, the Forest Service surface use regulations, discussed in subsection D(2)(b), are written in very general terms that provide little guidance on what controls may be imposed in particular situations. Specific controls are negotiated at the time a plan of operations is submitted or revised, and they can vary in scope or severity depending upon the local forest ranger. At times the controls maybe unduly restrictive; at other times they may be unduly permissive. Both the public and the miner might benefit from more specific, predictable controls based on land types and uses in an area.

5. The Valuable Mineral Deposit Criterion

The right to a mineral patent, which conveys ownership of a claim from the Government to the claimant, and the right to exclusive possession of an unpatented claim depend on the discovery of a valuable mineral deposit within the bounds of the claim. The *'valuable mineral deposit" criterion is the linchpin of the Mining Law. It is the indispensable element for acquiring and maintaining tenure. It is the element in the law that prevents (but, as will be shown below, not entirely successfully) the acquisition of land under the law for nonmineral purposes. And it is the flexible term that determines, according to the prevailing interpretation, the governing tradeoff between mineral and nonmineral resource values, by making it easier or harder to gain mineral rights on Federal land.

This subsection concentrates on the last aspect of the criterion—its role in the tradeoff between mineral and nonmineral resource values under the Mining Law. Recent interpretations that tighten the requirements under the criterion have been severely criticized by persons in the mineral industry, who quote the following statement by a former BLM official:

> There can be no gainsaying that the Mining Law of 1872 is not administered as it was originally written and intended. There has been a definite trend in decisions toward more stringent requirements to establish the validity of a claim. The requirements are innovations which have been superimposed on the basic law by the need for standards which can serve to prevent the subversion of the law for nonmineral purposes. Examples of these may be found in the narrowing application of the rule of discovery, the employment of the rule of marketability, the definitions of "common varieties, and the concern for economic values . . . .[66]

[64] Letter to John A. McComb, note 54, at 3; letter from John R. McGuire to John A. McComb, May 17, 1977.

[65] *United States* v. *Pittsburgh Pacific Co.*, 84 I.D. 282 (1977); *United States* v. *Kosanke Sand Corp.*, 12 I.B.L.A. 282 (1973).

[66] Hochmuth, "Governmental Administration and Attitudes in Contest and Patent Proceedings," 10 *Rocky Mt. Mineral Law Inst.* 467 (1965).

However, a longer run view of the history of administration of the Mining Law and a closer attention to its literal language reveal a different picture—a liberalization of the law’s administration in favor of the miner as it became apparent that the historical conditions on which the law was based no longer applied.

The Mining Law as originally written, and as it still exists in the literal language of the statute, was based on a perceived situation in which high-grade gold, silver, and other metal deposits were discovered at or near the surface of the land, shortly after entry upon the land, and were immediately worked and produced. Thus, the statute literally requires discovery prior to location of the claim, and it requires annual labor to be performed or improvements to be made on each claim. Each of these requirements has been liberalized by the courts and the Department of the Interior to accommodate the realities of exploring for and developing buried deposits.

Similarly, the assumption of high-grade surface deposits that could immediately be worked and produced led to initial decisions under the law requiring that the mineral character of the land be shown as a present fact, based on actual production or proof that profitable production could be undertaken, as well as proof that the land was more valuable for mineral production than for nonmineral purposes,” Subsequently, responding to the realities of lower grade or buried deposits, the diecisions have shifted back and forth from the strict present, comparative value test to a prospective (and sometimes merely hopeful) “prudent miner” test for mineral value, relying on the latter test particularly when the dispute involves rival mineral claimants rather than a mineral claimant versus the United States.[68] During the early part of the 20th century, when there was a generally lax attitude toward administration and enforcement of the mineral laws (see chapter 3), the “prudent man” test received fairly widespread application, although it never completely displaced the present value and comparative value tests, which continued to crop up in judicial and administrative decisions. With the current heightened concern over nonmineral resource values, the present value test has returned to prominence in the form of the marketability test, which requires proof that a deposit can be presently mined and marketed at a profit.[69]

The comparative value test is generally dormant, but it also could be revived. In 1973, the Department of the Interior’s Board of Land Appeals, over the dissent of three of its members who felt the issue was not ripe for decision, rejected the comparative value test on the basis of a 1914 administrative decision.[70] However, the Board apparently was unaware of (a) a line of judicial and administrative decisions since 1914 that have cited the comparative value test,[71] (b) evidence of congressional approval of the test, ” and (c) court decisions that have mandated inclusion of nonmineral values in

[67] *PLLRC Nonfuel Legal Study*, note 32, at 243-267, 393-394, 398-401; Brice, "Law of Discovery: Prudent Man and Marketability," in University of Arizona, College of Mines, *Symposium on American Mineral Law Relating to Public Land Use* 19, 21-23 (J.C. Dotson ed., 1966).

[68] *PLLRC Nonfuel Legal Study*, note 32, at 379-389; Brice, note 67, at 23-24.

[69] *Coleman* v. *United States*, 390 U.S. 599 (1968).

[70] *United States* v. *Kosanke Sand Corp.*, 12 I.B.L.A. 282, 299-302, 314-315 (1973).

[71] *PLLRC Nonfuel Legal Study*, note 32, at 394-438; Brice, note 67, at 23-29; G.O. Smith *et al.*, *The Classification of the Public Lands*, U.S.G.S. Bull. 537, at 25-26 (1913); *Dunbar Lime Co.* v. *Utah-Idaho Sugar Co.*, 17 F.2d 351, 354 (8th Cir. 1926); *Webb* v. *American Asphultum Mining Co.*, 157 F. 203, 205 (8th Cir. 1907); *United States* v. *Lillibridge*, 4 F. Supp. 204 (S.D. Cal. 1932); *United States* v. *Lavenson*, 206 F. 755, 763 (W.D. Wash. 1913); *Loney* v. *Scott*, 57 Ore. 378, 112 P. 174 (1910); *Bay* v. *Oklahoma Southern Gas, Oil and Mining Co.*, 13 Okla. 425, 73 P. 936 (1903); *United States* v. *Gray*, A-28710 (Supp.), [1964] Gower Federal Service (Mining) SO-1964-25 (May 7, 1964); *United States* v. *Dawson*, 58 I.D. 670, 679 (1944); *Layman* v. *Ellis*, 52 I.D. 714, 718-719 (1929); John McFayden, 51 I.D. 436, 442 (1926).

[72] See, e.g., H.R. Rep. No. 1203, 52d Cong., 1st sess. 1-2 (1892).

agency decisionmaking processes.[73] Two recent court decisions suggest that a return to the comparative value test may be required by NEPA.[74]

Nevertheless, at the present time nonmmineral values are not balanced directly against mineral values in order to decide whether to issue a mineral patent to Federal land. They are, however, considered indirectly to the extent that requirements for protecting nonmineral values exist. The costs of complying with those requirements are included in an increasingly comprehensive definition of the considerations a prudent miner would take into account, and they are factored into profitability calculations under the marketability version of the ''valuable mineral deposit' criterion.[75] This indirect approach fails to take into account a fairly large range of nonmineral values, but even so, it can create substantial uncertainty over whether the discovery of a valuable mineral deposit necessary for acquiring and maintaining tenure has been made.

Thus, the valuable mineral deposit criterion is unsatisfactory to both miners and nonmineral resource users. Miners point to the extreme uncertainty over tenure created by the marketability interpretation and its increasingly strict scrutiny of costs and financing, In effect, a mine must be well into the development stage before BLM will concede marketability, Prior to such a determination, which amounts to second-guessing of the miner's profitability calculations, the miner is liable to be dispossessed at any time despite the substantial investment made in exploration and initial development.

Nonmineral resource users, on the other hand, note that the valuable mineral deposit criterion is the only element of the Mining Law that limits the disposal of Federal land and the appropriation or destruction of its nonmineral resource values, by requiring a showing that minerals exist that can be mined at a profit, But, they point out, the criterion provides only minimal protection of nonmineral resources, because, as now interpreted, it considers only the miner's costs of complying with general environmental laws. It does not consider the value per se of the nonmineral resources. Moreover, the criterion is usually invoked only if a patent (title to the land) is sought by the miner. It is rarely applied during the early stages of exploration and development, and even production can occur under the law without a patent, Although discovery of a valuable mineral deposit is technically required to obtain possessor rights valid against the Government, and the Government can bring contest proceedings alleging failure to make such a discovery, the contest route is almost useless in practice, as is shown in subsection 7,

6. Lack of Payments for Damage to or Appropriation of the Land and Its Nonmineral Resources

There are not only no regulatory mechanisms under the Mining Law for balancing mineral and nonmineral resource values (rather, regulations require mitigating, to the

[73] See, e.g., *Ely* v. *Velde*, 451 F.2d 1130 (4th Cir. 1971); *Calvert Cliffs Coordinating Committee* v. *AEC*, 449 F.2d 1109 (D.C. Cir. 1971); *Zabel* v. *Tabb*, 430 F.2d 199 (5th Cir. 1970), cert. denied, 401 U.S. 910 (1971).

[74] *Global Exploration & Development Corp.* v. *Andrus*, Civ. No. 78-0642, slip opinion at 8-9 (D.D.C. Aug. 14, 1978); *Natural Resources Defense Council, Inc.* v. *Berklund*, Civ. No. 75-0313, slip opinion at 16-17 (D.D.C. June 30, 1978).

[75] *United States* v. *Pittsburgh Pacific Co.*, 84 I.D. 282 (1977).

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extent practicable, impacts on nonmineral resources resulting from some mineral activities), but also no payment incentives.

If the mineral explorer or developer were required to pay for the adverse impacts imposed on nonmineral resources (that is, the impacts not mitigated by regulatory requirements), and if the values of all nonmineral resources could be assessed adequately (which is difficult to do completely and to the satisfaction of all concerned), then mineral activities would not occur unless the net mineral value (the sale price of the mineral minus the cost of finding and producing it) exceeded the value of the nonmineral resources that would be lost, Moreover, there would be a continuing incentive to reduce the damage to nonmineral resources even when mineral activity proceeded: the less damage, the lower the required payments,

The mineral industry pays for such damages, or at least those that directly impact the owner, when it buys mineral rights for private land, An implicit or explicit part of the purchase or lease price covers the expected losses in nonmineral resource uses or values by the private landowner, If the private owner is not offered enough money (in a lump sum or as a royalty on mineral production) to compensate him for such losses, he will not permit mineral activity on his land. Similarly, the private landowner will not himself engage in mineral activities on his land if such activities would preclude nonmineral resource uses that are more valuable to him.

Because a mineral patentee under the Mining Law generally owns the surface as well as the minerals in the patented land, it could be argued that the availability of patents under the law assures balanced consideration of nonmineral values by mining claimants. But there are several major objections to this argument.

First, the purpose of the Mining Law is to promote mineral development, That purpose is not served when a patentee devotes the patented land to nonmineral uses, If there will be no mineral development, why grant a patent in the first place? The same objection would hold even if value were paid for the land. The expressed general policy for Federal nonmineral land is retention and management, not disposal. Furthermore, if value were paid, it would be “fair market value” and would exclude the various public values discussed below.

Second, the individual patentee (or other private landowner) usually does not consider the full range of nonmineral resource values attributable to the tract, but rather ordinarily weighs only those (generally commercial) values from which he derives benefit, Excluded from the accounting are the public or multiple-use values that flow from the tract’s being a part of the surrounding ecosystem: overall scenic view, wildlife habitat and range, access route, primitive status, and all of the ecosystem functions described in subsection C(3)(b). Decisions made by the patentee or other private landowner usually omit these types of values.

Third, in order to obtain a patent under the Mining Law, a valuable mineral deposit must first be discovered. A mining claimant exploring for such a deposit faces a high risk of failure. Out of the thousands of claims explored every year, only a few result in discoveries, Given the high risk of failure, the possibility of eventually obtaining a patent affords little incentive to protect surface resources during exploration.

Moreover, claims can be, and sometimes are, developed and mined without a patent. Finally, a patent does not include the surface in wilderness areas, homestead lands, and certain other areas.

The only payments required under the Mining Law are $2.50 or $5 per acre for a patent (if one is desired), bonds to insure reclamation of national forest land [if feasible), and payments to private surface owners of homestead land (with reserved Federal mineral ownership) for damages to crops, agricultural (only) improvements, and the value of the land for grazing (only). These payments clearly are not sufficient to ensure proper balancing of all mineral and nonmineral resource values, even on homestead land.

The absence in the Mining Law of required compensation payments at least comparable to those implicitly required on private land (which, as was discussed above, themselves do not cover public or multiple-use values) means that mineral resources on Federal land are underpriced in comparison with mineral resources on private land and in relation to the real total social costs of their discovery, development, and production. The under pricing of mineral resources on Federal land may tend to encourage their wasteful use. And this underpricing refers only to the lack of adequate payments for damage to or appropriation of the land and its nonmineral resources: it does not include the possible additional underpricing resulting from the lack of payments for the minerals themselves (see chapter 4, section E).

7. Abuse of Law to Obtain Land for Nonmineral Purposes

In the past, when the valuable mineral deposit criterion was interpreted more loosely and administered much more laxly than now, much Federal acreage was patented (passed into private ownership) under the Mining Law that had little mineral value but was quite valuable for one or more of its nonmineral resource uses—for example, timber, grazing, residential, commercial, or agricultural use. A patented claim may be used for any purpose. A 1974 General Accounting Office survey of 93 randomly selected mineral patents issued during fiscal years 1950 to 1972 in 10 western counties found no evidence that mineral extraction had ever taken place on land covered by 74 of the 93 patents. Seven were being mined, 66 were not being used for any apparent purpose, and **20** were being used for nonmining purposes, primarily residences or grazing.[76]

The recent stricter enforcement of the valuable mineral deposit criterion has served to limit such abuses of the Mining Law, which were paralleled in the late 19th and early 20th centuries by similar abuses of the nonmineral Federal land laws.[77] However, as was discussed in subsection D(5), the current interpretation of the criterion still allows people to obtain title to Federal land for which the nonmineral values may exceed the mineral value. Since the Mining Law is the last of the 19th-century Federal land disposal laws, there is a great temptation to abuse it to obtain title to land for nonmineral purposes.’” The temptation will persist as long as the law allows title to the

[76]GAO *Mining Law Study*, note 36, at 11-12.
[77]See ch. 3, secs. B and C.
[78]E.g., *DOI Mining Law Report*, note 33, at 15 (“salting” of mining claims with gold).

surface to be transferred along with the mining rights, and it will be reduced only to the extent that the valuable mineral deposit criterion is strictly interpreted and enforced.[79]

The potential for abuse would be lessened but not eliminated if a patent conveyed surface title that would revert to the Government if the surface were used for nonmining purposes. As is shown immediately below with respect to unpatented mining claims, such a limitation is difficult to enforce. Moreover, it would create a situation in which no one (neither the Federal Government, the public, nor the mineral patentee) could use the nonmineral resources on the land—hardly an efficient result. And it would continue to propagate the patchwork landownership pattern that, as will be discussed in the next subsection, is so detrimental to proper use and management of Federal land. The patchwork problem would exist until the reverter took effect, which could well be many decades. The reverter might never take effect, even after mining were completed, if the miner did nothing with the land thereafter, and thus did not use the land for nonmining purposes, which is required to trigger the reverter.

Prior to the time a claim is patented, use of the surface is limited to those uses necessary for or reasonably incident to mineral activities. However, since (a) no permission need be obtained from the Federal land management agency before entering on Federal land and staking a claim, (b) it is difficult to prove that a claimant is not engaged in mineral exploration or development as long as some activity (e.g., sampling or digging) is taking place, and (c) there are no fees for occupancy and only minimal ($100 worth per year) work requirements, thousands of persons have abused the free right of entry under the Mining Law in order to occupy and use Federal land for nonmineral purposes under the pretense of engaging in mineral activities.[80] Such abuse of the Mining Law, in many instances, hinders the efforts of persons and firms seeking in good faith to explore and develop the mineral potential of the public domain.

One of the major unauthorized uses of mining claims is their use as permanent or vacation residences by those with little or no interest in mining. Housing can be built legally on claims and associated millsites for those actually engaged in mineral activities on the claims. It is difficult to distinguish between such good faith mineral explorers and those who simply want to make free use of the surface of Federal land, since anyone sampling or scratching around on the surface can claim to be exploring for or developing a mineral deposit. The law does not require claimants to file proof of discovery of a valuable mineral deposit unless a patent is sought. Consequently, the Government bears the burden of proving that claims are being held for nonmineral rather than legitimate mineral purposes.[81]

Technically, discovery of a valuable mineral deposit is a prerequisite to location of a mining claim, and actual occupation and diligent exploration prior to such discovery protect the claimant only against adverse claims by third parties (under the judicially created pedis possessio doctrine), not against the Government. But strict en-

[79] See Senzel, note 44, at 12 n.5.

[80] McGuire, "Forest Service Mining Regulations," Remarks at the AMC Mining Convention, Sept. 28, 1976; *DOI Mining Law Report*, note 33, at 14-16.

[81] Letter to Senator Hatfield from R. Max Peterson, Deputy Chief, U.S. Forest Service, June 18, 1976, enclosing memoranda by Gould, Regional Mining Engineer, "Analysis of Unauthorized Occupancy of Mining Claims," June 1, 1976, and Lawrence, Office of the General Counsel, "Mining-Claim Abuses," May 18, 1976. See also *DOI Mining Law Report*, note 33, at 14.

forcement of the discovery requirement as a prerequisite to occupation would stymie good faith mineral occupants. Moreover, under current procedures, the Government can terminate unauthorized occupancies only by initiating and successfully prosecuting contest actions, which are expensive and time consuming, particularly if the occupant appeals all the way through the various levels of the Department of the Interior and the courts. The claimant can remain on the land until the claim is finally declared void and all appeals are exhausted. Even then, the claimant can resist eviction simply by locating a new claim on the same land, which starts the process all over again. Given the high cost, duration, and ineffectiveness of the contest mechanism, BLM can do little but attempt to correct the most flagrant abuses.[82]

The problems caused by unauthorized occupancy of mining claims for nonmineral purposes have been described as follows by a Forest Service Regional Mining Engineer with nearly 20 years' experience of such abuse of the Mining Law:

> Unauthorized occupancy is more than just a trespass which is of interest only to the land managing agency. To the would-be users of the public land it is an unavailable recreation site, an area where hunting or fishing are prevented: a route of access to other public land which is blocked by inappropriate signing, ("Private Proper [y-Keep Out—Survivors Will Be Prosecuted"); an invitation to initiate their own unauthorized occupancy. (''If they can do it, why not I?").
>
> To the potential mineral developer it is effectively a withdrawal of public land from good-faith mineral search and development, and thus antithetic to the basic purpose of the mining laws: to promote the development of the mineral resources of the public lands.
>
> To local government it is services that must be provided (e.g., schools, law enforcement, welfare payments, food stamps, unemployment benefits, aid to families with dependent children, etc.) far in excess of the modest taxes on the buildings (in the order of $100 annually), and without other contribution to the local economy; it is buildings constructed without regard to building and sanitation codes; because of the isolation of many it is game and fish laws disregarded.
>
> But to the land managing agency, too, it is more than just a case of trespass: It is a campground site that cannot be developed for public use: it is an impediment to a timber-sale, or to the routing of a needed road: it is an invitation to additional trespass which must be countered; it is the expenditure of hundreds of thousands of dollars annually (if not millions) that must be diverted from productive aspects of National Forest managrment: it is a land use for which, if authorized by a special use permit, a fee would he charged but under the circumstances is not paid: it is still another potential source of wildfire: in the case of a community o f organized occupants it can be and sometimes is a barrier to administration of large tracts of land, and a threat of physical harm, even death, to Forest Officers.[83]

8. **Impacts on Surface Management**

Mineral activities are compatible in principle with multiple-use management of Federal lands, but some legitimate occupancies under the Mining Law cause substantial problems for multiple-use management. Clearly, an actual mine will interrupt sur-

[82] Gould memorandum, note 81; *DOI Mining Law Report*, note 33, at 11, 20; *GAO Mining Law Study*, note 36, at 20, 34-41; Senzel, note 44, at 22 & n.18.

[83] Gould memorandum, note 81

face uses in the mined area and impact to some degree surface uses in adjacent areas. This is a necessary consequence of mineral activities and an example of reasonable sequential multiple use, given appropriate mitigation and reclamation measures based on proper weighing of the mineral and nonmineral values. Certain elements of the Mining Law, however, create problems for multiple-use land management that are not necessary incidents of mineral activity.

The right to acquire title to the surface of a mining claim causes gaps in the surface area being administered by the Federal land management agency. These gaps can affect efficient land management by, for example, blocking desirable public access routes, impeding wildlife migration and movement of grazing stock, preventing public recreational use, or permitting nonmineral uses (after mining is completed) that are not consistent with but rather detract from the desired public use of the surrounding Federal land.

The procedures specified by the Mining Law for laying out claims on the ground add to the problem caused by these private inholdings. Lode claims must be staked along the length of the vein, with a maximum length of 1,500 feet and a maximum width of 600 feet. The resulting irregularly shaped and overlapping claims form a complex pattern of landownership that creates confusion in the land records and serious problems for land managers,"'

Neither surface title nor irregularly shaped claims are necessary for mineral exploration or development. The outcropping high-grade veins developed in the 19th century, which motivated the irregularly shaped lode claiming procedures, have now been largely replaced as targets of exploration by buried or disseminated ore bodies underlying larger tracts more suitable to claiming in accordance with the rectangular subdivisions of the public land surveys. Moreover, hardrock minerals are developed under lease on Federal acquired land (for example, the Missouri lead belt) and on practically all State land (for example, Arizona copper). All fossil fuel and fertilizer minerals are developed under lease. A properly drafted lease can provide tenure as secure as full fee title.

Federal land management is also substantially affected before claims are patented and transferred into private ownership under the Mining Law. Since each claim that contains a valuable mineral deposit may be patented at the option of the mineral claimant, or worked or held indefinitely without obtaining a patent, there is a disincentive to plan or develop nonmineral resource activities in areas containing a significant number of active (or even inactive) mining claims. The plans or activities might be preempted at any time, into the indefinite future, by the mineral claimant, who could either destroy the nonmineral improvements or take them over (if a patent were obtained) without paying any compensation.

A similar disincentive to planning may occur even in areas not yet claimed but believed to be favorable for the occurrence of economic mineral deposits. Unless the area is totally withdrawn from the location of claims under the Mining Law, any nonmineral resource activity or plan may be completely preempted, without payment of

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[34] *DOI Mining Law Report*, note 33, at 21

compensation and with little or no advance notice, by the initiation of mineral activities and the associated acquisition of surface rights or title under the Mining Law.

Short-term public use of the nonmineral resources on a claim, or access across the claim, may also be prevented by claimants who erect barriers or otherwise seek to exclude the public, even when public use would not interfere with mining activities. This is particularly a problem with nonmineral occupants of mining claims, as discussed in the previous subsection. Sometimes mineral occupants also seek to exclude the public, despite the reservation of surface rights by the Government affirmed by the Surface Resources Act of 1955.[85] The mineral occupants often may be motivated by the fear of permitting peaceful entry by adverse claimants and thereby losing the prediscovery tenure afforded by the pedis possessio doctrine.[86]

An unpatented mining claim is presumed to be valid unless it has been declared invalid through appropriate agency proceedings. Thus, every unpatented claim is a ‘‘cloud’ on the Federal title to the land and may prevent or hinder Federal disposal or use of the surface or any underlying minerals. The Department of the Interior estimated in 1969 that there were more than 6 million unpatented claims on Federal land, not including unpatented claims on national forest land, and that it would cost hundreds of millions of dollars to clear the Federal title of all the abandoned or invalid claims.’[87] This problem was greatly reduced by the passage in 1976 of the BLM Organic Act, which requires the annual recordation of active interest in each unpatented mining claim and makes failure to record the required documents a legal abandonment of the claim.[88] However, hundreds of thousands of “active” unpatented claims will continue to exist: an average of almost 500,000 claims per year were being located in the Western States between 1961 and 1966, according to one estimate,[89] and affidavits of annual assessment work were being filed on some 160,000 claims, according to another[90] (the filing of such affidavits is not mandatory—see chapter 4, subsection D(2)(b)).

Many of these claims are being worked diligently and in good faith in serious attempts to discover and develop valuable mineral deposits. Many more, however, are being held for speculative mineral purposes by individual prospectors,[91] for unauthorized nonmineral occupancy purposes,[92] or for their nuisance value in hopes of being bought off by a private individual or Government agency wishing to make use of the land.[93] These unnecessary and costly clouds on the Government’s title are made possible by the minimal expense of maintaining a claim indefinitely without any requirement t for mineral production, and by the free and absolute right of entry under the Mining Law.

The miner's right, under the Mining Law, to enter, without advance notice or permission, onto land containing Federal minerals leaves the surface owner or manager with no voice in the timing of mineral activities, and with little or no chance to mitigate surface impacts resulting from the initial entry. This creates tensions, especially when

[85] *Anatomy of a Mine*, note 63, at 17; see ch. 3, subsec. E(1); *United States v. Curtis-Nevada Mines, Inc.*, 415 F. Supp. 1373 (E.D. Cal. 1976).

[86] *Anatomy of a Mine*, note 63, at 8-9.

[87] *DOI Mining Law Report*, note 33, at 12, 19-20.

[88] 43 U.S.C. § 1744 (1976).

[89] *University of Arizona PLLRC Study*, note 1, at 731, table 27.

[90] *DOI Mining Law Report*, note 33, at 20.

[91] See ch. 2, sec. F.

[92] See subsec. D(7).

[93] *DOI Mining Law Report*, note 33, at 15-16; Senzel, note 44, at 23.

the surface of the land being entered is in private ownership as a result of, for example, homesteading under the Federal nonmineral land disposal laws, The Federal Government reserved the mineral rights in millions of acres of western land now used for urban as well as rural purposes. Homeowners and ranchers do not like to find mineral exploration crews staking claims and drilling holes across their land, but such unannounced activity is permitted by the homestead laws and necessitated by the location requirements under the Mining Law. Violent conflicts sometimes result.[94] For land under the surface jurisdiction of the Forest Service, regulations require a notice of intent prior to any significant surface disturbance. Claim location activities, however, are excepted from this requirement, and it may be ignored in a race-to-discovery situation (see subsection D(2)(b)). Tensions could be greatly reduced if tenure were acquired by filing a claim for the desired land in the appropriate land office, rather than having to physically locate the claim on the ground, and if compensation were paid for any unavoidable damage to surface resources and improvements.

E. Coordination of Mineral and Nonmineral Activities Under the Mineral Leasing Laws

1. Relevant Provisions of the Mineral Leasing Laws

The main elements of the various mineral leasing acts, which generally apply to the fossil fuel and fertilizer minerals on public domain land and to all (except common-variety) minerals on acquired land, are discussed in sections C through E of chapter 3. The primary elements of the mineral leasing laws that distinguish them from the Mining Law with respect to coordinated mineral and nonmineral resource activities are (a) retention of surface title by the Federal Government, (b) discretionary authority to refuse to permit mineral entry on any or all tracts, (c) acquisition of tenure rights through applications filed in the agency offices according to the public land subdivisions, rather than through physical location and makework activity on the ground, (d] the absence of annual work requirements, (e) explicit authorization and direction to issue regulations and insert conditions in leases to prevent waste, safeguard the public welfare, and protect the public interest, and (f) authorization and direction to charge rentals and royalties, and to distribute 50 percent or more of the lease revenues and make loans against future revenues to the States impacted by mineral activity on Federal leases.

2. Unlimited Discretion to Issue or Refuse Permits or Leases

One of the most significant aspects of the mineral leasing laws is the complete discretion granted to the Secretary of the Interior to issue or refuse permits or leases on

[94] "Mineral Development on Federal Lands," hearings before the Subcomm. on Minerals, Materials, and Fuels of the Senate Comm. on Int. & Ins. Affairs, 93d Cong., 2d sess. 148-163 (1974); "Federally Owned Locatable Minerals," hearing before the Subcomm. on Public Lands of the Senate Comm. on Int. & Ins. Affairs, 91st Cong., 1st sess., Casper, Wyo. (1969); see Senzel, note 44, at 22 n.23; *Anatomy of a Mine*, note 63, at 26.

any or all tracts of Federal land. This discretion is limited only by the requirement to obtain the consent of the head of the surface management agency prior to issuing leases on acquired land, on land withdrawn or reserved for military purposes, or for coal or geothermal steam. [95]

As was noted in chapter 3, the discretion given to the Secretary is a two-edged sword. Until very recently, permits and leases were issued routinely to anyone who applied, with little attention given to the potential impact on nonmineral resources, But in the last few years concern over environmental degradation, natural area preservation, and possible excess leasing has led to an almost complete reversal in policy and practice, so that the discretion formerly exercised routinely in favor of the mineral industry is now often used to block mineral activity or to delay it pending lengthy reassessment of resource values and options. The issuance of permits and leases has practically ceased for many of the leasable minerals.

Such unlimited discretion, which can swing widely back and forth between the extremes of no consideration of surface resource values and absolute protection of such values, is unsatisfactory to both mineral resource users and nonmineral resource users. Specific guidelines that would place some limits on the Secretary's discretion could establish a sounder basis for mineral industry planning and a more secure protection of nonmineral resource values.

The requirement of consent by the surface management agency to the issuance of a mineral lease provides some check on the possible failure of the Secretary of the interior to consider surface values. But consent is now required only for leases on acquired or military land or for coal or geothermal steam leases. Moreover, there are no specific criteria for granting or withholding consent, so that the discretion is in one sense compounded rather than limited, particularly from the standpoint of the mineral industry.

The recently enacted Federal Coal Leasing Amendments Act of 1976 prohibits coal lease sales "unless the lands containing the coal deposits have been included in a comprehensive land use plan and such sale is compatible with such plan. [96] This prohibition would seem to require that coal mining be explicitly mentioned as a permissible use in the land use plan, since coal mining, especially surface coal mining, will almost always be in conflict with any nonmineral use in the plan. While such explicit designation of mining zones may be appropriate for minerals such as coal and oil shale, for which the location of large quantities of the mineral resource is already known, it does not seem practical for other minerals for which the location of the resource is generally not known prior to issuance of the permit or lease. Moreover, even for coal, the restriction on the Secretary's discretion is somewhat illusory since no criteria are specified for establishing coal leasing zones in land use plans, and the Secretary can always modify a land use plan to permit or prohibit coal leasing.

The guidelines issued by the Secretary of the Interior for recommendations on withholding Federal land from leasing for surface coal mine development require the local land management officer to base any such recommendation on a finding that:

[95] E.g., 30 U.S.C. §§ 201(a)(3)(A)(iii) (coal), 352 (acquired land) and 1014(b) (geothermal steam) (1976); 43 U.S.C. § 158 (military land) (1976).

[96] 30 U.S.C. § 201(a)(3)(A) (1976).

> 1. Reclamation in accordance with the [required] standards ., . cannot be attained by the application of known technology; or
> 2. Mining by such methods would create hazardous conditions that would involve significant risk to public health and safety, including, but not limited to, destruction of public or private property from rock or land slides, geological instability, significant adverse changes in natural flood patterns or conditions, or unavoidable deterioration of water quality or quantity in contravention of applicable law; or
> 3. Mining by such methods would be incompatible with, and would prevent, other recognized land uses of a higher value. In determining that such a higher value exists, the authorized officer shall take into account—
>
> The productivity and natural resource potential of the lands involved, including, but not limited to, significant and intensive irrigated or subirrigated agricultural or ranching uses;
>
> The presence of unique key wildlife habitats;
>
> Characteristics of exceptional fragility or of unique historic, cultural, scientific, or esthetic value; and
>
> Action by regional, State, or local governmental bodies to designate or recommend the designation of such lands, or adjacent lands which are geologically, hydrologically, or biologically related, as unsuitable for mining based upon criteria substantially similar to those set forth herein. q'

The report containing such recommendations must set forth "with reasonable specificity the facts on which such recommendation is based. ''[98]

These guidelines refer to physical land type or land use characteristics that can be readily identified during the land use planning process, and that perhaps could be used with respect to minerals other than coal. Together with the requirement for a written finding based on specified facts, they could serve as a basis for judicial review of a decision to grant or deny a lease, They therefore suggest one possible avenue for limiting the Secretary's current broad discretion without hampering sound land management. Now, however, they apply only to coal, are still rather general and not explicitly tied into the land use planning process, and are not binding on the Secretary, who can refuse to issue a lease for reasons other than those listed in the guidelines, or issue a lease despite the guidelines (which are guidelines for recommendations only).[99]

3. Preemption of Nonmineral Resource Values Once a Lease Has Been Issued

Although the Secretary of the Interior has practically unlimited discretion to issue or refuse permits or leases under the various mineral leasing acts, his control over mineral activities is greatly reduced once a permit or lease has actually been issued, At that point, the explorer or miner has legal rights under the leasing laws, which can be restricted only in accordance with provisions in the particular permit or lease or applicable regulations. The applicable regulations, according to the lease forms cur-

[97] "Coal Resources Regs. Guideline No. 1." 41 F.R. 43722 (1976).

[98] 43 CFR § 3041.2-1(b) (1976).

[99] Sec. 522 of the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. § 1272 (Supp. I 1977), requires the Secretary to withdraw or condition mineral leases so as to limit surface coal mining operations on Federal land determined to be unsuitable for all or certain types of such operations. An area *must* be designated unsuitable if reclamation as required by the Act is not technologically and economically feasible; it *may* be designated unsuitable if surface coal mining operations would be incompatible with state or local land use plans or could adversely affect important values on ecologically fragile or historic lands, renewable resource lands, or natural hazard lands. Draft unsuitability criteria have been published in U.S. Department of the Interior, *Federal Coal Management Report, Fiscal Year 1978*, app. A (1979).

rently in use,[100] include all regulations "now or hereafter in force. " But there is an explicit or implicit condition in each form that regulations issued in the future will be applicable to a preexisting lease only if they are "reasonable" and "not inconsistent with any express and specific provision" in the lease. The most basic provision of each lease is the one granting the lessee the right to mine and dispose of the leased deposits and to construct and maintain on the lease tract ''all works, buildings, plants, structures, and appliances necessary to the mining, processing, and removal of the deposits. " Thus, as is the case with the Forest Service surface use regulations under the Mining Law, any regulations promulgated after the issuance of the lease cannot be used to restrict the basic legal right to explore for, develop, and produce the leased mineral deposits. The right to explore or mine will outweigh all nonmineral resource uses and values, even nonmineral uses authorized prior to the mineral lease, no matter how valuable they might be or how unexpected the damage,[101] unless otherwise specifically provided in the mineral permit or lease or in the regulations existing at the time the lease was issued.

The mineral leasing laws, unlike the Mining Law, expressly authorize the Secretary of the Interior to issue regulations and direct him to insert provisions in mineral leases that he deems necessary to prevent waste, safeguard the public welfare, and protect the interests of the United States.[102] This authorization seems broad enough to support regulations or lease provisions that might render mineral exploration or production uneconomic in certain areas or under certain circumstances,'[103] as long as such regulations or lease provisions are reasonably necessary to protect important nonmineral resources.[104]

However, aImost all of the provisions in the mineral leasing regulations and lease forms relating to surface resoures are couched in broad language which, similar to the Forest Service surface use mining regulations under the Mining Law, simply requires "reasonable steps'" to prevent "unnecessary" soil erosion, water pollution, safety hazards, degradation of air quality, and damage to surface resources and, "so far as can reasonably be done, " rest oration of the surface to its former condition.[105] These provisions are not specific enough to prevent mining in unsuitable portions of a leased tract, nor to support restrictions on ongoing exploration and mining operations, even though such restrictions might be necessary to maximize the total resource value of the tract. Thus, there is pressure to withdraw tracts rather than leave them open to mineral activities.

There are a few specific provisions for certain leasable minerals. The lease form for hardrock minerals on acquired land requires approval by the authorized Federal officer for strip or open-pit mining; reduction or smelting of ores; operations or surface disturbance within 200 feet of any building; or damage to improvements, timber, crops,

[100] E.g., BLM Lease Forms 3120-7 (1977) (competitive public domain oil and gas), 3110-1 (1977) (noncompetitive public domain oil and gas), 3110-3 (1973) (noncompetitive acquired land oil and gas), 3520-2 (1971) (potassium), 3520-3 (1977) (sodium), 3520-6 (1972) (acquired land hardrock minerals). See also 38 F.R. 33189 (1973) (oil shale); Coal Lease W-6266, Mar. 23, 1976.

[101] See, e.g., *Gulf Oil Corp.* v. *Morton*, 493 F.2d 141, 149 (9th Cir. 1974). But see, for coal, Surface Mining Control and Reclamation Act of 1977, § 523(b), 30 U.S.C. § 1273(b) (Supp. I 1977).

[102] E.g., 30 U.S.C. §§ 187, 189 (1976).

[103] See *DOI Task Force Report*, note 4, at 64; *Natural Resources Defense Council, Inc.* v. *Berklund*, Civ. No. 75-0313, slip opinion at 18-19 (D.D.C. June 30, 1978).

[104] *Richard P. Cullen*, 18 I.B.L.A. 414 (1975); *A.A. McGregor*, 18 I.B.L.A. 74 (1974).

[105] See 30 CFR pts. 211 (coal), 221 (oil and gas), 270 (geothermal), and 231 (all other minerals) (1977); 43 CFR subpts. 3109 (oil and gas) and 3204 (geothermal), pts. 3040 (coal) and 43 (all other minerals) (1976); and the BLM lease forms cited in note 100.

or other cover on the leased tract, It also requires payment for cut or destroyed timber, "any and all damage to or destruction of property" on federally owned surface, and damage or injury to livestock, crops, trees, pipelines, buildings, and other improvements on privately owned surface.[106] The recently enacted Surface Mining Control and Reclamation Act of 1977 provides detailed requirements for reclamation of land disturbed by surface coal mining operations, and prohibits such operations where the reclamation requirements cannot be met; within specified distances from occupied dwellings or public roads, buildings, parks, or similar facilities; within national parks, wildlife refuges, national trails, wild and scenic rivers, wilderness areas, and most national forests; or on fragile, historic, renewable resource, or natural hazard lands designated unsuitable for surface coal mining operations.[107]

Even under these provisions, however, mining operations once authorized will ordinarily preempt nonmineral resource values. For example, the Surface Mining Control and Reclamation Act focuses on reclamation requirements rather than provisions to balance mineral and nonmineral values during exploration or mining, except for a few provisions related to water supply and quality and soil storage. Outside of those areas declared unsuitable for surface mining (an all-or-nothing sort of determination), the coal lessee is required only to preserve soil for reclamation, protect of offsite water supply and quality, and "to the extent possible using the best technology currently available, minimize disturbances and adverse impacts of the operation on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable."[108]

4. Unpredictable Nonmineral Resource Protection Requirements

Mineral explorers and developers under the leasing laws face substantial uncertainty as a result of the vague and general wording of almost all the current lease provisions and regulations concerning nonmineral resource protection. Like the similarly worded Forest Service surface use regulations under the Mining Law, they are subject to ad hoc and unpredictable interpretation and implementation.

Specific controls on particular mining operations are negotiated through I he process of submission and approval of exploration or mining plans, Although technically the controls imposed through this process cannot go beyond the restrictions expressed or implied in the particular lease or governing regulations, the general wording of the lease provisions and regulations (together with the lessee's desire to avoid the delays involved in administrative or judicial appeals) give the responsible Federal officer considerable leverage.

Additional uncertainty with respect to nonmineral resource protection requirements is created for the nonfuel leasable minerals by the fact that production leases (and hence lease provisions) for such minerals are issued for land not previously known to be valuable for such minerals only after exploration has been successfully

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[106] BLM Lease Form 3520-6 (1972). Similar requirements are imposed for any mineral permit or lease on land under the jurisdiction of the Department of Agriculture by a special stipulation in BLM Form 3103-2 (1964).

[107] 30 U.S.C. §§ 1201-1328, especially §§ 1260 & 1272 (Supp. I 1977). There are also special provisions to protect agricultural land in alluvial valleys. See note 99.

[108] 30 U.S.C. §§ 1265(b)(24), 1266(b)(11) (Supp. I 1977).

completed under a prospecting permit. Apparently, the Secretary of the Interior is free to insert any lease provision reasonably required to protect the nonmineral resources, even though the provision might render production uneconomic, and even though considerable time and effort may already have been spent on exploration.[109] However, nonmineral resource protection requirements in such "preference-right" production leases have until now been as vague and general as those in other leases, even though the availability of the exploration data should make it possible to formulate much more specific requirements.

In sum, nonmineral resource protection requirements in the mineral leasing regulations and lease forms are usually quite general and provide considerable latitude for interpretation, Recently, however, there have been some attempts to reduce uncertainty concerning how the requirements will be applied in particular cases. For example, the Department of the Interior in 1977 issued a booklet, Surface Operating Standards for Oil & Gas Exploration and Development, which provides guidelines for siting, construction, use, and rehabilitation of access roads, pipelines, wells, and other facilities. The guidelines are intended to aid oil and gas operators in drawing up surface use plans required to be submitted by the 1976 Notice to Lessees on Approval of Operations (NTL-6). Even this booklet is fairly general, since it is national in scope. But it notes that supplemental guidelines and methods that reflect local site and geographic conditions may be available from the local Federal land office. In particular, it advises that:

> Exploration, drilling or other development activity may be prohibited during certain times of the year. For example, development activity during certain spring months may be curtailed when in close proximity to significant breeding grounds. This applies as well to critical wildlife areas during certain winter months, New operations may be temporarily prohibited or restricted when the ground is wet and muddy and significant damage could result from use. Buffer areas near streams and recreation areas may be withheld from surface disturbing activities.

These and other sorts of specific restrictions, such as restrictions on activities on steep slopes, are beginning to find their way into individual leases. They are based on analysis of the land types and uses in particular areas. They represent a balancing approach toward the conflict between mineral and nonmineral resource activities on a tract of land, as opposed to the all-or-nothing, open-or-closed withdrawal approach traditionally used,

The Bureau of Land Management has gone a step further with these area-specific restrictions in certain districts by developing and promulgating them as part of its land use planning process. Thus, both mineral and nonmineral resource users can comment on and influence the development of the restrictions through the public participation procedures of the land use planning process. Moreover, the restrictions are published as part of the land use plan for the area, and therefore reduce uncertainty by providing advance notice of some of the major nonmineral resource protection requirements that will be imposed on mineral leases in the area.

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[109] See *Montana Eastern Pipeline Co.*, 55 I.D. 189 (1935), and the sources cited in notes 103 and 104

So far, the restrictions adopted in these land use plans, although more specific than the usual "mitigate if possible" language in the leasing regulations and lease forms and more flexible than the open-or-closed withdrawal approach, have been fairly broad-gauged themselves—for example, seasonal restrictions on operations or limitations on surface disturbance within specified distances of certain sites. However, they represent an interesting indication of an approach that could improve nonmineral resource protection while leaving land substantially open to mineral activity, through implicit or explicit designation of land types or categories that can be fitted with appropriate protective stipulations. [110]

5. The Valuable Mineral Deposit Criterion and Preference-Right Leases

The valuable mineral deposit criterion, discussed in subsection D(5), which has been the source of so much conflict and uncertainty under the Mining Law, was incorporated into the leasing acts to serve as the basis for determining whether exploration activity under a prospecting permit had been successful enough to development into a "preference-right" production lease.

Almost immediately, however, the criterion was weakened in practice to require only a showing that a mineral deposit had been found that the explorer was willing to try to produce. This application of the criterion did not cause much objection, since a lease did not convey title to the surface or the minerals (unlike the situation under the Mining Law), and since there was initially no great concern over possible damage to nonmineral resources as a result of operations under a lease.

Recent concern over the environmental impacts of mining operations has led to stricter interpretation and enforcement of the valuable deposit criterion under the mineral leasing acts as well as the Mining Law. In the first formal definition of the criterion under the leasing acts, the Secretary of the Interior has affirmed that the criterion is the same as that used under the Mining Law, and he has ruled that the cost of complying with lease provisions must be included in determining whether a valuable mineral deposit has been discovered.'" Thus, not only does the marketability test with its strict scrutiny of costs and financing apply to applications for preference-right leases, but the Secretary can also affect the costs being considered by inserting weak or tough nonmineral resource protection provisions in proposed leases.

The availability of a preference-right production lease is made even more uncertain by two additional factors. First, the leasing laws require that an applicant for a preference-right lease for sodium, sulfur, or potassium show that the land is "chiefly valuable" for the development of the mineral involved. [112] This requirement apparently expressly incorporates the comparative (mineral versus nonmineral] value test, discussed in subsection D(5), for granting mineral production rights. To date, however, it does not seem to have been enforced. Second, as discussed in subsection D(3)(b) of chapter 4, the issuance of a preference-right lease may be discretionary with the Sec-

[110] E.g., BLM Rawlins District, *Proposed Decisions. Management Framework Plan, Overland Unit. Wyoming* (Apr. 8, 1977); BLM Billings District, *Land Use Recommendations and Land Use Decisions, Buffalo Creek Unit, Montana* (June 30, 1973)

[111] 43 CFR §§ 3520.1-1, 3521.1-1 (1976).

[112] Ibid.

retary of the Interior: discovery of a valuable mineral deposit under a prospecting permit may only entitle the permittee to a preference right to a lease, that is, a right of first refusal if the Secretary should decide to issue a lease,

6. Lack of Payments for Damage to Nonmineral Resources

One of the major purposes of the Mineral Leasing Act of 1920, reiterated in the debates and committee reports leading to its passage, was to assure that those Federal lands containing fossil fuel or fertilizer minerals would be conserved and developed as prudent men would conserve and develop their private properties. As was discussed in subsection D(5), prudent men would not allow mineral development on their private property unless they were reimbursed in some fashion for the value of the nonmineral uses of the property that were lost or diminished as a result of the mineral development.

Partially in recognition of this fact, and partially to ensure diligent development, the authors of the Mineral Leasing Act established minimum rentals to be paid by mineral lessees under the Act. The minimum rentals were tied to the nonmineral value of the land, which was at the time considered to be fairly low, since only commercial nonmineral uses were valued.[113] Thus, the rentals generally were set at a minimum of $0.25 per acre for the first year of the lease and rose to a minimum of $1 per acre after 5 years. Some of the rental rates were fixed rather than being specified as minimums,

Even for the rentals specified as minimums, few have been raised over the years since 1920, and those have been raised only slightly, despite enormous increases in the valuation of commercial and noncommercial nonmineral resources on Federal land. The rentals, therefore, do not serve as payments for damage to nonmineral resources caused by mineral activities under a lease.

Royalty payments on production have also stayed fairly low, and it is sometimes doubtful whether they cover even the Government's "fair share" of the mineral value, let alone the damage to nonmineral resources. Moreover, royalties are not appropriate instruments for ensuring payment for damages to nonmineral resources, since royalties are paid only when production occurs, and substantial damage to nonmineral resources may occur without production as a result of exploration and development activities.

Finally, neither rental nor royalty payments under the Mineral Leasing Act are used to reimburse the Federal Government for damages to nonmineral resources on the leased land. As will be discussed in subsection E(3) of chapter 6, mineral revenues under the Act are almost all turned over to the Western States or used to finance irrigation projects in those States. Thus, the land management agencies receive little or no compensation for damages to Federal nonmineral resources caused by mineral activities under the Mineral Leasing Act. This lack of compensation tends to promote an unfavorable attitude toward mineral leasing on the part of the land management agencies.

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[113] See, e.g., 58 Cong. Rec. 4540, 4541 (daily ed. Aug. 25, 1919) (remarks of Senator Fall).

As with miners under the Mining Law, mineral lessees under the mineral leasing laws must pay private surface owners of homestead land (with reserved Federal mineral ownership) for damages to crops, agricultural improvements, and the value of the land for grazing. In addition, certain private surface owners (those who, for at least 3 years, have resided on the land, personally conducted farming or ranching operations thereon, or received directly a significant portion of their income from such operations) can negotiate for a more substantial payment from potential coal lessees, since no coal lease can be issued without the surface owner's written consent, [114] Even for coal leases, however, these required payments to surface owners are usually insufficient to ensure proper balancing of all mineral and nonmineral resource values by the mineral lessee.

Some lease forms and regulations require mineral lessees to pay for damages to certain nonmineral resources, but there are very few such provisions, and they are generally limited to only a few nonmineral resources, such as timber.[115]

7. Impacts on Surface Use and Management

Generally, unnecessary disruption of surface use and management is much less of a problem under the mineral leasing laws than it is under the Mining Law. This is primarily because the Federal Government retains title to the surface and approves and supervises operations under the mineral leasing laws, and also because tenure rights under the mineral leasing laws generally expire after a certain time in the absence of active mineral development. But, given the lack of adequate diligence requirements (or in some cases enforcement of those requirements) discussed in chapter 4, management and planning of surface use can be unnecessarily disrupted for the full primary period (ordinarily 20 years) of even an "inactive" lease, since, until the expiration of the primary period, there is alway the possibility that mining will be begun with consequent damage to surface improvements. Moreover, for some minerals the primary period extends or can be renewed indefinitely, even in the absence of production. In such cases, long-range land planning is precluded.

F. The Role of National and State Environmental Laws

Federal and State air quality, water quality, toxic substances control, and other environmental laws of a general nature usually apply to mineral activities on Federal land. The mining industry has, until recently, unanimously argued that only such general environmental laws should apply to environmental aspects of mining on Federal land, that the Mining Law, at least, should remain a pure property tenure and ownership statute without any environmental provisions, and that the general Federal and State environmental laws adequately protect the environment.[116]

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[114] Surface Mining Control and Reclamation Act of 1977, § 715, 30 U.S.C. § 1305 (Supp. I 1977).

[115] See, e.g., BLM Lease Form 3520-6 (1972) (acquired land hardrock minerals); U.S. Department of the Interior, *Surface Operating Standards for Oil & Gas Exploration and Development* 35 (1977).

[116] E.g., Marsh, *A Critique of the General Accounting Office Report on the General Mining Law*, Colorado Mining Ass'n Publication 2-77, at 4 (1977).

However, general environmental laws do not reach the central issues of land resource allocation and use. Minerals are part of the land and, as such, are intimately bound up with the nonmineral resources in and on the land. Mineral activities inevitably impact nonmineral resource uses and values. Therefore many people believe that any mineral disposal statute, and especially one like the Mining Law that disposes of the surface along with the minerals, can never be treated as simply a mineral title statute, but rather must be recognized as a statute that necessarily affects the allocation and use of the tract of land involved and all its mineral and nonmineral resources,

These central issues of land resource allocation and use would not be adequately addressed even by adoption of general Federal or State land use laws, For one thing, it is doubtful that the Federal Government would or should ever leave the protection of nonmineral resources on its land solely in the hands of the States. In 1976, 20 States, including six Western States, did not even have a hardrock reclamation statute.[117] Problems with State coal reclamation statutes led to passage of a Federal statute. Moreover, even a Federal land use law would be ineffective given the existing mineral disposal statutes, because mineral activities under those statutes preempt the land use planning process, unless withdrawals from mining are effected, in which case it is the mineral laws that are preempted. Federal land use laws for Federal land already exist—for example, the Federal Land Policy and Management Act of 1976[118]-but they do not resolve the basic issues of coordinating mineral and nonmineral resource uses. It is not likely that the issues will be resolved as long as mineral tenure is treated as something separate from land tenure and use.

G. The Response to Inadequate Procedures for Coordination of Mineral and Nonmineral Activities Under the Federal Mining and Mineral Leasing Laws: Withdrawals and Similar Restrictions

Current nonmineral resource protection procedures applicable to locatable and leasable minerals generally are limited to ad hoc negotiation of mitigating measures. Thus, Congress and the executive branch have withdrawn large amounts of land from availability under the Federal mineral laws in order to protect nonmineral resources that they believed were inadequately protected by existing laws and regulations. In other cases, administrative delay and public opposition have blocked mining ventures in the absence of a formal withdrawal. Mineral development is thereby completely precluded, even in cases where properly restricted mineral activities might be entirely compatible with protection of nonmineral uses and values. In recent years, increased demands on Federal land for nonmineral resource uses and a heightened concern for the environment have led to a substantial reduction in the amount of Federal land available for mineral development.

Tables 5.1 and 5.2 summarize data compiled in appendix B on the availability for mineral activity of various categories of Federal onshore land in 1975. Table 5.1

[117] Imhoff, Friz, and LaFevers, *A Guide to State Programs for the Reclamation of Surface Mined Areas*, USGS Circ. 731 (1976).

[118] 43 U.S.C. §§ 1701-1782 (1976).

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Table 5.1 .—Availability of Federal Onshore Land for Development of Fossil Fuel and Fertilizer Minerals

The Status i n 1975a
(millions of acres)

Designated use	Formally closed		Highly restricted		Moderate or slight restriction	
Military	22.9	(2.80A)	–	–	–	–
Indian (nonreservation)	0.9	(0.1%)	–	–	–	–
National parks, recreation areas, historic sites	26.0	(3.2°4)	0.2	(0.0°/0)	0.4	(0.0°/0)
Wildlife protection	1,9	(0.2%)	29.4	(3.60/')	–	–
Wild and natural areas. .	0.2	(0.0°4)	29.7	(3.5°/0)	65.3	(8,0°/0)
Agricultural, stockraislng, water supply, flood control . . .	7.8	(0.9°/0)	9.1	(1.1 0/')	65.8	(8.0°/0)
Energy development	7,4	(0.9°/0)	16.1 b	(1.9%)	–	–
Mineral conservation.	23,9	(2.9°4)	4.8	(0.6°/0)	0.1	(0.0°/0)
Spatial surface occupancy	5.4	(0.7°/0)	0.5	(0.1%)	–	–
Other or none	—	—	0.6	(0.1°/0)	242.5	(29.4°/0)
Subtotal non-ANCSA, . .	96.4	(11 .7%)	81.4	(9.9%)	374.1	(45.4 %)
Alaska Native selections. . .	49.2	(6.0°4)	–	–	30.8	(3. 7%)
Alaska State selections. ...	39.1	(4.7°4)	–	—	16.4	(2.0°/0)
ANCSA d-1 . .	71.4	(8.7%)	–	—	—	—
ANCSA d-2	65.0	(7,9°/0)	—	—	—	—
Subtotal ANCSA.	224.7	(27.3%)	–	—	47.2	(5.7%)
Total, ...	321.1	(39.0°/0)	8 1 . 4	-(9.9%)	421.3	(51 .1 %)

aThe Alaska situation was changed in late 1978 by major new executive withdrawals that resulted in no increase (over prior ANCSA withdrawals noted in this table) in the land formally closed to development of the fossil fuel and fertilizer minerals. See appendix B, section O.
b9.0 overlaps stricter ANCSA withdrawals and is not included in totals.

covers the 823.8 million acres of Federal onshore land in which the Government owned the fossil fuel and fertilizer minerals, which are available under the mineral leasing laws.[119] Table 5.2 covers the 799.9 million acres in which the Government owned the hardrock minerals (minerals other than the fossil fuel, fertilizer, and common-variety minerals), which are generally locatable under the Mining Law but are leased or otherwise available on over 100 million acres.

Both tables classify land as either formally closed to mineral activity, highly restricted, or subject to moderate or slight restriction. The "formally closed" classification includes land explicitly closed to mineral activities by statute (for example, National Petroleum Reserve No. 4 and almost all national parks in 1975) or by a published Secretarial order (for example, wildlife, military, or oil shale land). The "highly restricted" classification includes land which, while formally open to mineral activities, is restricted by statutory conditions (for example, powersites), statutory and administrative conditions (for example, wilderness areas or certain reclamation projects), or administrative conditions (for example, BLM's primitive and natural areas) to such an extent that mineral activity is greatly discouraged, although it sometimes occurs. The "moderate or slight restriction" classification includes all other Federal onshore land, which is generally open to mineral activities, although there will usually be some requirement to mitigate the impact of mineral activities on the surface resources

[119]Except sulfur, which is leasable in New Mexico and Louisiana only.

Table 5.2.—Availability of Federal Onshore Land for Development of Hardrock Minerals
The Status In 1975a
(mill Ions of acres)

Designated use	Formally closed		Highly restricted		Moderate or slight restriction	
Military	22.9	(2 9°0)				
Indian (non reservation)	09	(o 1 °0)				
National parks, recreation areas, historic sites	189	(2.4°0)	7 3b	(0.9%)	0.4%	(0.0%)
Wildlife protection	30.0	(3 7°0)	1.3	(0.2%)		—
Wild and natural areas	10	(0.1%)	28.9b	(3 .6%)	65.3b	(8.2%)
Agricultural. stockraising, water supply, flood control	127	(1 6°0)	4 .2b	(0.5%)	419	(5 2°0)
Energy development	59	(o 7°0)	15.2C	(1.9%)	24	(o 3°0)
Mineral conservation	28.5	(3 6°0)	—	—	0.3	(0.0°0)
Spatial surface occupancy	54	(0,7°0)	05	(0.1%)	—	
Other or none	10	(o 100)		—	242.1b)	(30.3 %)
Subtotal non-ANCSA	1272	(15 9°0)	48.4b	(6.1%)	352.4b	(44.0%)
Alaska Native selections,	492	(6.2 %)	.	—	30.8b	(3.9%)
Alaska State selections	—	—	—		55.5b	(6.9%)
ANCSA d-1	300	(3 7°0)		—	414	(5.2%)
ANCSA d-2	650	(8 .1%)	—	—	—	—
Subtotal ANCSA.	1442	(18 O °o)	—	—	127.7b	(16.0%)
Total	271.4	(33. 9%)	48.4b	(6.1%]	480.1b	(60.0)

[a] The Alaska situation was changed in late 1978 by major new executive withdrawals that, according to rough estimates provided to OTA by the Bureau of Land Management's Alaska Native Claims Office, resulted in a net increase (over prior ANCSA withdrawals noted in this table) of approximately 13 million acres (1.6%) in the land formally closed to hardrock mineral development. See appendix B, section O.
[b] *3.6 (0.5%) of the total highly restricted acreage (0.2 in national parks, etc., 0.7 in wild and natural, and 2.7 in agricultural, etc.), and 114.1 (14.3%) of the* total moderate or slight restriction acreage (0.4 in national parks, etc., 0.1 in wild and natural, 27.3 in other or none, 30.8 in Alaska Native, and 55.5 in Alaska State) were formally closed to the Mining Law but available through Federal lease, Native lease, or State location or lease
[c] 9.0 overlaps stricter ANCSA withdrawals and is not included in totals.

of the land, or the land may be closed to development of a few minerals (for example, land open to location of metalliferous minerals only is classified as being moderately restricted for hardrock mineral activity).

The "formally closed" column in each table represents formal withdrawals by Congress or the executive branch. The other columns represent land that has not been withdrawn but may be subject to discretionary restrictions or refusals to lease. Thus, the data in the "formally closed" column can be used to gain a rough idea of the scope of and reasons for withdrawals.

Initially, it can be noted that, excluding the temporary but massive land withdrawals in Alaska under the Alaska Native Claims Settlement Act (ANCSA), but including "normal" withdrawals in Alaska, 11.7 percent of the Federal land was closed to mining of the fossil fuel and fertilizer minerals and 15.9 percent was closed to mining of the hardrock minerals in 1975, These figures do not reflect the relative magnitude of withdrawals under the mineral leasing laws and the Mining Law, since (as indicated in note b in table 5.2), some acreage withdrawn from the operation of the Mining Law nevertheless remained available for hardrock mineral activity under various leasing laws. If this acreage (31.4 million non-ANCSA acres) is added to the "formally closed' column in table 5,2, then the figures do reflect the relative magnitude of withdrawals under the two types of laws: 11.7 percent withdrawn under the mineral leasing laws and 19.8 percent, or almost twice as much, withdrawn under the Mining Law, as of 1975.

The ANCSA data in the tables were based on very rough estimates and assumptions (explained in appendix B). Again, however, it should be noted that the data were based on availability under any law, and not just the Mining Law (in the case of table 5.2) or the Federal mineral leasing laws (in the case of table 5. I). Because of ANCSA requirements, all the ANCSA-related acreage was withdrawn from the operation of all the Federal mineral laws, except for approximately 41.4 million acres of d-l land left open to location of metalliferous minerals only, The ANCSA acreage listed as having been available for mineral activity in the tables was almost all available from the State of Alaska or the Alaskan Natives, as explained in appendix B. The ANCSA data, therefore, are not particularly useful for analyzing normal withdrawal patterns and forces.

The preceding two paragraphs illustrate one major distinction between OTA's analysis of withdrawal statistics and other published analyses:[120] the OTA analysis recognized that land was available for mineral activity (e. g., hardrock activity) if it was available from any source (e.g., Mining Law, Mineral Leasing Act of 1920, special Federal leasing law, Alaska mineral law, or Native contract), rather than classifying land as unavailable simply because it was not available under the usually applicable law (e.g., Mining Law). In addition, the OTA analysis separated out the effect of the ANCSA-related withdrawals since they are a special and unusual case that is not indicative of normal withdrawal forces or trends. Finally, the OTA analysis was based on a more complete compilation and review of available data (see appendix B) than was undertaken for other analyses,

As was noted above, the tables disclose that almost twice as much land was withdrawn from locations under the Mining Law as from mineral leasing, if only normal (non-ANCSA) withdrawals are taken into account. This is not surprising, since withdrawals are the only means of controlling entries under the Mining Law, whereas entries under the mineral leasing laws can be prevented by refusals to lease or restricted through appropriate lease conditions. Land management officials will often withdraw an area from entry under the Mining Law but leave it open to mineral leasing.[121] In some cases (e. g., wildlife refuges) the land is "open" to leasing in theory only, and leases will very rarely be authorized. In other cases, however, the land is genuinely left open to leasing under protective stipulations.[122] The amount of land either formally withdrawn or highly restricted (for example, by policies that discourage leasing or issuance of necessary rights-of-way) is approximately the same for the Mining Law and the mineral leasing laws. (There have been moratoria on the issuance of any new leases for certain minerals under the mineral leasing laws in the last few years.) As more experience is gained with recently initiated attempts to devise appropriate protective stipulations (see subsection E(4)), more land may be truly open to leasing, and less reliance may be placed on the traditional all-or-nothing withdrawal approach.

[120] Bennethum and Lee, "Is Our Account Overdrawn?" *Mining Congress J.*, September 1975, at 33-48; U.S. Department of the Interior, *Mining and Minerals Policy, 1976*, at 81-93 (1976).

[121] E.g., BLM Carson City District, *Fort Churchill-Clan Alpine Land Use Guides, Fort Churchill-Clan Alpine Planning Units, Nevada*, at 13 & 16.

[122] E.g., BLM Las Vegas District, *Virgin Valley Land Use Guide, Virgin Valley Planning Unit, Nevada*, at 18-19.

The "designated use" breakdown in the tables shows that, apart from ANCSA withdrawals, in 1975 only 3.4 percent of the Federal onshore land was closed to mining of the fossil fuel and fertilizer minerals and 6.2 percent to mining of the hardrock minerals for environmental or cultural reasons (parks, recreation areas, historic sites, wildlife protection, and wild and natural areas). About twice as much Federal land was withdrawn for other uses (for example, military use, irrigation projects, and even energy development and mineral conservation). On the other hand, approximately two-thirds of the "highly restricted" category in each table was due to cultural or environmental uses.

The aggregate effect of the withdrawals on mineral exploration, development, and production may be much greater than suggested by the percentages in the tables if, as seems to be the case, the withdrawals often occur in those areas where the geology is most favorable for economic mineralization (see subsection A(3)). On the other hand, the effect of the withdrawals may be less than is indicated because many mineral leases and mining claims exist in the withdrawn areas (having been issued or located prior to the withdrawals). For example, it has been estimated that there are 11,000 uranium mining claims in the Glen Canyon National Recreation Area. In 1975, 82.6 million acres (11.1 percent) of the public domain were under mineral lease, and, estimating very roughly, 80.0 million acres (10.8 percent) were covered by mining claims. It was not possible to determine how much of this acreage was in withdrawn areas.

There is a need for a cumulative State-by-State and nationwide accounting of the use status of Federal land. Such an accounting should permit Federal management of minerals and land to progress beyond its current essentially ad hoc procedures. The land use planning process already underway on Federal land could include a unit-by-unit summary of land status, including withdrawals, which is aggregated at successively higher levels of the relevant agencies and culminates in a comprehensive land status report. Computerization of the land status records at the local level might greatly simplify statistical reporting and increase the accuracy, timeliness, and ease of maintaining those records.

As was indicated above, cultural and environmental protection and preservation motivated only about one-third of the actual closures of Federal land to mining as of 1976. The remaining two-thirds were closed to protect stock driveways, administrative sites, dams, military security, water supplies, physical improvements, opportunities for State and Native selections, and even mineral conservation and development (geothermal resource areas and petroleum and oil shale reserves), The reason for many of these closures was, in essence, a lack of provision in the mineral laws for compensation for nonmineral uses foreclosed by mining. That is, even where mining would be the highest and best use of a tract of land, the Federal Government, like any private landowner, is not willing to permit mining when no compensation would be paid for the destruction of existing valuable improvements (for example, dams, administrative facilities, or substantial recreational facilities) or for the loss, even temporarily, of important nonmineral resources (for example, a watershed that supports a municipal water supply), Many withdrawals for cultural and environmental reasons would not be necessary if appropriate environmental controls could be agreed on and established to protect various types of cultural and environmental values. Similarly, many withdrawals to protect valuable improvements or economically important nonmineral uses would not be necessary if procedures existed whereby miners would compensate for the loss of such improvements or uses.

The "withdrawal problem" is one of the more visible symptoms of the lack of adequate measures for coordinating mineral and nonmineral resource uses on Federal land. The increased removal of Federal land from availability for mineral activities reflects a belief on the part of Congress, the executive branch, and the general public that mineral activities under existing laws and regulations do not properly take account of nonmineral resource values.

The situation appears similar to that which occurred during the first two decades of this century, when the increasing amounts of land being withdrawn from mineral entry forced a reappraisal of the Federal mining laws that eventually resulted in the adoption of a leasing system for the fuel and fertilizer minerals. (It should be noted that the administration of the leasing system has resulted in substantial uncertainty and confusion for both miners and those interested in nonmineral resource protection. See section E.) The issues then were competition, mineral conservation, and a fair return to the Government for its fuel and fertilizer minerals. The issues now are protection of and compensation for the nonmineral resources affected by mining on Federal land.

This discussion suggests that the solution of the "withdrawal problem'" depends not so much on procedural reforms (although such reforms are needed) as on adjustments to the mining and mineral leasing laws that will satisfy the concerns about nonmineral resource values.

H. Summary and Options

This section summarizes the material discussed in the previous sections of this chapter by presenting four major options for consideration. The options are presented in ascending degree of the amount and character of change involved when compared with the existing systems—no changes at all, moderate adjustments to the existing systems, major adjustments to the existing systems, and a shift to integrated mineral and nonmineral resource management. The options, other than the ''no change'" option, are presented in skeletal form in table 1 at the end of the executive summary. In each option other than the "no change'* option, an attempt is made to eliminate unnecessary or duplicative regulation, to address questions of efficiency and equity in other regulations, and, where it seems appropriate, to replace regulatory restrictions with more flexible payment requirements or incentives.

Option 1. The Existing Systems ("No Change" Option)

The existing laws treat mineral exploration, development, and producticm as distinct activities outside the mainstream of the land use planning and management process for Federal onshore land, even though mineral and nonmineral resource uses are unavoidably intertwined. The mineral laws reflect the belief that mineral production is the best use of any tract of land and thus make mineral activity the preferred use on any Federal land that is open to such activity. Except for recent enactments governing coal, the laws contain no explicit procedures for coordinating mineral activities with nonmineral activities.

Regulations have been promulgated under the mining and mineral leasing laws to control the impacts of mineral activities on surface resources. These regulations are couched in broad language and do not contest the miner's preferred right to explore for and develop the minerals in a tract. The regulations are not tailored to varying land characteristics and do not attempt to control the method of development, but rather seek to mitigate its impact on surface resources by relying on negotiated approval of operating plans.

The regulations applicable to activities under the Mining Law do not cover most Federal land. They do not apply to unpatented mining claims outside the national forests or to patented mining claims outside the national parks or wilderness areas. The Forest Service regulations, which were adopted in 1974 against a background of uncertainty about the extent of the Forest Service's authority to control the impacts of Mining Law activities, have minimal sanctions, do not require filing of notices of activity by most mineral explorers, and are sometimes hesitantly enforced. However, the Forest Service has imposed and enforced strict surface protection requirements in certain areas.

Many provisions in the Mining Law result in unnecessary damage to surface resources and disruption of surface use and management. For example, the Federal and State claim marking and work requirements (including State discovery work requirements and Federal pedis possessio and assessment work requirements) require a mineral explorer to disturb the surface without any benefits necessarily being obtained in terms of efficient or diligent mineral activity. The pedis possessio requirements also encourage mineral explorers to attempt to prevent use of the surface by others. The irregular shapes of claims, coupled with the miner's right to acquire title to the surface as well as to the minerals, lead to a jigsaw pattern of surface ownership that can frustrate efficient planning and management of surface use. Federal land use planning and management are further inhibited by the knowledge that any plan or use can be preempted at any time by mineral activities under the Mining Law, unless the land is withdrawn from mineral entry, or even by nonmineral activities on a nearby patented claim. Medium- or long-range land use planning is also inhibited under the mineral leasing laws when leases are issued or can be renewed for indefinite periods without any production.

On the other hand, because the regulatory controls on mineral activities under the existing laws, although generally weak, are broadly worded and applied in an ad hoc manner to specific mineral projects, they can create considerable uncertainty with respect to the requirements that will actually be imposed on a particular project, Technically, the controls cannot go beyond the restrictions expressed or implied in the governing regulations (or lease), and they cannot substantially interfere with the miner's right to develop the mineral deposit as he sees fit. But the broad wording of the regulations, together with the miner's desire to avoid the delays involved in administrative or judicial appeals, give the responsible Federal officer considerable leverage to delay, or impose substantial restrictions on, mineral activities. Furthermore, strict conditions can be imposed on nonfuel mineral projects under the leasing laws after exploration and before development, even if such conditions would make development and production uneconomic, since a lease is required for development and production after successful exploration under a prospecting permit.

Additional uncertainty with respect to mineral tenure results from the use of the "discovery of a valuable mineral deposit" test for acquiring development and production rights to any mineral under the Mining Law and to nonfuel minerals under the leasing laws. Under the present interpretation of the test, nonmineral values are not balanced directly against mineral values in order to decide whether mineral development and production rights should be granted, although such a comparative value test has been used in the past and could enjoy a resurgence. However, some nonmineral values are considered indirectly to the extent that regulations protecting such values impose costs on the miner. Such costs are included in an increasingly comprehensive definition of the considerations a prudent miner would take into account in deciding whether a mineral deposit is valuable. This indirect approach must necessarily leave out a fairly large range of nonmineral values, Thus it does not go far enough, in the opinion of surface resource users, On the other hand, miners believe that it goes too far in second-guessing their profitability calculations and exposing them to the danger of losing tenure after considerable effort has been spent on exploration,

Activities under the mining and mineral leasing laws are subject to Federal and State air quality, water quality, toxic substances control, and other environmental laws of a general nature that impose stringent requirements for mitigation of certain impacts resulting from mineral activity. However, these general environmental laws do not reach the central issues of land resource allocation and use that are at the core of today's debate over Federal mineral land management.

Existing laws require very few payments for damage to or appropriation of nonmineral resources. Payments of $2.50 or $5 per acre are required to obtain title to the surface under the Mining Law, and annual rentals of only $0.25 to $2 per acre are required under the leasing laws. In addition, bonds to insure reclamation, if feasible, and payments for damages to privately owned crops, agricultural improvements, and grazing values may be required, These payment requirements are not sufficient to ensure proper balancing of mineral and nonmineral resource values,

The lack of adequate regulatory or payment mechanisms under the existing laws has been partially responsible for the withdrawal of increasing amounts of Federal land from the operation of the mining and mineral leasing laws in recent years, Formal withdrawals of land from the operation of the Mining Law have been almost double those under the leasing laws, if only normal withdrawals are taken into account (that is, omitting the unique situation posed by ANCSA). (See section G for the calculations and analysis.) This is because initial access to land for mineral activities under the Mining Law is a statutory right that can be blocked only by withdrawal, while initial access under the leasing laws is at the discretion of the Secretary of the Interior, who can block access by refusals to lease as well as by formal withdrawals, The amount of land either formally withdrawn or highly restricted (for example, by policies that discourage leasing or issuance of necessary rights-of-way) is approximately the same for the Mining Law and the mineral leasing laws. Withdrawals and antileasing restrictions continue to be made, and are maintained, to protect mineral and nonmineral resource uses and values that Congress or the executive branch believes are inadequately protected by existing regulations and payment requirements. Mineral activity is thereby completely precluded, even though properly restricted mineral activities might be entirely compatible with protection of such uses and values.

Conversely, mineral activity continues to be the preferred use on nonwithdrawn land under the Mining Law and on leased land under the leasing laws. Mineral rights, once acquired, override all nonmineral resource values, regardless of the relative values of the mineral and nonmineral resources, Mineral rights may be acquired by simply staking out a claim under the Mining Law, Advance notice to or permission from the Federal or private surface owner is not required. The Secretary's discretion to grant access under the leasing laws may be exercised, as it was until very recently, routinely in favor of granting access, with little attention paid to the potential impact on nonmineral resources, except in those few cases where access must also be approved by the Federal agency responsible for management of the surface,

The Mining Law has been abused by persons who are not interested in mineral activity but rather want to make use of or even obtain title to the surface. This abuse has been made possible by the absolute right of entry under the law, the very weak and practically unenforceable controls over diligent activity, and the lack of adequate controls over use of the surface. Even though some actions have been taken to curb this abuse, such as removing common-variety minerals from location under the Mining Law and requiring all claims to be recorded at the Federal land office, some abuse remains because of the underlying difficulties with enforcing provisions of the Mining Law.

Option 2. Moderate Adjustments to the Existing Distinct Systems

Almost all the moderate adjustments discussed in section G of chapter 4, dealing with improved coordination of mineral activities undertaken by different individuals and firms, could also improve coordination of mineral activities with nonmineral activities.

For example, unnecessary surface damage, jigsaw land use patterns, and uncertainty about land status are caused by existing Federal and State claim location and marking requirements under the Mining Law. These problems could be greatly reduced by replacing the physical location procedures with filings in the local Federal land office according to subdivisions of the public land surveys. For unsurveyed land, claims could be required to be rectangular in shape, oriented north-south or east-west, and depicted and described (through reference to permanent physical features) on the best available map of the area, A survey of the claim could be required as a precondition to development. The surface damage attributable to unproductive pedis possessio and assessment work requirements under the Mining Law could be reduced by replacing the maximum size limits on individual claims with generous limits on the size of an area that could be treated as a unit for the purpose of satisfying work requirements, and by allowing payments in lieu of actual work and "banking" of excess work. Payments for mineral value comparable in magnitude to those required by non-Federal landowners could be instituted to avoid possible underpricing and inefficient use of Federal land.

Similar adjustments, also described in section G of chapter 4, could be made to maximum acreage limits, work requirements, and payments for mineral value under the mineral leasing laws,

The remaining adjustments outlined in section G of chapter 4, such as minimum sizes for mining claims and mineral leases, time limits on development tenure, and produce-or-pay conditions on production tenure, would make it easier to keep track of land status and would prevent land from being held indefinitely without any development or production.

Other adjustments could also be made that would improve coordination of mineral and nonmineral activities without making major changes in the existing systems. For example, the existing requirement of consent by the surface management agency to issuance of leases for certain minerals on certain lands could be extended to leases for all minerals on all lands. (The requirement would not apply to mining claims under the Mining Law.) Ad hoc, broadly worded surface use regulations, similar to those now in existence for some mining claims and all leases, could be applied across the board to mineral activities on all lands under all the Federal mineral laws. Such regulations could include a prohibition on any residential use of the surface of a mining claim or mineral lease without permission from the surface management agency or surface owner, No surface-disturbing mineral activity could proceed without first filing a notice of intent with the surface management agency or surface owner,

These adjustments would eliminate or revise many regulations that cause needless and unproductive expense to the miner and unnecessary adverse impacts on nonmineral resources, particularly under the Mining Law. They would also reduce some of the uncertainty over land use management and planning under the existing systems by placing some diligence-related conditions on the duration of mineral tenure and by making all mineral activities subject to Forest Service-type regulations requiring limited mitigation of impacts on surface resources.

However, the adjustments would not resolve the most serious problems involved in coordinating mineral activities with nonmineral activities under the existing systems. On the one hand, they would not reduce miners' uncertainty about nonmineral resource-related controls over mineral access and tenure, On the other hand, they would not affect any person's absolute right to locate mining claims on any nonwithdrawn area of the public domain, and to obtain ownership of the surface as well as the minerals on discovery of a valuable mineral deposit. Nor would they affect the absolute preference given to mineral activity on any land covered by a mining claim or mineral lease. Mineral rights, once acquired, would continue to override all nonmineral resource values. Thus, the adjustments would not significantly reduce the pressure for withdrawals of land from mineral activity in order to protect mineral and nonmineral resource values.

Some additional moderate adjustments could be made to lessen slightly the adverse effect that withdrawals have on mineral availability. Stale withdrawals no longer needed to protect nonmineral resource values could be identified and eliminated through a better withdrawal review program. Or, if such a program would be impractical because of the poor condition of land records, a fresh start could be made by terminating all withdrawals, except those made by Congress, that are not confirmed by the responsible agency within a certain number of years—a sort of re-recordation requirement for withdrawals analogous to the recordation requirement for mining claims. But the latter approach would run the risk of inadvertently leaving important nonmineral resources unprotected.

In addition, some continuing mineral appraisal activity on withdrawn lands could be provided through a specific Government program for periodic assessment of the mineral resource potential of such lands. The program might include detailed Government exploration and evaluation needed to decide whether certain withdrawn land should be reopened to private mineral activity,

Option 3. Major Adjustments to the Existing Distinct Systems

Several of the most serious problems involved in coordinating mineral activities with nonmineral activities under the existing systems would be eliminated by the major adjustments described in section G of chapter 4 for improved coordination of mineral activities considered by themselves. These include: replacing pedis possessio exploration tenure under the Mining Law with a secure, limited-in-duration exploration right; establishing more realistic, flexible, and enforceable work requirements under the mining and leasing laws; eliminating the ‘‘discovery of a valuable mineral deposit” test for acquiring development and production tenure under the laws; limiting patents (fee title) under the Mining Law to the minerals in the claimed land, with a right to use the surface for mining-related purposes upon payment of rentals: and eliminating or restricting overriding royalties.

Two of the above adjustments— the elimination of the “discovery of a valuable mineral deposit” test under the mining and mineral leasing laws and the provision of secure exploration tenure under the Mining Law— would greatly reduce the uncertainty now faced by explorers and miners under the mining and leasing laws. An analogous adjustment would make the “preference right to a lease” for successful prospectors under the leasing laws a clear option exercisable by the prospector, rather than a mere right of first refusal should the Government decide to issue a development-production lease. These adjustments, however, would eliminate some of the most important protections of nonmineral values that now exist (see, e.g., subsection D(5)). To compensate for the loss of these protections, the statutory right of access under the Mining Law could be converted to access at the discretion of the Secretary of the interior or the surface management agency, or both, as is now the case under the leasing and sale laws. (Unlike now, the access under each law, once granted, would be secure for exploration, development, and production.) In addition, the surface use regulations under each law could be strengthened. The surface management agencies could be given clear authority to control the surface impacts of mineral activity, including the power to prohibit some or all surface impacts when necessary to protect important surface values. Finally, miners could be required to pay for damage to some publicly owned as well as privately owned surface resources and facilities in order to encourage mineral activity that is efficient from the standpoint of total resource use,

These adjustments could provide for better balancing of mineral and nonmineral resource values than occurs under the existing systems. They would substantially reduce the need to rely on the withdrawal power to protect nonmineral resource values. They would also greatly reduce the uncertainty that currently exists with respect to maintaining exploration tenure under the Mining Law and acquiring development and production tenure for the nonfuel minerals under the mining and mineral leasing laws.

However, there still would be considerable uncertainty about the acquisition of exploration tenure and about the specific nonmineral resource protection requirements that would be applied after tenure is acquired in any particular case. Perhaps these uncertainties could be reduced by guidelines limiting the Government's discretion over access and over specification of nonmineral resource protection requirements after access is granted. But excessively restrictive guidelines would not adequately protect nonmineral resource values, given the current broad nature of nonmineral resource protection requirements.

Option 4. A Shift to Integrated Mineral and Nonmineral Resource Management

The adjustments listed in the two preceding options do not resolve the fundamental dilemma of how to provide for open access to and secure tenure on Federal lands for private mineral exploration, development, and production while also assuring proper balancing of mineral and nonmineral resource values during each stage of mineral activity (see subsection C(4)).

One approach that might go a long way toward resolving this fundamental dilemma would build on the emerging practice of basing surface use restrictions under the leasing laws on analysis of the land types and land use characteristics of particular areas, In certain instances, these area-specific restrictions have been developed and promulgated as part of the normal land use planning process.

Surface use restrictions tied to land classifications established by the surface management agencies as part of their normal land use planning process might provide greater assurance of adequate protection of nonmineral resource values on Federal land, since such restrictions could vary for different areas to take account of the vast differences in surface values and their sensitivity to disruption from mining. Because the restrictions would be much more specific and localized and would be published in advance in the land use plan for an area, they should also greatly reduce mineral explorers' and producers' uncertainty about the surface use conditions applicable to the various stages and types of mineral activity in the area, If specific restrictions tied to land types and values in an area could be devised and promulgated as part of the normal land use planning process, and if such restrictions were adequate to protect the important nonmineral resource values in the area, there should be much less pressure for withdrawal of land from mineral activity. Moreover, there should be much less need for making the acquisition of mineral rights depend on the discretion of the Secretary of the Interior or the surface management agency. Once the new system was firmly in place, access to Federal land under the mineral laws could be made nondiscretionary, and many, if not all, of the existing withdrawals perhaps could be revoked. Access to certain areas might still be very highly restricted in order to protect very important nonmineral resource values, but it would not be completely precluded.

A surface use restriction might be too protective for the less unusual nonmineral resource values, because a restriction could not be violated no matter how valuable or potentially valuable the mineral resources in an area might be. This problem can be overcome, in part, by relaxing the restrictions that protect these less unusual nonmineral resource values as mineral activity successfully progresses from exploration through production. For example, there might be severe limits on or even prohibitions against roadbuilding or other types of surface disturbance in certain areas during exploration, which would be relaxed or eliminated for development and production.

For the easier-to-value nonmineral resources, surface use restrictions might be replaced entirely by compensation requirements. A schedule of payments could be developed along with the surface use restrictions as part of the land use planning process for an area, with some nonmineral resources values being absolutely protected through restrictions and others being conditionally protected through compensation requirements. The individual explorer or miner could decide on his own whether the potential mineral values were worth the cost of paying for damage to the conditionally protected nonmineral resource values, and he could structure his project to minimize such required compensation by minimizing the damage.

In sum, this option would replace the existing open-ended and broadly worded surface use regulations promulgated primarily at the national level with more specific and predictable conditions tied to land types and uses at the local level, substitute flexible charges for absolute restrictions where appropriate, and ensure open access and secure tenure once such conditions and charges were firmly in place.

6.

Coordinating Federal, State, and Local Controls and Payment Requirements

6.

Coordinating Federal, State, and Local Controls and Payment Requirements

The institutional setting of mineral management on Federal land—that is, the division of authority horizontally among the Federal agencies and vertically between the Federal and State governments—is as critical as the substantive content of the laws.

The division of authority among the Federal agencies has been based on a questionable distinction between “mineral” or “economic” aspects and “nonmineral” or “land management” aspects of natural resource management, with adverse effects on efficient, integrated management of Federal resources.

The States have considerable authority under the Federal mineral laws to regulate and tax private mineral activities on Federal land. Except for the States’ anachronistic authority over tenure requirements under the Mining Law, the present structure of Federal and State regulatory authority seems to be working fairly well, although continued improvements in coordination would be helpful. Current methods and levels of State taxation, however, may cause waste of Federal mineral and nonmineral resources.

State mineral taxes can and apparently do provide enough revenue to cope with the adverse socioeconomic impacts of mineral activities. The problem is timely distribution of a State’s revenues to its impacted communities. Federal mineral revenues provided to the producing States are not needed and so far have not been used to cope with adverse socioeconomic impacts and, therefore, subsidize the general spending programs of these States.

A. Federal Interagency Coordination

1. Agency Responsibilities Prior to Enactment of the Department of Energy Organization Act

All minerals in Federal land, except uranium leased on certain types of land by the Department of Energy and common-variety minerals (sand, gravel, etc.) sold by the Department of Agriculture on land under its jurisdiction, are disposed of under laws administered by the Department of the Interior.

The Secretary of the Interior's authority under the Mining Law generally is limited to determining whether valuable mineral deposits have been discovered by a mining claimant and to requiring limited mitigation of the mineral activity's impact on nonmineral resources before a patent is issued. The authority to require limited mitigation of impact on nonmineral resources is shared with the Secretary of Agriculture for national forest land. No coordination problems have yet arisen, since only the Secretary of Agriculture has actually issued regulations requiring mitigating measures to be undertaken.[1]

For minerals subject to disposal under the mineral leasing laws, the Secretary of the Interior has broad authority to establish procedures for mineral lease acquisition, approve or disapprove lease applications, insert lease conditions, require diligent exploration and development, set rentals and royalties, approve or disapprove mining plans, and generally take whatever actions he deems necessary to promote efficient and competitive mineral operations that take into account optimum use of all mineral and nonmineral resources on Federal (and non-Federal) land. The Secretary's authority has been delegated to and is split between two Interior agencies: the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS). (The new Office of Surface Mining has been given responsibility for supervising reclamation of the surface impacts of coal mining on Federal lands.)

The current division of responsibilities between BLM and USGS for mineral leasing on onshore Federal land is specified in Secretarial Order No. 2948.[2] Generally, the order makes BLM responsible for (a) deciding whether mineral leases will be issued and (b) formulating lease requirements for nonmineral resource protection and reclamation, It makes USGS responsible for (c) formulating lease requirements for diligent mineral activities and payments for mineral value and (d) supervising and inspecting mineral operations under a lease.

More specifically, BLM is responsible for processing lease applications, formulating lease requirements for nonmineral resource protection and reclamation, issuing leases or disapproving lease applications, handling and recording lease transactions, approving or disapproving surface uses outside the actual operating area defined in an exploration or mining plan, collecting rentals, and conducting inspections to ensure compliance with nonmineral resource protection requirements outside the operating area.

USGS, on the other hand, is responsible for identifying and classifying known mineral areas, evaluating specific mineral resources prior to lease issuance, providing geologic, engineering, economic, and other technical mineral resource expertise to BLM, formulating engineering and economic lease requirements (rentals, royalties, bonds, unit values, parceling, diligent development, conservation, minimum production, and all other operating requirements), collecting royalties, supervising mineral operations, approving or disapproving exploration and mining plans in the leased area, conducting inspections to ensure compliance with all (mineral and nonmineral)

[1] See ch. 5, subsec. D(2)(b).

[2] U.S. Department of the Interior, "Division of Responsibility Between the Bureau of Land Management and the Geological Survey for Administration of the Mineral Leasing Laws—Onshore," Secretarial Order No. 2948, Oct. 6, 1972.

lease requirements in the operating area, and ordering remedial action or referring leases to BLM for cancellation because of noncompliance with lease requirements.

In sum, BLM is primarily responsible for the multiple-use land management aspects of mineral leasing, while USGS is primarily responsible for the technical mineral operation aspects, Thus, BLM has the responsibility for approving leases and USGS has the responsibility for approving exploration and mining plans under leases, but neither agency can grant an approval that is inconsistent with the recommendations of the other agency in the other agency's primary area of responsibility. Disagreements are resolved by the Assistant Secretaries responsible for each agency, or, if the Assistant Secretaries should disagree, by the Under Secretary.

One apparent flaw in the Secretarial order is the complete removal of BLM from the supervision and inspection of the mineral operation's effects on nonrnineral resources after a lease has been issued. BLM, not USGS, is the agency with the nonmineral resource expertise, but USGS is given sole authority for supervising mineral operations and conducting inspections to assure compliance with all mineral and nonminerUI lease requirements in the operating area.

A less obvious flaw in the Secretarial order is the questionable distinction it draws between the mineral resource aspects of mineral leasing, which are made the sole responsibility of USGS, and the multiple-use land management aspects, which are made the sole responsibility of BLM, at least prior to issuance of a lease (see the previous paragraph), As is discussed in chapter 4,[3] many of the "mineral engineering and economics" terms and conditions of a mineral lease (payment, diligent exploration and development, mineral conservation, minimum production, continuous production, and other performance requirements and incentives), if improperly specified, can result in substantial unnecessary damage to nonmineral resources and prevention or disruption of nonmineral resource planning, development, and management.

In practice, USGS and BLM have overcome these flaws by blurring the sharp distinctions made in the Secretarial order, at least when the land being leased is under the jurisdiction of BLM rather than some other surface management agency (e.g., the Forest Service). Working agreements entered into by the two agencies generally maintain the specified division of expertise, but recognize that each agency's expertise is insufficient to carry out its designated functions. The agencies pool their expertise to draw up lease terms and conditions (e.g., rentals, royalties, bonds, diligence requirements, and environmental protection and reclamation conditions), evaluate resources and select tracts for leasing, review operating plans, and conduct lease inspections.[4]

USGS's responsibilities under the Federal mineral laws are handled by a distinct division, the Conservation Division, whose only other responsibility is the identification and classification of water powersites. BLM's mineral responsibilities, on the other hand, although focused in its Division of Minerals Management, necessarily draw upon the full expertise of the agency in land and resources management. Both the USGS Conservation Division and BLM administer the leasing of phosphate, potash,

[3] Ch. 4, subsecs. F(3) and F(4).

[4] U.S. Bureau of Land Management and U.S. Geological Survey, "Cooperative Procedures Pertaining to Onshore Oil, Gas and Geothermal Resources Operations," Aug. 29, 1975, and "Working Agreement, BLM-GS Onshore Mineral Lease Operations Exclusive of Oil, Gas, Geothermal, and Oil Shale," Nov. 24, 1976.

sulfur, sodium, geothermal steam, and the fossil fuel minerals on public domain land and the leasing of all minerals on acquired land. BLM is solely responsible for administering claims to nonleasable minerals under the Mining Law on public domain land.’

The national offices of the USGS Conservation Division and BLM provicie overall policy and guidance for the administration of mineral activities on Federal land. The actual detailed administration of individual leases, however, including tract selection, rentals, royalties, bonds, formulation of lease terms and conditions, issuance of leases, approval of operating plans, and supervision and inspection of operations, is handled by field offices of the two agencies scattered throughout the United States. Only the field offices have the detailed knowledge of mineral and nonmineral resources in an area necessary for responsible decisions on whether to lease and under what conditions.

BLM has 11 State offices and 56 district offices in the 11 contiguous Western States and Alaska, which contain 93 percent of the onshore Federal land, and an Eastern States’ office with two satellite offices. These State and district offices are responsible for the management of all mineral and nonmineral resources on 470 million acres of BLM land, which constitute about 62 percent of the total onshore Federal landholdings, and for the management of the mineral resources only on the 290 million acres of onshore Federal land controlled by other Federal agencies and the 63 million acres of non-Federal onshore land for which the Federal Government has reserved all or some mineral rights.

The USGS Conservation Division has 3 regional offices, 6 Area Oil and Gas Supervisor offices with 13 subsidiary district offices, 6 Area Mining Supervisor offices with 7 subsidiary district offices, 7 Area Geologist offices with 6 subsidiary district offices, an Area Geothermal Supervisor office with 3 subsidiary district offices, and an Area Oil Shale Supervisor office with no subsidiary district offices. The Area Supervisor and Geologist offices, with their subsidiary district offices, work with the BLM State and district offices to gather mineral resource data and manage mineral activities on all 760 million acres of Federal onshore land and the 63 million acres of non-Federal onshore land for which the Federal Government has reserved all or some mineral rights.

The area and district offices of the Area Oil and Gas, Geothermal, and Oil Shale Supervisors have responsibility for management of onshore oil and gas, geothermal steam, and oil shale, respectively. The area and district offices of the Area Mining Supervisors have responsibility for the management of all other onshore leasable minerals: coal, phosphate, potash, sodium, and sulfur on public domain land and all minerals (other than oil, gas, geothermal steam, and oil shale) on acquired land, The area and district offices of the Area Geologists provide geologic expertise for management of all onshore minerals.

The United States Geological Survey Conservation Division and BLM are responsible for offshore (OCS) mineral leasing, under divisions of responsibility very similar to those described in the text for onshore leasable minerals. The offshore mineral leasing programs are administered in both agencies by program offices distinct from those administering onshore mineral programs, and overall policy direction is provided by the Assistant Secretary of the Interior for Program Development and Budget, rather than by the Assistant Secretaries responsible for USGS and BLM.

For the 290 million acres of onshore Federal land under the surface management of an agency other than BLM, BLM's and USGS's mineral management activities are coordinated at the field level with the surface management activities of those agencies. The largest Federal land management agency other than BLM is the Forest Service, which manages 187 million acres of national forests and grasslands, or about 25 percent of the total onshore Federal landholdings. Other major Federal land management agencies include the Fish and Wildlife Service, the National Park Service, and the Bureau of Reclamation in the Department of the Interior (over 63 million acres total): the Armed Services, including the Corps of Engineers, in the Department of Defense (almost 31 million acres total): the Department of Energy (over 2 million acres, on which it conducts a uranium leasing program); and the Tennessee Valley Authority (almost 1 million acres)."

When a Federal agency other than BLM has jurisdiction over the surface of land to be leased for mineral activity, BLM ordinarily will issue the lease only with the consent of that agency and subject to nonmineral resource-related conditions it specifies. This deference to the surface management agency is founded on sound principles of multiple-use land management, As President Ford stated in one of his last reports to Congress: "It is not reasonable to assign land management responsibility to one department and, at the same time, empower another department to arrange and manage leases for one particular and major form of utilizing those assets."" However, perhaps because of oversight," an express requirement of consent by the surface management agency to issuance of leases for land under its jurisdiction was not included in the Mineral Leasing Act of 1920, Such a requirement has been included in all major revisions of or additions to the mineral leasing laws since 1940, Thus, a lease may be issued only with the consent of the surface management agency, and subject to such conditions as it may require to ensure adequate utilization of the land for the purposes for which it was acquired or is being administered, if the lease is on acquired (rather than public domain) land, if it is on land withdrawn or reserved for military use, if it is for geothermal steam in land under the surface jurisdiction of the Department of Agriculture or in land subject to an application for a Federal Energy Resources Commission permit or license, or if it is for coal in any Federal land.'

There is no obvious reason for preserving the distinction between those instances in which consent by the surface management agency is required and those in which it is not. The distinction can be explained only by reference to the history of the Federal mineral laws. As President Ford stated, the land management agency should have the power to veto mineral leases that will be detrimental to overall mineral and nonmineral resource management. Thus, the requirement of consent by the surface management agency should be extended to all mineral leases, together with the authority of the surface management agency to insert provisions in the lease to ensure proper balancing of mineral and nonmineral resource values and uses,

"The acreage figures cited in this and the preceding paragraphs are from U.S. Bureau of Land Management, *Public Land Statistics, 1976*, tables 9 and 17 (1977).

'*The Organization of Federal Energy Functions, A Report From the President to the Congress*, January 1977, at 44 (hereinafter cited as *Ford Administration Energy Organization Report*).

"See the exchange among Representatives Hernandez, Ferris, and Lenroot in 53 Cong. Rec. 1224 (daily ed. Jan. 14, 1916).

'Reorganization Plan No. 3 of 1946, § 402, 60 Stat. 1099 (1946) and 30 U.S.C. § 352 (1976) (acquired land); 30 U.S.C. § 201 (a)(3)(A)(iii) (1976) (coal); ibid., § 1014(b) (geothermal steam); 43 U.S.C. § 158 (1976) (military land).

There are strong reasons for not only giving the surface management agency veto authority over mineral leasing, but also entrusting it with all or most of the mineral leasing function for land under its jurisdiction. First of all, responsibility for mineral leasing decisions would be clearly placed in one spot, rather than being split between BLM and the surface management agency, as occurs now. Controversial decisions, such as those related to the preference-right phosphate lease applications in the Los Padres and Osceola National Forests, could not be passed back and forth between the agencies, with each hoping the other would make the difficult decision. Second, the responsibility would be placed with the agency most familiar with the status of the land, the geology of and mineral activity on and around specific tracts, the legal restrictions (such as water power, watershed, or wildlife protections mandated by law) affecting the availability of mineral resources from those tracts, and the relative value of mineral and nonmineral resources on those tracts. Tract selection and evaluation for mineral leasing purposes could be based from the start on multiple-use evaluation and planning, which is the critical concern with, for example, the vast known deposits of Federal coal and oil shale, thereby avoiding wasted time and effort on tracts that will be vetoed by the surface management agency if initial selection is left to another agency, Third, if the surface management agency is given jurisdiction over the mineral resources as well as the nonmineral resources, it will have an incentive, now lacking, to give due weight to mineral resources in its resource inventory, management, and planning programs. Fourth, only such joint jurisdiction over mineral and nonmineral resources in a tract can assure the integrated total-resource perspective mandated by Congress in recent enactments such as the Geothermal Steam Act of 1970, the Federal Coal Leasing Amendments Act of 1976, and the Federal Land Policy and Management Act of 1976.

An objection may be raised that the surface management agencies do not have sufficent mineral expertise to accept responsibility for mineral leasing on their own land. But neither does BLM, which is now responsible for all mineral leasing. BLM relies on USGS for mineral resource evaluations and recommendations on mineral-related lease provisions. USGS could just as easily provide the evaluations and recommendations to the surface management agency.

There may also be an objection that the dispersion of mineral leasing authority to each surface management agency would prevent formulation of comprehensive mineral resource development programs, adoption of uniform procedures, and collection of comprehensive data on Federal mineral resources. But the data have always been in the local offices of the surface management agencies or have been collected by USGS and the U.S. Bureau of Mines rather than BLM, USGS could serve as the central repository of mineral resource and development information. It could also encourage uniformity through its mineral tract evaluations and recommendations on specific lease provisions, and an interagency committee chaired by USGS could draft standard forms and publish handbooks and other materials to share information and promote uniformit y.

Comprehensive mineral resource development programs are difficult to implement no matter who has responsibility for mineral leasing, particularly when, as is currently the case, each surface management agency has the express or de facto authority to veto tracts selected for mineral leasing. Yet, removal of this veto authority could severely undermine multiple-use land management.

Moreover, if comprehensive mineral resource development programs for Federal land are to be meaningful, they must be based on realistic assessments of mineral resource potential and availability on Federal land, and they must be implemented through explicit linkages to land management and mineral research plans and programs. Only the surface management agencies, assisted by USGS, are in a position to assess the availability of mineral resources on Federal land in the light of geology, laws, administrative requirements, relative resource values, and so forth; and only they are in a position to implement development programs through the ongoing land management process.

Finally, comprehensive mineral resource development programs can be devised and implemented without divorcing the mineral leasing function from the land management process of which it is an integral part. A useful model is the resource assessment and long-range planning program mandated for renewable natural resources (for example, forest and range) by the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended.[10] The Act directs the Secretary of Agriculture to develop a long-range program for the Nation's renewable resources that will assure an adequate supply of such resources in the future while maintaining the integrity and quality of the environment, The Act specifically required an immediate assessment of the Nation's renewable resource situation and a recommended plan of action based on that assessment, followed by revised assessments every decade and revised plans every half-decade. The recommended plans are to be chosen from a set of alternatives encompassing the range of choices that could be made. The consequences of various courses of action, as well as the costs of implementing each alternative, must be described. Evaluation of the potential effect of proposed actions on the environment is an integral part of the planning process.

The assessments and plans are the responsibility of the Forest Service, and the plans provide national direction for all three arms of the Forest Service organization: the National Forest System, which administers the federally owned national forests and grasslands: State and Private Forestry, which assists and cooperates with managers of State and privately owned forest and related land; and Research, which finds improved ways to manage timber and forest rangelands.

The renewable resource assessment is based on aggregate data compiled by the Forest Service and other Federal agencies from various sources. It forms the basis for tentative policies, objectives, and goals for each arm of the Forest Service, and in particular for tentative renewable resources production goals for the National Forest System. These tentative goals are passed down through the regional, area, forest, and district offices of the System, where they are disaggregated and revised into successively more detailed objectives based on access to more detailed data on land resource status and capabilities and multiple-use considerations contained in local land management plans. Program proposals are formulated at the district level, where the most information is available, and percolate back up through the system until they are final-

[10] 16 U.S.C. §§ 1600-1614 (1976).

ly combined into a national program. Program actions and funding levels in the national program, once approved, are divided into allocations to the various districts.

The formulation and implementation of realistic mineral production goals for Federal land, if this were desired, would require a similar procedure. Tentative targets established by USGS or some more broadly scoped mineral policy agency, based on a national mineral supply-and-demand assessment and a plan for research, development, and production, would be a statutorily mandated part of the national direction for all Federal land management programs. Each Federal land management agency would be required to produce a recommended leasing program within a specified period of time (for example, 1 year) to meet its allocated portion of national mineral production. The recommended leasing program would contain explicit leasing schedules and acreages, broken down to the district level, and would be based on a discussion of alternatives and the fiscal, environmental, resource conservation, socioeconomic, and other consequences of each alternative. Should a recommended program deviate from the tentative targets established by the Mineral Policy Agency and be unacceptable to that agency, the President would make the final decision.

This procedure would permit establishment of a comprehensive mineral leasing program and would provide an effective mechanism for implementation of the program. At the same time, it would assure leasing schedules that were realistically based on detailed on-the-ground data and expertise and were consistent with balanced land management for optimum mineral and nonmineral resource use. Thus, realistic comprehensive mineral leasing programs may not only allow but also require the mineral leasing function to be integrated into the land management process of each surface management agency.

There is some question, however, whether "comprehensive mineral leasing programs" make sense. Unlike the renewable resources, the location of almost all mineral resources is unknown, so that the allocation of "leasing targets" is speculative. Even for those minerals, such as onshore coal and oil shale, which are known to exist in large quantities in certain areas, leasing does not automatically guarantee production. Consequently, leasing targets based on production goals are often no more than guesswork.

For all mineral leases, no matter which Federal agency has jurisdiction over the surface, USGS now has the primary and, in some instances, the sole responsibility for inspecting mineral operations under the lease and enforcing compliance with the lease terms and conditions, including terms and conditions inserted at the request of the surface management agency. (Surface impacts of coal-mining operations are the responsibility of the new Office of Surface Mining in the Department of the Interior.) It is not at all clear that USGS should have this responsibility.[11] One of the basic missions of USGS is the investigation, identification, and encouragement of development of the mineral resources of the United States. The agency responsible for inspecting mineral operations and enforcing compliance with laws, regulations, and lease terms designed to protect the Government's interest in its mineral and nonmineral resources probably

[11] U.S. National Aeronautics and Space Administration, *Onshore Lease Management Program Study for the U.S. Geological Survey* 73-74 (1974).

should not also be primarily responsible for furthering mineral investigation and development. Yet that is the position USGS is placed in, Similar conflicts in the recent past have led to removal of mine health and safety responsibility from the U.S. Bureau of Mines to the Mining Enforcement and Safety Administration (and most recently to the Mine Safety and Health Administration in the Department of Labor) and transfer of the U.S. Atomic Energy Commission's responsibilities for development and regulation of nuclear power to two separate agencies, one (the Department of Energy) responsible for development and the other (the Nuclear Regulatory Commission) responsible for regulation.

It seems that the surface management agency, which has responsibility for the nonmineral resources on the leased tract, should have at least joint, if not sole, responsibility for inspecting operations under the lease and enforcing lease terms, As was noted above, BLM has joint responsibility with USGS for land under BLM's jurisdiction, despite the provisions of Secretarial Order No. 2948.

2. The Effect of the Department of Energy Organization Act

The Department of Energy Organization Act, enacted in 1977, transferred certain aspects of onshore energy mineral leasing from the Department of the Interior to the new Department of Energy. The transfer is likely to create serious coordination problems and disrupt the trend toward integrated total-resource management, with only minimal, if any, contribution to the primary functions of the Department of Energy.

Subsection 302(b) of the Act transfers to and vests in the Secretary of Energy the functions of the Secretary of the Interior to promulgate regulations under the Federal mineral leasing laws and the Energy Policy and Conservation Act that relate to the—

(1) fostering of competition for Federal leases (including, but not limited to, prohibition on bidding for development right by certain types of joint ventures):
(2) implementation of alternative bidding systems authorized for the award of Federal leases;
(3) establishment of diligence requirements for operations conducted on Federal leases (including, but not limited to, procedures relating to the granting or ordering by the Secretary of the Interior of suspension of operations or production as they relate to such requirements);
(4) setting rates of production for Federal leases; and
(5) specifying the procedures, terms, and conditions for the acquisition and disposition of Federal royalty interests taken in kind.[13]

Subsection 302(b) transfers only the authority to issue regulations relating to the five listed functions. However, subsection 302(c) transfers the authority to actually establish production rates for each and every Federal lease, in addition to the authority transferred in subsection 302(b)(4) to issue regulations relating to establishment of such production rates.[14] Moreover, subsection 303(c) requires the Secretary of the Interior to afford the Secretary of Energy at least 30 days prior to publication or other prescription of the terms and conditions of any Federal lease in which to disapprove

[12] Ibid., at 52-85.
[13] 42 U.S.C. § 7152(b) (Supp. I 1977).
[14] Ibid., § 7152(c).

any term or condition of such lease that relates to any matter with respect to which the Secretary of Energy has authority to promulgate regulations under subsection 302(b), and no such term or condition may be included in such a lease if it is disapproved by the Secretary of Energy.]’

A “Federal lease” is defined as referring only to leases of oil, gas, coal, oil shale, tar sands, and geothermal resources[16]— that is, only the leasable energy minerals (except for uranium, which is leasable on acquired land and certain limited categories of public domain land).

The net effect is that the Secretary of Energy may dictate the terms and conditions of any Federal energy mineral lease as long as they relate to “competition” or “diligence” or other equally vague words, even though subsection 303(a) of the Act declares:

> The Secretary of the Interior shall retain any authorities not transferred under section 302(b) of this Act and shall be solely responsible for the issuance and supervision of Federal leases and the enforcement of all regulations applicable to the leasing of mineral resources, including but not limited to lease terms and conditions and production rates. No regulation by the Secretary [of Energy] shall restrict or limit any authority retained by the Secretary of the Interior under section 302(b) of this Act with respect to the issuance or supervision of Federal leases. [17]

Moreover, unlike the Secretary of Energy’s veto over lease terms and conditions drafted by the Secretary of the Interior, the Secretary of the Interior is allowed only to ‘‘comment” on the content and effect of regulations drafted by the Secretary of Energy. [18]

The transfer of authority to prescribe regulations relating to acquisition and disposal of Federal royalties taken in kind does not raise any apparent problems for continuing judicious land management by the Secretary of the Interior.

However, the other transfers could seriously affect the Secretary of the Interior’s land management responsibilities, Although the transferred functions were presented by the administration as economic aspects of energy mineral leasing, distinct from the land management aspects, their exercise can have substantial adverse effects on nonmineral resource values.

The choice of a bidding system involves, among other things, a choice of using either the level of royalties (per-unit payments on the gross amount or value of production), the amount of the bonus (a lump-sum payment not tied to production), the profit share, or some other variable as the bidding element. The selection of the appropriate bidding system is important for the proper balancing of competition, diligence incentives, and so forth, which are legitimate concerns of the Department of Energy. But, as is discussed in detail in section E of chapter 4, the bidding system and its results can also greatly affect conservation of the mineral and nonmineral resources on Federal land, which is a major concern of the Secretary of the Interior. For example. royalty payments are a continuing per-unit overhead cost of mineral production that can be

[15] Ibid., § 7153(c).
[16] Ibid., § 7101(c).
[17] Ibid., § 7153(a).
[18] Ibid., § 7153(b).

absorbed only by the higher grade deposits in a lease. The higher the royalty, the higher the cutoff grade for production, and therefore the higher the amount of mineral left in the ground, even though all or some of that mineral could have been mined at a lower royalty rate. This part of the problem, it may be hoped, would be taken into account by the Department of Energy. However, there is another part of the problem that might be overlooked. The fact that more mineral is left in the ground means that either a greater amount of land must be mined (and disturbed) for a given quantity of mineral production or the same tract of land must be disturbed more than once (for example, under a subsequent lease at a lower royalty rate).

As is discussed in detail in subsection F(4) of chapter 4, mandatory production rates, continuous production requirements, rentals, work requirements, time limits, and other diligence requirements can have similar effects.

Production rate requirements that are based on or encourage overly rapid production, or development of only the most profitable energy mineral deposits (which is a serious potential problem with respect to each energy mineral resource), can result in leaving behind less profitable but nonetheless economically recoverable energy and associated nonenergy mineral deposits. Thus, once more either additional land must be mined or the same tract must he mined twice to achieve a given quantity of energy and nonenergy mineral production. In either case, needless damage is inflicted on the land resource. If more land is mined rather than mining the same tract twice, as will often happen because of the lower quality of the unmined mineral, then minerals (both energy and nonenergy) that could have been recovered will never be produced. The Secretary of Energy will be responsible only for the energy mineral recovery. The Secretary of the Interior must be concerned about the adverse effects on the land and on nonenergy mineral recovery, both of which remain his responsibility.

Rentals combine diligence and land use payment features. Rentals that are designed only to ensure diligence and do not charge for the temporary or permanent loss of nonmineral resource values caused by the mineral activity result in underpricing of the mineral in relation to the true total costs of its production and therefore encourage both overproduction of the mineral and excessive damage to nonmineral values.

Overly stringent diligence or minimum production requirements can force excessive mining activity and thus increase the damage to nonmineral resources, including the local socioeconomic fabric in sparsely populated regions. On the other hand, inadequate diligence or rental requirements permit large amounts of land to be held for mineral speculation, thereby increasing nonproductive lease transaction and management costs, disrupting long-range planning of nonmineral land uses, and discouraging investment in nonmineral resource activities on the leased land.

Clearly, the transferred functions are not merely economic aspects of leasing, distinct from overall resource and land management. The formal distinction drawn between eocnomic and land management issues does not exist in practice. As was shown in subsection A(I), the effort to draw a similar distinction in defining the respective responsibilities of USGS and BLM in the Department of the Interior, under Secretarial Order No. 2948, has not worked and has led to adoption of working agreements providing for joint responsibility.

The adoption of the distinction in the Department of Energy Organization Act is the consequence of historical circumstance. The outgoing Ford administration recognized the inseparability of all aspects of mineral leasing from proper land management. Its report to Congress on the organization of Federal energy functions stated: “Energy leasing and lease management functions of the Bureau of Land Management and U.S. Geological Survey are inherent in the responsibility for managing, preserving, and appropriately utilizing the [Federal] lands.”]' The Department of Energy Act proposed by the Ford administration did not transfer any energy mineral leasing function to the Department of Energy.[20]

However, incoming officials of the Department of the Interior under the new Carter administration, unfamiliar with the complex details of mineral leasing, accepted the questionable distinction between the economic and the land management aspects of mineral leasing, and they therefore agreed to the transfer of the economic aspects to the new Department of Energy. Hearing no complaint from the Department of the Interior, Congress enacted the transfer. (Some other, more obvious potential incursions on the Secretary of the Interior’s land management responsibilities were modified or eliminated.]

The transfer inserts the Secretary of Energy into the middle of the energy mineral leasing process, The Secretary is necessarily an energy advocate. He can be expected to formulate regulations and to veto lease terms from the perspective of increased energy production rather than on the basis of total impact on energy mineral, nonenergy mineral, and nonmineral resources,[21] even though the functions transferred to him can and do have substantial impact on all three types of resources.

The transfer runs counter to the trend of recent legislation, such as the Geothermal Steam Act of 1970, the Federal Coal Leasing Amendments Act of 1976, and the Federal Land Policy and Management Act of 1976, which adopt a total resource perspective in the management of Federal land and its minerals. ’z The Secretary of Energy is not given similar authority with respect to production of water power from Bureau of Reclamation dams, which serve multiple-use purposes and whose water is controlled for various energy and nonenergy purposes based on multiple-use considerations.

Moreover, the broad wording of the transfer will almost surely create coordination problems between the Department of Energy and the Department of the Interior. Many lease terms and conditions, such as rentals or bonds, are primarily useful for land management purposes but also intentionally or unintentionally may have effects on diligence or competition. [23] Can the Secretary of Energy control all such lease terms and conditions? What lease term does not affect diligence or competition? The debate over respective jurisdictions is likely to cause considerable delays and even stalemates in energy mineral leasing.

The transfer also creates strange allocations of responsibility in certain situations, The Secretary of the Interior is left with a meaningless role with respect to ener-

[19] *Ford Administration Energy Organization Report*, note 7, at 44.
[20] Ibid., at 59-78.
[21] Ibid., at v-vi, 33-34, 44.
[22] See, e.g., ch. 2, sec. F.
[23] See ch. 4, subsec. C(3)(b)

gy mineral leasing on land under the surface jurisdiction of a non-Interior agency. As was noted in subsection A(I), when an agency other than BLM has jurisdiction over the surface of the land to be leased, BLM ordinarily will issue the lease only with the consent of, and subject to surface protection conditions specified by, that agency. The consent must be obtained and the conditions must be included if the mineral lease is on acquired land or land withdrawn or reserved for military purposes, or if it is for geothermal steam or coal. Thus, the non-Interior agency controls the surface aspects, and the Secretary of Energy controls the mineral aspects of the lease, leaving BLM with only the paperwork. On nonmilitary public domain land, on the other hand, BLM can override the surface management agency with respect to surface stipulations for noncoal and nongeothermal energy mineral leases, even though it has no interest in the surface or the energy minerals (the latter being controlled by the Department of Energy).

Finally, there appears to be no strong reason for the transfer, particularly in light of all the difficulties it causes. The two main problems with energy mineral leasing in the past have been inadequate supervision of lessees' mineral activities to ensure diligence and compliance with other lease requirements, and inadequate attention paid to environmental and other nonmineral resource impacts.[24] Insufficient leasing of energy minerals has not been the problem. Vast acreages of Federal onshore land are under lease for coal, oil and gas, and even geothermal steam. ” As the Ford adminstration stated, “the policies established by the Administration in support of accelerated recovery of energy resources on Federal lands coupled with the longstanding Department [of the Interior] policy in support of utilization and development of the Federal lands . . . do create a general bias within the Department toward energy resource development.[26] Moreover, the transfer does not address any perceived insufficiency in leasing, because it clearly leaves the decision whether to lease with the Secretary of the Interior.

The transfer does not address the problem of inadequate protection of nonmineral resource values.

The transfer appears to address the problem of inadequate diligence and competition. However, it is not clear that the Department of Energy, which is an amalgam of the Federal Energy Administration (FEA), the Energy Research and Development Administration (ERDA), and other energy agencies and functions, will be any tougher on the energy industry than its constituent elements have been in the past.

Even if the Department of Energy should maintain a tough position, the impact on energy mineral production is likely to be small. Strict diligence requirements will result in abandonment of leases more often than in increased production, since production decisions depend primarily on the market. Any increased production that does result will often be at the expense of maximum ultimate recovery and conservation of resources.[27]

In sum, the energy mineral leasing provisions of the Department of Energy Organization Act reflect an oversimplified view of the tremendous complexity of land man-

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[24] See subsec. A(1) and ch. 4 and 5.

[25] See U.S. Bureau of Land Management, *Public Land Statistics, 1976*, table 78 (1977); ch. 4.

[26] *Ford Administration Energy Organization Report*, note 7, at 34.

[27] See ch. 4, subsec. F(4).

agement for various mineral and nonmineral resource uses. The split jurisdiction they established is based on a distinction between economic and land management issues that does not exist in practice, The split will likely result in serious coordination problems, with resultant delay, inefficiency, and adverse environmental and socioeconomic impacts. The authority gained by the Secretary of Energy does not seem all that essential to the mission of his Department, but it could cause significant land management problems for the Secretary of the Interior.

The Secretary of Energy’s important interest in general policy issues relating to energy development on Federal onshore land might be more appropriately addressed through the Leasing Liaison Committee established by section 210 of the Act.[28] As the Ford administration concluded, involvement in the details of the leasing process seems both unnecessary and unwise.[29]

B. State and Local Concerns Regarding Mineral Activities on Federal Land

1. The Magnitude of the Federal Land Presence in the West

Onshore Federal land is a very significant portion of the total national land base. In 1975, the Federal Government owned one-third of the Nation’s land, not including reserved mineral interests in 63 million acres.”) Even after the massive transfer of about 149 million acres to the State of Alaska and the Alaskan Natives is completed (only 12 million acres were listed as transferred in 1975),[31] more than 27 percent of the Nation’s land (30 percent if the reserved mineral interests are included) will be owned by the Federal Government.

Over 90 percent of the Federal onshore land is in the 11 contiguous Western States and Alaska. The Federal acreage amounted to 64 percent (69 percent including reserved mineral interests) of the total land in these States in 1975, and it will amount to 51 percent (56 percent including reserved mineral interests) after the extensive land transfer in Alaska is completed. The Federal ownership percentage for individual States is listed in table 6.1 and ranges from 29 percent (30 percent including reserved mineral interests) in Washington to 87 percent in Nevada. The percentages for total Federal mineral acreage are actually higher than those listed in table 6.1, since the data on 7 million acres of mineral interests reserved in these States since 1948 are not broken down by State and thus could not be included in table 6.1. A similar high percentage of Federal ownership exists for coal deposits in western North Dakota, although the percentage of Federal ownership in the State as a whole is less than 16 percent.

[28] 42 U.S.C. § 7140 (Supp. I 1977).

[29] *Ford Administration Energy Organization Report*, note 7, at 34, 44.

[30] Based on data in U.S. Bureau of Land Management, *Public Land Statistics, 1976*, tables 7 and 17 (1977).

[31] Ibid. Only 1 million of the 13 million non-Federal acres listed in table 7 of *Public Land Statistics* were privately owned. The remaining 12 million represent transfers to the State of Alaska. See app. B to this report.

[32] See the sources cited in the two previous footnotes.

Table 6.1 .—Federal Land and Mineral Ownership in the Western States

State	Percentage of land owned by U.S. in 1975	Percentage in 1975 including mineral Interests reserved before 1949
Alaska	96 (59)*	96(59)*
Arizona	43	47
California	45	48
Colorado.	36	45
Idaho.	64	67
Montana	30	42
Nevada	87	87
New Mexico	34	45
Oregon	53	55
Utah	66	68
Washington	29	30
Wyoming	48	68

*The percentage given in parentheses for Alaska indicates Federal landownership after completion of transfers to the State and the Natives.

SOURCE: Derived from data in U.S. Bureau of Land Management, *Public Land Statistics*, 1976, tables 7 and 17 (1977) and data in app. B.

The percentage of land and mineral interests actually owned by the Federal Government in these States, although high, does not indicate the full extent of the Federal influence over and even control of land use and economic activity in the States. Although much of the Federal land in the West is in large continuous blocks, a substantial amount of Federal acreage is in "checkerboard" tracts—sections of Federal land alternating with sections of railroad or State school grant land—or is otherwise interspersed with parcels of private and State land. Figure 2.1 in chapter 2, which depicts the principal Federal landholdings in 1976, including areas of interspersed ownership containing at least 25 percent Federal land but not including federally reserved mineral interests, gives a more complete picture of the extent to which Federal landholdings influence life in the Western States.

Given the magnitude of the Federal land presence in the West, it is only natural that the Western States should be extremely interested in the effects that mineral activity on Federal land might have on the physical, social, and economic environment.

2. State and Local Concerns About Direct Physical Impact

The direct impacts of mineral activity on surface resources and the physical environment, and the importance of the nonmineral resources on Federal land from both commercial and noncommercial points of view, are discussed in detail in chapter 5. Because much of the economy and lifestyle of the Western States depends on the preservation of their nonmineral natural resources, these States and their citizens have insisted that mineral activity on Federal land be conditioned on restoration of all nonmineral values and on preservation of those nonmineral values not capable of being restored.

One particularly critical area of State and local concern has been the impact of mineral activity on the quality and quantity of water, which is scarce and therefore ex-

''See ch. 5, secs. A, B, and C.

tremely valuable in the Western States. Water is required in varying amounts for mining and related energy development activities, and its use for those activities can substantially reduce the quantity and quality of water available for nonmineral resource activities. Moreover, some mineral deposits—for example, some coal deposits—themselves serve as aquifers, so that mining of the deposits could destroy or severely damage the existing water collection and recharge system. [34]

Another area of State and local concern is the limited protection afforded to private owners of former Federal land whose ownership is subject to a reservation by the Federal Government of some or all minerals in the land. Generally, the private surface owner cannot prevent development of the federally reserved minerals and is entitled legally only to reimbursement for damages to crops, agricultural improvements, and the value of the land for grazing purposes.[35] Moreover, for minerals subject to the Mining Law rather than the leasing laws, a mineral explorer may and (because of the provisions for acquisition of tenure) almost always will enter onto privately owned surface and commence operations without any prior notice to the surface owner or the Federal Government, Needless to say, conflicts can and sometimes do occur. [36]

3. State and Local Concerns About Indirect (Socioeconomic) Impact

In addition to the direct effects on the physical environment, mineral activities on Federal land can have substantial impacts on State and local economies and ways of life. These impacts can be both beneficial and adverse.

Mineral activities depend on the existence of an adequate infrastructure of facilities and services to support the mineral operations.[37] This infrastructure includes the transportation network; housing; health services such as hospitals; utilities; retail outlets such as grocery stores; and other public and commercial facilities and services required to support the population of a given geographic area.

When additional mineral activities are undertaken in an area that already has a substantial population and an extensive infrastructure, the incremental demand on existing facilities and services may be comparatively small. The additional activity usually can be easily absorbed. Beneficial effects are perceived as outweighing adverse consequences for the local social structure,

On the other hand, when mineral activities are undertaken in a sparsely populated rural area that has only minimal infrastructure, the incremental demand on existing facilities and services can be considerable, Although judging the nature and extent of social and economic impacts is a complicated process, past experience suggests that, in these cases, the adverse effects sometimes outweigh the beneficial ones, Large-scale mineral activities inevitably alter the local economy and bring about changes in the traditional way of life.

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[34] U.S. Water Resources Council, *Water for Energy Self-Sufficiency*, ch. 3 (October 1974); Federation of Rocky Mountain States, Inc., *Energy Development in the Rocky Mountain Region: Goals and Concerns* 34, 42-44, 85-87 (1975); Nehring and Zycher, *Coal Development and Government Regulation in the Northern Great Plains: A Preliminary Report*, RAND Corp. Rept. No. R-1981-NSF/RC, at 62-65, 83-85, 101-104 (August 1976).

[35] Mall, "Federal Mineral Reservations," 10 *Land & Water L. Rev.* 1, 21, (1975); see ch. 5, subsec. D(6) and E(6).

[36] See ch. 5, subsec. D(8).

[37] See ch. 2, subsec. D(6).

State and local concerns about these indirect effects are greatest in the Rocky Mountain and Great Plains regions and in Alaska, where extensive development of fuel minerals is projected. These are all sparsely populated regions; for the maintenance of their economies, they are dependent on farming, ranching, tourism, hunting, fishing, hiking, and other dispersed activities, as well as on mineral development. The projected scale of fuel mineral development is far greater than any past mineral activities and would markedly alter local and regional economies and living patterns.

The greatest projected development is for Wyoming, western Colorado, northeastern Utah, and northwestern New Mexico, where potential fuel mineral developments overlap one another. Any oil shale development will occur in northwestern Colorado and adjacent areas in northeastern Utah and southwestern Wyoming. Major coal development will occur in the same areas plus northwestern New Mexico, western North Dakota, and eastern Montana and Wyoming. Known deposits of uranium are scattered widely throughout Wyoming, western Colorado, New Mexico, Arizona, southern Utah, and southwestern Nevada, In addition, oil and gas development is concentrated in Wyoming, northern Colorado, northeastern Utah, and northwestern New Mexico.

An inevitable result of this development will be regionwide population changes. One 1975 study estimated that the development of coal, oil shale, and uranium deposits in the Rocky Mountain region could each attract some 150,000 permanent residents or a total of up to half-a-million people by 1985. [38] A more recent assessment estimates that between now and the year 2000, the population increase caused by fuel mineral development in the eight Western States will range from 768,000 to 1,248,000 people.”) The impacts of these population changes will be greatest far from metropolitan centers in the rural areas near energy development projects. Increases as great as 600 percent through the year 2000 are projected for some local areas.

An example of the results of large-scale mineral and energy development is Sweetwater County, Wyo. Rapidly expanding oil and gas development, new trona (sodium carbonate) mining, and construction of the Jim Bridger powerplant boosted the population of Sweetwater County from 18,000 in 1970 to 37,000 in 1974. Most of the population influx occurred in and around the town of Rock Springs, which had a population of only 11,000 in 1970.

The town and county were overwhelmed. Schools, health facilities, housing, recreation facilities, retail stores, telephone facilities, and municipal services such as fire and police protection, water, sewers, and sanitation were inadequate. No funds were available for needed expansion and improvement. Much of the new population settled in mobile homes and substandard housing in scattered developments on the fringe of Rock Springs, Alcoholism, drug use, crime, divorce, suicide, and other indicators of social stress all rose dramatically. [40]

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[38] Federation of Rocky Mountain States, note 34, at 19-29; see Northern Great Plains Resources Program, *Socio-Economic and Cultural Aspects Work Group Report* (June 1974).

[39] I. White, et al., 2 *Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development* 864 (1977) (proposed for the U.S. Environmental Protection Agency).

[40] University of Denver Research Institute, *The Sweetwater County Boom: A Challenge to Growth Management* (July 1974); U.S. General Accounting Office, *Rocky Mountain Energy Resource Development: Status, Potential, and Socioeconomic Issues*, EMD-77-23, July 13, 1977, at 32-35 (hereinafter cited as GAO *Socioeconomic Issues Study*).

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One of the most widely publicized examples of the effects of rapid development is seen in Alaska in connection with the construction of the Trans-Alaska Pipeline. Fairbanks became the staging, management, and service center for construction activities. It was the northernmost terminus of the railroad and paved highway prior to the building of the North Slope Haul Road to Prudhoe Bay. In 1970, the population of Fairbanks and the surrounding North Star Borough was 45,864; in 1975, it was estimated to be 63,350—a 24.8-percent increase. An accurate count of the population changes was never taken, however. At the peak of construction activities, the pipeline project employed 22,000 workers, 16,000 of them dispatched from the union halls in Fairbanks. More than 500 management personnel lived in the area; 1,164 workers were housed in a construction camp nearby.

As a result of this influx, a housing shortage occurred, with attendant increases in rents and purchase prices. The telephone company "ran out of numbers" and could add no new customers to the existing system. Electrical consumption grew faster than the electric utility's generating capacity. During the winter of 1975-76, "peakload alerts" were issued calling for consumers to restrict their use of electricity.

But not all of the expected impacts came to pass. For the school year 1974-75, the school district had expected 11,994 students, 3,150 more than the 8,844 projected without pipeline development. That fall 8,864 actually enrolled. Anticipated squatter communities did not arise since some individuals who traveled to Fairbanks brought trailers or campers in which to live while others moved in with friends and acquaintances. "Sleeping rooms" or "dormitories"-beds placed in available space in homes—and other kinds of shared-housing arrangements became available.'[1]

Similar difficulties were experiences in Valdez, Alaska, the southern terminus for the Trans-Alaska Pipeline. In January 1974, the population was l,350; by July 1975, it had risen to 6,512. A portion of the new residents were housed in specially prepared camps; even so, the population of the town itself had reached 3,500. All of the available services and utilities were inadequate, The sewer, water, telephone, and electric systems were all near capacity in 1974. For example, there were 12 circuits with 1,114 installed telephones; by January 1976, 32 more circuits and 4,262 new telephones had been added, but the system was still overloaded.

A shortage of housing was the greatest impact from the influx of new people. In July 1975, almost 60 percent of the residents were living in temporary housing. The cost of constructing permanent housing had risen to $90 per square foot and bank mortgages were hard to obtain. Some of the difficulties in constructing new housing stemmed from requirements retained after the relocation of the town following the 1964 earthquake and tsunami. Because the new town was built with urban renewal funds, the Department of Housing and Urban Development imposed strict regulations that resulted in legal entanglements concerning the sale and use of land and thus caused long delays in response to market demands for housing.

In spite of these dislocations, the majority of Valdez residents judged the pipeline boom in a favorable light. Surveys conducted in the spring of 1974 and replicated in

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[1] Dixon, *What Happened to Fairbanks? The Effects of the Trans-Alaska Oil Pipeline on the Community of Fairbanks*, Alaska (1978)

the fall of 1975 revealed a generally high level of satisfaction with the changes in the community, Even most long-time residents who were not directly employed in pipeline-related industries and who were all affected by the adverse impacts favored continued development of the oil industry for Valdez, The final consequences of the construction of the pipeline are yet to be measured. Which of the short-term impacts will result in long-term changes can only be judged with the passage of more time.[42]

The "boom" occurrence is not the only concern of State and local officials and residents. Following the boom there is the possibility of a subsequent "bust" when labor-intensive construction activity is followed initially by production activity requiring many less workers and eventually, after 20 to 50 years, by termination of the product ion itself.

A variety of Federal, State, and local measures have been taken to deal with the social and economic impacts of mineral development. Some of the major sources of revenues for these programs are discussed in section E of this chapter. In general, Federal initiatives range from revenue sharing to specific mitigation program support, such as the National Institute of Mental Health training grant to the University of Wyoming for multidisciplinary human services teams to serve energy-impacted communities.[43] As is discussed more fully in sections D and E of this chapter, State programs range from the assessment and planning for mitigation of impacts as a precondition for energy development siting to the adoption of funding and enabling mechanisms for moderating impacts.[44] Local responses often are dependent on the existence of Federal and State support, although the instances of cooperation between local authorities and mineral development industries are growing. Examples of the latter are found in oil shale industry support of mitigation strategies in northwestern Colorado and the open planning process of community impact management adopted by an electric cooperative in eastern Wyoming.[45]

The emergence of these mitigation strategies demonstrates a growing recognition that the adverse effects of rapid growth induced by major mineral activities can be exacerbated if the growth is not managed. The effects of a rapid expansion in infrastructure are not only economic and social. Equally important are the environmental and land use consequences, Uncontrolled growth can, for example, resuIt in land use decisionmaking by default. It can lead to incursions into ecologically fragile areas which may preclude the best use not only of the land in question, but also of neighboring lands. Once such an incursion has been made, there may be no opportunity to reverse the process.

[42] Baring-Gould and Bennett, "Social Impact of the Trans-Alaska Pipeline Construction in Valdez, Alaska 1974-75," testimony prepared for Canada's Mackenzie Valley Pipeline Inquiry (n.d.). See also, Baring-Gould, Bennett, and Heasley, "The Valdez Project: A Longitudinal Study of a Trans-Alaska Pipeline Boom Town," paper presented at the Pacific Sociologic Association meeting, San Diego, Calif., 1976.

[43] U.S. Department of Health, Education, and Welfare, Alcohol, Drug Abuse, and Mental Health Administration, "The Impact of New Boomtowns: The Lessons of Gillette and the Powder River Basin," *New Dimensions in Mental Health*, December 1977, at (ADM) 77-514.

[44] Peelle, "Mitigating Community Impacts of Energy Development: Some Examples for Coal and Nuclear Generating Plants in the United States," paper presented at the annual convention of the American Association for the Advancement of Science, Houston, Tex., January 1979.

[45] *Economic Impact of the Oil Shale Industry in Western Colorado*, hearing before the Subcomm. on Public Lands of the Senate Comm. on Int. & Ins. Affairs, 93d Cong., 2d sess. 12 (1974); Valeu, "Community Impact Management (Open Planning Process)—Case Study, Wheatland, Wyo.," paper presented at the annual convention of the American Association for the Advancement of Science, Houston, Tex., January 1979.

C. State and Local Authority to Regulate or Tax Mineral Activities on Federal Land

Congress has complete power over Federal land under the Property Clause of the Constitution, which states: "The Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States , . . ."[46] The Constitution also gives Congress the power to "make all Laws which shall be necessary and proper for carrying into Execution" its specifically enumerated powers,[47] and provides that "the Laws of the United States , . . shall be the supreme Law of the Land; . . . any Thing in the Constitution or Laws of any State to the contrary notwithstanding,[48]

The U.S. Supreme Court has held that these constitutional provisions give the Congress plenary authority over Federal land in any State, so that any law passed by Congress respecting the use, disposal, or protection of the Federal land will override or preempt any conflicting State law.[49] However, a State retains jurisdiction over Federal lands within its borders unless it has consented to the exercise of exclusive jurisdiction by Congress; therefore, the State may regulate activities on Federal land to the same extent as it regulates such activities on non-Federal land unless Congress has adopted a law preempting State regulation.[50]

A State cannot, without congressional consent, regulate or tax Federal instrumentalities (e.g., agencies). It may, however, regulate or tax private parties who do business with the Federal Government, as long as the regulation is directed to, or the tax is assessed on, the private party or interest and not on the Federal Government or its interests, unless the Congress has expressly immunized the private party or interest from State regulation or taxation, or unless the State regulation or taxation would "affect the title of the United States or embarrass it in using the lands or interfere with its right of disposal. "[51]

Thus, a State can regulate and tax private activities on or interests in Federal land, including private activities under the Federal mining and mineral leasing laws and private interests in minerals acquired under those laws, unless such State regulation or taxation is in conflict with a Federal statute (or regulation adopted pursuant to such statute) or would "embarrass" or interfere with the United States' right to use and dispose of the land.

None of the Federal mining or mineral leasing laws expressly or implicitly preempts State regulation or taxation of private mineral activities on or interests in Federal land. In fact, the laws generally expressly preserve the States' jurisdiction over such activities and interests.

[46] U.S. Const. art. IV, § 3, cl. 2.
[47] Ibid., art. I, § 8.
[48] Ibid., art. VI, cl. 2.
[49] *Kleppe* v. *New Mexico*, 426 U.S. 529 (1976).
[50] Ibid.
[51] *James* v. *Dravo Contracting Co.*, 302 U.S. 134, 142 (1937), quoting *Surplus Trading Co.* v. *Cook*, 281 U.S. 647, 650 (1930); L. Tribe, *American Constitutional Law* 254-255, 391-399 (1978).

The Mining Law of 1872, which was essentially a codification of State and local laws and practices, was designed to legitimize the appropriation and disposal of Federal minerals occurring under such laws and practices.[52] The Act declares that:

> All valuable mineral deposits in [Federal] lands . . . shall be free and open to exploration and purchase, and the lands in which they are found to occupation and purchase . . . under regulations prescribed by law, and according to the local customs or rules of miners in the several mining districts, so far as the same are applicable and not inconsistent with the laws of the United States.[53]

Under the Act, the regulation of possessor rights was left to local custom and rules so long as such rules were not inconsistent with the laws of the United States or of the State or territory in which the mining district was located. The Act established only a few requirements relating to the maximum and minimum sizes of a claim, the minimum amount of annual work, and the minimum location and discovery procedures.[54] The details, including the power to restrict the dimensions of claims to much less than the statutory maximum[55] and to impose more burdensome work requirements,[56] were left to State and local law and custom. The local customs and rules of the miners, which had been shaped, enforced, and sanctioned by State legislation even prior to 1872,[57] have since been almost completely superseded by State statutory requirements.[58] The States, therefore, exercise a substantial amount of control over the very disposal of Federal hardrock mineral rights under the Mining Law, at least in the absence of any Federal regulations inconsistent with the State requirements. Although the Federal lands are "free and open to exploration and purchase," they are "free and open . . . according to the local customs or rules of [the State]." The States may regulate and specify procedures for mineral entries, as long as such regulations are not inconsistent with Federal law[59] and do not frustrate the purposes of the Mining Law.[60]

At the opposite end of the location-patent process, it should be clear that a State may exercise its full police (regulatory) power with respect to patented mining claims, since the lands embraced in such a claim are no longer Federal lands. Even where the surface is retained by the United States, the patented mineral estate is private property and thus as fully subject to State regulation as any other private property in the State. In fact, the Mining Law even allows the States to condition the right to receive a patent for a claim: "As a condition of sale, in the absence of necessary legislation by Congress, the local legislature of any State or Territory may provide rules for working mines, involving easements, drainage, and other necessary means to their complete development; and those conditions shall be fully expressed in the patent.[61]

The possessor right under an unpatented mining claim is also a private property interest that can be regulated and taxed by the States. A holder of a valid unpatented claim has the exclusive right to mine the hardrock deposits in the claim without having to pay any royalties to or obtain any approval from the Federal Government, The U.S. Supreme Court has stated:

[52] Swenson, "Legal Aspects of Mineral Resources Exploitation," in P. Gates, *History of Public Land Law Development* 699, 708-723 (1968).

[53] 30 U.S.C. § 22 (1976).

[54] Ibid., §§ 26, 28, 35.

[55] *Paley's Park Mining Co.* v. *Kerr*, 130 U.S. 256, 261 (1889); *North Noonday Mining Co.* v. *Orient Mining Co.*, 1 F. 522, 527-528 (C.C. Cal. 1880); *Rosenthal* v. *Ives*, 12 P. 904 (Idaho 1887).

[56] *Northmore* v. *Simmons*, 97 F. 386 (9th Cir. 1889).

[57] See *Jennison* v. *Kirk*, 98 U.S. 453 (1879).

[58] Trelease, Bloomenthal, and Geraud, *Cases and Materials on Natural Resources* 417, 464, 476-478, 484-485, 492-493, 508-509, 527 (1965).

[59] *Judson* v. *Herrington*, 162 P.2d 931 (Cal. App. 1945); 1 *Am. Law of Mining* § 7.5, at 106 (1960).

[60] *Butte City Water Co.* v. *Baker*, 196 U.S. 119 (1905).

[61] 30 U.S.C. § 43 (1976).

> [An unpatented mining] claim is property in the fullest sense of that term; and may be sold, transferred, mortgaged, and inherited without infringing any right or title of the United States, The right of the owner is taxable by the State; and is "real property. " . . . The owner is not required to purchase the claim or secure patent from the United States; but so long as he complies with the provisions of the mining laws, his possessor right, for all practical purposes of ownership, is as good as though secured by patent.[62]

The possessor right attached to an unpatented claim, therefore, is subject to State regulation as well as taxation, even if the State regulation is more stringent than applicable Federal regulations (e.g., the Forest Service mining regulations), as long as the State regulation is not inconsistent with Federal law and does not interfere with the Federal Government's right to dispose of its mineral land.[63]

In sum, the private property interest of a mining claimant under the Mining Law is subject to the full exercise of the States' police power. The Mining Law was intended as a codification and preservation of State regulation of the location and use of mining claims. Indeed the States are given substantial power over the actual process of acquisition of private rights under the Mining Law. Although a State cannot burden the acquisition process with unreasonable requirements or requirements inconsistent with Federal law, it may specify the details of the acquisition process and then fully regulate the resulting private property interest.

In contrast to the Mining Law of 1872, the Mineral Leasing Act of 1920 provides a detailed Federal management and disposal system covering acquisition of private mineral rights, retention of Federal ownership and control, payment of royalties and rentals, and specification of the speed and manner of exploration, development, and production. The States are given no role in the lease-issuance or maintenance-of-tenure process. However, two sections of the Leasing Act explicitly confirm the applicability of the States' police power to mineral activities under the Act. Section 32, after authorizing the Secretary of the Interior to prescribe all necessary and proper rules and regulations, states that:

> Nothing in this Act shall be construed or held to affect the rights of the States or other local authority to exercise any rights which they may have, including the right to levy and collect taxes upon improvements, output of mines, or other rights, property, or assets of any lessee of the United States.[64]

Section 30 directs the Secretary to insert in each mineral lease

> . . . provisions for the purpose of insuring the exercise of reasonable diligence, skill, and care in the operation of said property; a provision that such rules for the safety and welfare of the miners and for the prevention of undue waste as may be prescribed by said Secretary shall be observed; . . . and such other provisions as he may deem necessary . . . for the protection of the interests of the United States, for the prevention of monopoly, and for the safeguarding of the public welfare.

The section then declares that "None of such provisions shall be in conflict with the laws of the State in which the leased property is situated." [65]

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[62] *Wilbur* v. *United States ex rel. Krushnic*, 280 U.S. 306, 316-317 (1930).

[63] *State ex rel. Andrus* v. *Click*, 524 P.2d 969 (Idaho 1976); see *Forbes* v. *Gracey*, 94 U.S. 762 (1877).

[64] 30 U.S.C. § 189 (1976).

[65] Ibid., § 187.

The legislative history of these sections clearly indicates congressional intent to let the States' police power govern the operations of Federal mineral lessees, Although the primary focus was on health and safety matters, the States' police power was preserved with respect to all aspects of the public welfare, including but not limited to prevention of monopolies.[66] As Representative Mondell stated during the debate on the pertinent language in section 30, "Instead of being a limitation on the power of the Federal Government to protect [the public welfare], this is a limitation on the authority of the Federal Government to permit practices which the State law prohibits.'")[67] All participants in the debate agreed that the States could exercise their police power to enact requirements stricter than those in the Federal law; the disagreement arose over whether the section allowed the States to weaken the Federal provisions.

The authority of the States to impose stricter requirements on Federal mineral lessees than are imposed by the Federal Government itself has been recognized by the courts,[68] and Congress has recently reaffirmed this State authority with respect to reclamation of Federal land disturbed by coal mining.[69]

The Geothermal Steam Act of 1970 does not, as do the Mining Law of 1872 and the Mineral Leasing Act of 1920, expressly preserve the State police power with respect to private activities or interests under the Act. There is only a statement that "Nothing in this Act shall constitute an express or implied claim or denial on the part of the Federal Government as to its exemption from state water laws.[70] But, since the Act does not purport to preempt the States' police power, the States may, under the principles discussed at the beginning of this section, regulate private activities on and tax acquired private interests in Federal land under the Act, as long as such regulation or taxation is not in conflict with specific provisions in the Act or regulations promulgated pursuant to those provisions.

Federal laws other than the basic mining and leasing acts may contain provisions that limit the exercise of the States' police power with respect to mining activities on Federal land. For example, many of the Federal statutes providing for nonmineral entries on Federal land specifically reserved the mineral deposits in such land to the Federal Government, together with the right of miners to enter such land and develop the mineral deposits in accordance with the Federal mining or mineral leasing laws. The Acts provide for the payment to the surface owner of certain damages caused by prospecting and mining.[71] State statutes that attempt to condition the federally reserved right of access on the consent of the surface owner, or that seek to enlarge the damages recoverable by the surface owner, directly conflict with the Federal statutory provisions. However, there is no such conflict with respect to the reclamation requirements contained in State laws.[72]

Finally, there are constitutional limits to a State's exercise of its police power even in the absence of a Federal statute explicitly preempting that power. For exam-

[66] See, e.g., 58 Cong. Rec. 7643-7647 (Oct. 28, 1919).

[67] Ibid., at 7644.

[68] See *Mid-Northern Oil Co.* v. *Walker*, 268 U.S. 45 (1925); *Texas Oil & Gas Corp.* v. *Phillips Petroleum Co.*, 277 F. Supp. 366 (W.D. Okla. 1967), aff'd. 406 F.2d 1303 (10th Cir. 1969), cert. denied, 396 U.S. 829 (1969); cf. *Wallis* v. *Pan American Petroleum Corp.*, 384 U.S. 63 (1966).

[69] Surface Mining Control and Reclamation Act of 1977, § 505, 30 U.S.C. § 1255 (Supp. I 1977).

[70] 30 U.S.C. § 1021 (1976).

[71] Although the exact extent of recoverable damages under the acts is subject to dispute, it apparently would include at least damages to crops, agricultural improvements, and the value of the land for grazing purposes. Mall, "Federal Mineral Reservations," 10 *Land & Water L. Rev.* 1, 21 (1975).

[72] Ibid., at 51-54.

pie, the State regulation or taxation cannot discriminate against mineral activities on Federal land by imposing stricter burdens on those activities than are imposed on similar activities on non-Federal land in the State. If the State regulation is so restrictive as to amount to a taking of private property, the State must compensate the property owner for the value of the property taken. Overly burdensome State regulation or taxation that substantially discourages mineral development on Federal land might be held to be an invalid interference with the Federal power to dispose of Federal property. It should be noted, however, that extremely burdensome State regulation or taxation has been upheld against claims of unconstitutional taking of private property,[73] and that the congressional debate on passage of the Mineral Leasing Act of 1920 indicates that State taxation would be valid even if it were so burdensome as to preclude development of the Federal leasable minerals.[74]

D. State and Local Regulatory Controls: Coordination With Federal Requirements

1. Control Over Surface Disturbance and Reclamation

Almost all the mining States have adopted legislation regulating surface disturbance associated with mining activities, both by prohibiting such surface disturbance in certain areas and by closely controlling its impact in areas where it is allowed. In addition, some States have enacted statutes requiring State approval of the siting of mining activities or associated energy conversion and transmission facilities. These statutes coexist with, and sometimes are explicitly tied to, State and local land use plans and zoning requirements. Except where specific exceptions are made in these statutes, they are generally considered by the States to be applicable to both Federal and non-Federal lands.[75]

The most common form of State legislation is a mined-land reclamation statute. Some States (for example, New Mexico) currently impose reclamation requirements on only a few minerals, primarily coal. Others (for example, Idaho, North Dakota, Montana,[76] and Wyoming) include all minerals. Some statutes cover surface mining only, while others cover both underground and surface mining. All these statutes prohibit mining operations in the absence of an approved reclamation plan and a permit. Substantial bonds are required to ensure completion of the reclamation. Some of the States require permits for prospecting or even preparatory activities prior to prospecting or mining.

Most State reclamation statutes specify certain areas where mining will not be allowed, including, for example, areas that cannot be reclaimed as required; areas where mining would constitute a public nuisance or endanger the public health and

[73] See L. Tribe, *American Constitutional Law* 460-461 n. 3 (1978); *Pittsburgh* v. *Alco Parking Corp.*, 417 U.S. 369 (1974).

[74] See the debates cited in note 66.

[75] See generally Federation of Rocky Mountain States, note 34, tables 10 and 11, at 36-39.

[76] Article IX, § 2, of the Montana Constitution requires that all lands disturbed by the taking of natural resources be reclaimed. This constitutional mandate is implemented through a series of acts codified in title 50 of the Revised Code of Montana. Ch. 10 covers coal and uranium, whether mined by surface or underground methods; ch. 12 covers hardrock minerals; and ch. 15 covers bentonite, clay, scoria, phosphate, sand, and gravel.

safety; areas adjacent to occupied dwellings, buildings, public roads, parks, streams, lakes, or other public property; and areas of exceptional, critical, or unique biological, ecological, scenic, historical, archaeological, or cultural significance.

A few State statutes provide that certain lands containing federally owned minerals may be exempted from the State reclamation requirements, but only if such lands are governed by Federal laws or regulations at least as stringent as the State requirements.[78]

However, many State reclamation statutes contain weak substantive requirements, due in large part to a fear that stronger requirements would drive mineral operators away to more lenient States, Moreover, enforcement efforts in almost all States have been weak because of inadequate staffing and funding.[79] Attempts to develop strong State programs have also been hindered by uncertainty over the development of Federal reclamation requirements, which did not exist until recently and are themselves vague and weak for minerals other than coal.[80]

Congress addressed these problems, for coal mining only, in the Surface Mining Control and Reclamation Act of 1977, which establishes tough Federal reclamation requirements for coal mining operations,[81] allows States to apply their own requirements to operations on Federal land if the State requirements are at least as stringent as the Federal requirements,[82] provides for State administration of the Federal requirements themselves on Federal land through cooperative agreements with the Secretary of the Interior (except for the Secretary's responsibility for issuing leases, approving mining plans, and designating areas as unsuitable for mining),[83] and provides Federal technical assistance, training, and funds for the development, administration, and enforcement of the State programs, including full funding of any State program under a cooperative agreement for administration of the Federal requirements on Federal land.[84]

Many of the State reclamation statutes attempt to protect surface owners who do not also own the underlying minerals by requiring consent of the surface owner to mining operations that cause surface disturbance, as well as payment of certain specified damages should mining be allowed, Some statutes, such as Wyoming's, provide for issuance of a permit despite a refusal of consent if the mining operations would not "substantially prohibit the operations of the surface owners" and if the required reclamation can be accomplished. North Dakota's Surface Owner Protection Act allows the mining applicant to sue for a determination of rights if consent is refused. The situation in Montana is not clear. The Montana Strip and Underground Mine Reclamation Act generally requires the consent of the surface owner, but exempts federally owned minerals from the consent requirement. However, the Montana Land Owner Notification Act requires notice to and consent by the surface owner of private land, without any such explicit exemption for Federal minerals. It does exempt discovery pits required to locate a mining claim on Federal land if excavated by hand with hand tools,

[77] See Mont. Rev. Code 50-1042 (Supp. 1978); Wyo. Stat. Ann. 35-502.24(g) (Supp. 1978).

[78] For example, the Montana statutes covering bentonite, clay, scoria, phosphate, sand, gravel, and hardrock minerals.

[79] Thompson and Lindahl, Congressional Research Service, Library of Congress, *State Surface Mining Laws: A Survey, A Comparison With the Proposed Federal Legislation, and Background Information*, Pub. No. 95-25, Senate Comm. on Energy & Nat. Res., 95th Cong., 1st sess. (Comm. Print 1977); U.S. General Accounting Office, Letter B-118678, May 17, 1977.

[80] See ch. 5, subsecs. D(2)(b) and E(3).

[81] 30 U.S.C. §§ 1251-1279 (Supp. I 1977).

[82] Ibid., § 1255.

[83] Ibid., § 1273.

[84] Ibid., § 1295.

and it does not apply where the prospecting or mining operation is "in accordance with the terms of a prospecting permit or lease covering any mineral interest in said land. "

As was discussed in the preceding section, State surface owner consent provisions that purport to apply to federally reserved minerals conflict directly with the Federal laws defining the respective rights of the surface owner and the mineral explorer-developer. Such provisions are, therefore, invalid as applied to federally reserved minerals. More generally, State surface owner consent provisions are subject to serious challenge as unconstitutional impairments of contract obligations and takings of property without just compensation, The Kentucky Court of Appeals recently struck down the surface owner consent provisions of the Kentucky strip-mining statute on precisely these grounds. It noted that, while the State's exercise of its police power might justify a complete prohibition of strip mining in all or certain designated areas, surface owner consent provisions permit private individuals (the surface owners) to frustrate whatever environmental conservation purpose the legislation may have by granting their consent, and therefore the primary purpose of such provisions is "to change the relative legal rights and economic bargaining positions of many private parties under their contracts rather than [to] achieve any public purpose. " The court specifically noted that the consent provision did not involve the construction and validity of the underlying contracts and deeds.[85]

However, the Federal Government, as owner of the federally reserved mineral deposits, may require surface owner consent as a condition to allowing some third party to acquire development rights for the federally reserved minerals. It very recently has imposed a surface owner consent requirement for issuance of leases for federally reserved coal deposits when such deposits are to be mined by other than underground mining techniques.[86] In addition, surface coal mining operations cannot be begun, even when the Federal Government owns the surface as well as the subsurface, if the surface is subject to a nonmineral (e.g., grazing) lease or permit, unless the surface lessee or permittee has given his written consent or the coal miner has executed a bond to secure payment for any damages to the crops or tangible improvements of the surface lessee or permitted."' A similar requirement applies to development of any Federal mineral underlying nonfederally owned surface.[88]

It should be noted that a requirement of surface owner consent (rather than simple payment for damages to surface values) allows the surface owner rather than the Federal Government to appropriate the value of the Federal minerals as well as the value of the non federally owned surface,

2. Control Over the Use of Water

Control over the use of water, including water used by private parties on Federal land, has always been a jealously guarded State prerogative, especially in the arid

[85] *Department for Natural Resources and Environmental Protection v. No. 8 Limited of Virginia*. 528 S.W.2d 684 (Ky. 1975).

[86] Surface Mining Control and Reclamation Act of 1977, § 714, 30 U.S.C. §1304 (Supp. I 1977).

[87] Ibid., § 715, 30 U.S.C. § 1305 (Supp. I 1977).

[88] See note 71.

Western States.[89] The Federal Government generally has acquiesced in each State's control over the water within its boundaries, although water rights are implicitly reserved by the Federal Government in connection with reservations or withdrawals of Federal land for a particular public purpose.") Thus, the Federal Surface Mining Control and Reclamation Act of 1977 states: "Nothing in this Act shall be construed as affecting in any way the right of any person to enforce or protect, under applicable law, his interest in water resources affected by a surface coal mining operation,''"

The State reclamation statutes require a comprehensive assessment of the water-related impacts of mining and reclamation. It can be anticipated that permits to mine will be refused when the responsible State agency determines that insufficient water would be available for reclamation or that significant damage to an aquifer would occur, Both the Montana and Wyoming reclamation statutes authorize suits by property owners against mining operators for damages due to pollution, diminishment, or interruption of water supply. The Federal Surface Mining Control and Reclamation Act reinforces the State laws with respect to surface coal mines by requiring the operator of any such mine to "replace the water supply of an owner of interest in real property who obtains all or part of his supply of water for domestic, agricultural, industrial, or other legitimate use from an underground or surface source where such supply has been affected by contamination, diminution, or interruption proximately resulting from such surface coal mine operation.[92]

In at least one respect, however, Federal and State interests in the use of water may conflict, Both Montana and Wyoming prohibit the use of water for slurry pipelines to export coal out of the State. The Wyoming legislature has made one exception, subject to certain restrictions and a right of termination, for the use of 20,000 acre-feet of water per year for a coal slurry pipeline to Arkansas.[93] Such explicit restrictions on the interstate use of water (there is no ban on use of water for any coal slurry pipeline within the State) would seem to be invalid as an unconstitutional discrimination against interstate commerce.[94]

3. Control Over the Location and Timing of Construction of Mineral-Related Facilities and Infrastructure

State and local governments can exercise substantial control over the location of mineral-related facilities and infrastructure through land use plans, zoning, permit, and other requirements related to land use and development.

Such requirements can significantly affect mineral activity on Federal land even when they are not applied directly to it, because much if not most of the infrastructure required to support mineral activity on Federal land—roads, powerlines, sites for ma-

[89] U.S. Water Resources Council, *Water for Energy Self-Sufficiency*, ch. 3 (October 1974). See generally Hutchins, Ellis, and De Braal, *Water Rights Laws in the Nineteen Western States*, U.S. Department of Agriculture Misc. Pub. No. 1206 (3 volumes: 1971, 1974, 1977).

[90] E.g., *Cappaert* v. *United States*, 426 U.S. 128 (1976).

[91] 30 U.S.C. § 1307 (Supp. I 1977); see 30 U.S.C. § 1021 (1976) (geothermal steam). More generally applicable is 30 U.S.C. § 51 (1976).

[92] 30 U.S.C. § 1307 (Supp. I 1977).

[93] Mont. Rev. Code 89-867(2) (Supp. 1977); Wyo. Stat. Ann. 41-10.5 (Supp. 1975).

[94] See L. Tribe, *American Constitutional Law*, ch. 6 (1978); cf. ibid. at 404-412.

jor conversion or generation facilities, housing, etc.—will be on non-Federal land. Moreover, mining claims patented under the Mining Law are no longer Federal land.

But State and local control over land use apparently is not limited to non-Federal land. According to the principles discussed in section C, the States' police (regulatory) power may be exercised with respect to private activities (but not those of the Federal agencies themselves) on Federal land, and it thus should extend to activities of mining claimants and mineral lessees on Federal land unless Congress has preempted its application, which Congress does not seem to have done. The Federal mining and mineral leasing laws do not preempt, but rather explicitly preserve, the application of the States' police power. And the recently enacted Federal Land Policy and Management Act of 1976 (BLM Organic Act) contains several provisions that affirm the applicability of the States' police power to private activities on Federal land. For example, the right-of-way provisions require each right-of-way across Federal land to contain conditions that will "require compliance with State standards for public health and safety, environmental protection, and siting, construction, operation, and maintenance of or for rights-of-way for similar purposes if those standards are more stringent than applicable Federal standards.[95] The sales provisions require that, prior to conveyance of any land administered by BLM, notification be given to any State or local agency "having zoning or other land use regulatory jurisdiction in the geographical area within which such lands are located, in order to afford the appropriate body the opportunity to zone or otherwise regulate, or change or amend existing zoning or other regulations concerning the use of such lands prior to such conveyance."[96] The land use planning provisions require that,

> [T]o the extent consistent with the laws governing the administration of [BLM] lands, [the BLM shall] coordinate the land use inventory, planning, and management activities of or for such lands with the land use planning and management programs of the States and local governments within which the lands are located . . . . In implementing this directive, the [BLM] ., . shall provide for meaningful public involvement of State and local government officials . . . in the development of land use programs, land use regulations, and land use decisions for [BLM] lands, including early public notice of proposed decisions which may have a significant impact on non-Federal lands. . . . Land use plans of the [BLM] under this section shall be consistent with State and local plans to the maximum extent [the Secretary of the Interior] finds consistent with Federal law and the purposes of this Act.[97]

State and local land use and zoning requirements that effectively prevented the exercise of mineral rights acquired under the Federal mining and mineral leasing laws might be held to constitute a "taking" that would require payment of just compensation under the Federal Constitution, although decisions of the U.S. Supreme Court in the past have not required compensation in cases where mines were closed down as public nuisances.[98] Moreover, overly aggressive State and local regulation of private activities on Federal land that effectively stymied Federal land use planning and management would not be valid.

[95] 43 U.S.C. § 1765(a) (1976).
[96] Ibid., § 1720 (emphasis not in original).
[97] Ibid., § 1712(c)(9); cf. ibid., § 1712(f).

[98] *Goldblatt* v. *Town of Hempstead*, 369 U.S. 590 (1962); *Hadachek* v. *Sebastian*, 239 U.S. 394 (1915); see L. Tribe, *American Constitutional Law* 457-465 (1978).

Generally, however, these sorts of problems have not arisen and are not likely to arise under current practices. Traditional land use planning and zoning are not common in the rural regions of the West where actual and projected mining activity is concentrated,[99] Where local zoning does exist, it is rarely extended to Federal land, but rather is used to control infrastructure development on associated non-Federal land. And, in some instances, the zoning power is limited with respect to mineral-related activities. For example, the Wyoming statute authorizing counties to zone and adopt land use plans with respect to unincorporated areas provides that "no zoning resolution or plan shall prevent any use or occupancy reasonably necessary to the extraction or production of the mineral resources . . ,[100] However, the Wyoming Conservation and Land Use Study Commission has recommended that this restriction be repealed.[101]

Major mineral development activity affects areas or regions encompassing many different communities and counties. Local land use planning and zoning by each affected community and county may result in conflicts and failure to adopt a comprehensive land use policy.[102] It can also result in a plethora of uncoordinated permit requirements that unnecessarily delay desirable development.[103] A few States have recently enacted comprehensive siting legislation to assure sufficient advance planning and coordination of permitting procedures for major energy facilities, including transmission facilities and routes. The laws require that a permit be obtained for any covered facility; require 5 to 10 years advance notice of all new construction, or commencement or termination of operation, of a covered facility; require submission of substantial detailed information concerning any planned facility; provide for extensive studies of socioeconomic and environmental impact (the cost of the studies is borne by the applicant); and require public hearings after notification of all affected State agencies, communities, and local citizens prior to issuance of a permit. Permits will be granted only if the environmental and socioeconomic impacts are acceptable and if the proposed facility will be compatible with (a) the public health and safety, (b) State and local land use plans and zoning requirements, unless the local requirements are unreasonably restrictive, and (c) Federal and State environmental standards. The laws provide for a "one-stop" siting and route approval agency. No further State or local approvals need be obtained once the permit has been issued.[104]

The States' emphasis on better planning, evaluation, and coordinated use of transportation and transmission corridors is complemented by the right-of-way provisions in the BLM Organic Act, which, as noted above, require rights-of-way across Federal land to comply with State siting, construction, operation, and maintenance standards that are more stringent than the Federal standards.[105] In addition, the Federal provisions require utilization of rights-of-way in common, to the extent practical, in order to minimize adverse environmental impacts and the proliferation of separate rights-of-way.[106] The Secretary of the Interior may require the user of any right-of-way, land, or other facility on BLM land to maintain or contribute his proportionate share

[99] See Federation of Rocky Mountain States, note 34, at 38-39.

[100] Wyo. Stat. Ann. 18-289.1 (Supp. 1975).

[101] Wyoming Conservation and Land Use Study Commission, 1 *Statewide Land Use Planning Program for Wyoming* (October 1974).

[102] See, e.g., *Economic Impact of the Oil Shale Industry in Western Colorado*, note 45, at 12, 17.

[103] Cf. Bosselman, Feurer, and Siemon, *The Permit Explosion: Coordination of the Proliferation* (1976).

[104] Nehring and Zycher, note 34, at 89-93, 106-115, 135

[105] 43 U.S.C. § 1765 (1976).

[106] Ibid., § 1763.

for the maintenance of such facility and to reconstruct such facility when such reconstruction is determined to be necessary to accommodate his use. [107]

E. State and Local Mineral Taxation and Revenue Distribution: Coordination With Federal Payment Requirements and Revenue Distribution

1. State and Local Mineral Taxes: Types and Effects

At least five different types of taxes are imposed by State or local governments on mineral activities: property taxes, income taxes, sales taxes, franchise or license taxes, and severance taxes. All of these different types of taxes are imposed concurrently in some States, while others rely on only one or a few of the types. The total tax burden on the mineral industry in any one State depends on the number of different taxes imposed, the basis of each tax [for example, net versus gross value), and the level (rate) of each tax.

Owners of mineral property (or interests in mineral property such as mineral leases or mining claims), like owners of nonmineral property, are subject in each State to an ad valorerm property tax on the value of the mineral property. Valuation of mineral property, however, is more difficult than valuation of most nonmineral property, at least insofar as the value of the mineral deposit itself is concerned rather than the value of mine equipment and facilities, In some States, the value of the mineral deposit itself (that is, the ore body in the ground) is estimated by calculating the present value of all future projected net earnings from the mining operation. However, this valuation method is difficult and speculative, so most States instead use the (net or gross) value of annual production, or in some instances a capitalization of annual net income, as a proxy for the fair market value of the mineral property.[108] Once the value of the mineral property is determined by either method, it is multiplied by a certain percentage to obtain the “assessed value” of the property. Often, the mine equipment and facilities are assessed separately from the ore body itself, using traditional fair-market-value valuation methods. Finally, the actual property tax is calculated by applying the tax rate, usually called a mill levy, to the assessed value. The mill levy is the same for mineral and nonmineral property, but it will usually vary from one part of a State to another, because it is set by each local government based on local revenue needs.

Most States also have corporate and personal income taxes on net income received from activities in the State, The mining industry is subject to income taxes the same as any other industry, except the mining industry is often taxed at a much lower effective rate as a result of mineral depletion allowances and other special tax subsidies.

[107] Ibid., § 1762(c).

[108] Laing, "Effects of State Taxation on Mining Industry in Rocky Mountain States," 72 *Q. Colo. Sch. of Mines*, No. 2, at 61-68 (April 1977); Ballard, "Comparison of Metal-Mining Taxation in 13 Selected Western States," 176 *Eng. & Mining J.*, June 1975, at 32, 37.

Many States impose sales taxes on the net or gross value of sales of certain goods or products in the State. A sales tax is usually applied only at the retail level, and is applied uniformly to all covered goods and products, including mineral products. Some sales taxes exclude mineral fuels used for industrial purposes,

Some States impose franchise or license taxes for the privilege of doing business in the State. The tax may be imposed on only certain types of businesses, and the basis for and rate of the tax will often vary depending on the type of business. Several States have imposed franchise or license taxes as a substitute for income taxes and have applied such taxes to all business activity in the State. A few States have imposed a special license tax on net or gross income from the production of certain minerals in addition to generally applicable franchise or income taxes. Such a special license tax is in effect a severance tax (see below).

The principal type of tax applied specifically to mineral activity as a distinct form of economic activity is the severance tax, which is imposed on the activity of severing natural resources from the land in the State (a severance tax is often imposed on timber as well as mineral production). Mineral severance taxes are almost always imposed in addition to the other State and local taxes, described above, that are generally applied to all industries within the State, Severance taxes may be imposed on all or only some minerals and are usually set at different rates for different minerals. The tax may be specified as a flat fee per unit of production, with or without adjustment for inflation, or as a percentage of the net or gross value or proceeds of production.

The reclamation fee or tax imposed by State reclamation laws to cover the expenses of State reclamation programs is often a form of severance tax, as are *'natural resource excise" taxes and similar taxes on mineral production per se.

A severance tax, or any tax based on the quantity or value of production, is in effect a royalty, because it is a charge levied on each unit of production. If it is based on the gross rather than the net quantity or value of production (net value is gross value—i.e., sale price—less costs of extraction and processing), it can prevent mining of low-profit mineral deposits that otherwise could supply needed minerals. In addition, as was discussed in chapter 4,[109] it can result in reduced mineral production if mineral production is actually started. Almost all mineral tracts contain deposits of varying thickness and quality. A tax based on gross quantity or value of production, no matter how small the tax is, may make it unprofitable to extract some portion of the lower grade ore in the depositor to extract ore from a lower grade deposit in the tract, which otherwise could have been profitably extracted. Thus, the tax encourages "high-grading" of mineral deposits while production is underway, discourages investment in techniques for boosting production through tapping of the lower grade portions of the deposits (e.g., secondary and tertiary recovery techniques for oil and gas deposits], and forces premature termination of production when all the higher grade ore has been extracted. Mineral resources that could have been extracted are left in the ground and will probably never be extracted given the high costs of restarting production once it has been terminated. The result is not only a loss of producible minerai resources, but also more damage to nonmineral resources than would otherwise be in-

[109] Ch. 4, subsecs. E(2) and F(3).

curred, since more deposits will have to be mined to obtain the desired quantity of mineral production. Even when the same mine is reopened, the surface will be disturbed twice rather than only once.

Nevertheless, State taxes (or Federal royalties) based on the gross quantity or value of mineral production would be efficient if they served as a charge for the net environmental, socioeconomic, and other costs imposed on persons other than the mineral producer by each additional unit of production. If that were the case, the mineral producer would simply be forced to weigh all mineral and nonmineral benefits and costs in deciding whether to produce the additional unit. If the total costs outweighed the benefits, the production of one more unit would be wasteful.[110]

But production payments, whether based on the net or gross value of mineral production, do not serve as such a charge for costs imposed on others, since the amount of damage is not directly related to the quantity or value of production. For example, most of the environmental and socioeconomic damage occurs in the exploration and development stages of mineral activity before production has even begun-indeed, production may never begin, even though exploration or development, or both, have been completed. Once the mine has been opened and production has begun, little or no additional environmental and socioeconomic damage may result from each unit of production. For example, digging farther in an existing tunnel or pit to produce lower grade ore may result in little if any additional surface disturbance. In fact, as was discussed above, it may prevent additional surface disturbance caused by a later reopening of the mine or the opening of another mine.

Sometimes it is thought that gross-value taxes provide more certain and predictable tax revenues when economic conditions, and hence profitability, decline. But a gross-value tax may lead to less stable rather than more stable revenues under such conditions, since it can make mining unprofitable and thus cause termination of production and a total loss of tax revenue, whereas a net-value tax would continue to bring in revenue, even though the revenue might be reduced. Moreover, stability of revenue is most critical at the local level, which relies heavily on property taxes. A large portion of the property tax base associated with mineral and energy development is made up of equipment and facilities and other fixed capital items that can be assessed using traditional fair market value methods, rather than an annual proceeds method, and that therefore can provide a substantial revenue base independent of production. This is the case, for example, with the major energy generation and conversion facilities that are viewed as posing some of the more substantial socioeconomic problems, Mines themselves are also very capital intensive.[111] Thus, it has been suggested that the most reasonable tax on a mine, from the standpoint of mineral production, resource conservation, and stable tax revenue, may be a property tax based on "the assessment of the mine plant on the same basis used for any other industrial plant and the assessment of the ore body based on the 'net proceeds' calculation."[112] Any fluctuation in the net proceeds portion of the property tax (or any alternative type of tax on net value) "could be overcome by an averaging [over several years] method, or

[110] See ch. 4, subsec. E(1).

[111] Federation of Rocky Mountain States, note 34, at 65.

[112] Laing, note 108, at 99.

even a minimum requirement based on payments in previous years. But in all fairness, some allowance for payments in periods of nonproduction should carry over to productive years in the form of tax credits.''[113]

Tax liability based on the gross value of production can result, as was discussed above, in substantial waste of mineral and nonmineral resources. However, many States impose mineral taxes based on the gross amount or value of production of some or all minerals,'" For example, Montana has imposed a 30-percent tax on the gross value of surface-mined coal other than low-grade lignite, an additional "resource indemnity trust" (severance) tax of one-half of 1 percent on the gross value of all mineral production including coal, and a property tax based on an assessed valuation of 45 percent of annual gross proceeds of surface coal mines.[115] When these taxes are added to the minimum 12.5-percent Federal royalty and the 10-percent (or 35 cents per ton, whichever is less) Federal reclamation fee on the gross value of surface-mined Federal coal[116] (half of the Federal royalty and fee are paid directly to the State of Montana[117]), plus overriding royalties reserved by assignors of Federal coal leases that can be equal to half or more of the Federal royalty,'" it is apparent that mining of Federal coal in Montana could be extremely wasteful in terms of maximum economic recovery of mineral resources and conservation of mineral and nonmineral resources, despite Federal and State requirements and declarations of concern related to maximum recovery and resource conservation.[119]

The mineral industry is usually the only industry subjected to gross-value taxes (other than the retail sales tax). Property taxes for nonmineral business properties are based in theory on fair market value—that is, what a buyer would be willing to pay for it. A buyer will be willing to pay only the present value of projected future net earnings from the property. General franchise or license taxes are either a flat fee or a percentage of net proceeds from the business. Moreover, the mineral industry is usually the only industry other than the timber industry subjected to special production taxes such as the severance tax.

Several reasons have been offered for the heavier tax burden placed on the mineral industry under most State tax systems (but note that the burden is usually lighter for one tax—the income tax—as a result of mineral depletion allowances and special expense provisions). First, it is reasoned that mineral resources, or at least the higher grade mineral resources, have an inherent value above the value added by the effort spent in finding, developing, and producing them—a "natural bounty" that can be taxed away and used for the benefit of the public as a whole without affecting mineral production or overall efficiency. However, State efforts to capture the natural bounty, if any exists, for Federal minerals can be objected to on the grounds that (a) the bounty belongs to the Federal Government, as owner of the resource and also as representative of all citizens in the Nation, rather than to any particular State and its citizens and

[113] Ibid., at 100.

[114] See *Laing*, note 108, at 39-70; Ballard, note 108; Yasnowsky and Graham, "State Severance Taxes on Mineral Production," *Proc. 105th AIME Ann. Meeting*, 1976, at 45-58, reproduced as U.S. Bureau of Mines paper OP 63-76; Colorado Legislative Council, *Report to the Colorado General Assembly: Recommendations for 1976 Committee on Mineral Taxation*, Res. Pub. No. 214 (November 1975).

[115] Laing, note 108, at 46-52.

[116] 30 U.S.C. § 207(a) (1976); ibid., § 1232 (Supp. I 1977).

[117] See subsec. 3.

[118] See ch. 4, subsec. F(3).

[119] See ch. 4, subsec. F(4); Federation of Rocky Mountain States, note 34; Strip Mined Coal Conservation Act of 1973, Mont. Rev. Code 50-1401 to 1409 (Supp. 1977).

(b] the U.S. Congress has explicitly declared that the Federal Government shall collect this bounty for leasable minerals by requiring fair market value to be paid for such minerals. Moreover, as was discussed in detail in section E of chapter 4, payment requirements designed to capture this natural bounty should be based on net rather than gross value of production.

A variation on the natural bounty rationale is the conversion of this bounty into a "natural heritage" belonging to the State, which is irretrievably lost when the mineral is removed from the earth and sold for private profit, thus justifying a State tax to compensate the State (or, more precisely, its citizens) for at least a portion of its lost wealth.[120] The natural heritage rationale suffers from the same flaws as the natural bounty rationale on which it is implicitly based: the "heritage" belongs to the Federal Government rather than to the State insofar as Federal land is involved, and the "lost wealth" can be no more than the net value of production. A tax based on gross value captures the wealth added by the efforts of mineral operators in addition to the value of the mineral deposit in the ground prior to identification, development, and production. Moreover, the natural heritage rationale is a rather circular one: the mineral deposit does not have any monetary value to the State or its economy until it is found and produced, so that discovery and production of the mineral deposit produces or "frees" value rather than resulting in any loss of value to the State, The mineral will have no value to the State if it is never produced, Finally, the gross-value tax itself results in a loss in mineral wealth or "natural heritage" because it prevents some low-grade deposits from being mined and causes high-grading of other deposits.

Similarly, a tax imposed to create a "trust fund" to tide the State over when all its minerals have been removed is a forced subsidization by present consumers across the Nation of a continued higher level of spending by the State that is no longer needed to pay for the impacts of mineral development (see the next paragraph) and would never have been possible in the first place if there had been no mineral activity, If the State wants to maintain a high level of economic activity in its "postmineral era" rather than returning to its prior rural base (augmented by the capital improvements constructed during the mineral era), it might be healthier and more productive for the State, and the Nation as a whole, if that economic activity were maintained through development of new profitmaking industry rather than through income from a trust fund. Moreover, the basic premise for the establishment of a trust fund—the exhaustion of the State's mineral resources—is itself flawed in at least some cases: Montana officials, for example, estimate that the State has enough recoverable coal "to last us a thousand years with some left over.[121]

A fourth rationale advanced for a heavier tax burden on the mineral industry is the burden placed on State—and especially local—governments in rural areas by mineral activity, particularly activity that produces the boom-bust phenomenon. However, the capital-intensive facilities and related economic activity associated with mineral and energy production will almost always produce sufficient additional tax revenue through normal property taxes, sales taxes, and income taxes to pay for the additional public facilities and services required as a result of the mineral activity. The problem

[120] See, e.g., Colo. Rev. Stat. 39-29-101 (Supp. 1977).
[121] Richards, "Boom in Strip Mining: Windfall for Montana," Washington Post, May 22, 1977, at A1, A4.

is not insufficient revenue, but rather ensuring that the revenue gets to the affected jurisdiction in a timely manner, so that needed public facilities and services are in place before the boom hits and are paid for before the bust, if there is a bust.[122] The problems of revenue distribution and timing are discussed in subsection 2, where it is also pointed out that the amount of mineral revenue being collected by some States is greatly in excess of the amount required to cover the socioeconomic impacts of mineral activity. For example, ones studv, using generous estimates of The State and local investments and expenditures required to cope with the socioeconomic impacts of a surface coal mine producing 10 million tons per year in Montana, calculated that a 11 the necessary public investment and expenditures could be covered by using only 62.5 percenl of the first year's severance tax to cover the necessary capital investment and 12.5 percent of the first and each succeeding year's severance tax to cover annual expenditures on services.[123] The rest of the severance tax, plus all the State and local property. income, sales, and resource indemnity trust taxes at attributable to the mineral activity, plus all the mineral leasing revenue received from the Federal Government (see subsection 3), would be surplus revenue.

When this abundance of revenue is acquired by the State at the expense of consumers throughout the Nation, and when it is collected through gross-value taxes that may prevent mining of much Federal coal and result in high-grading of other coal, serious questions may be raised as to whether Montana's mineral taxation system, and others like it, impose an intolerable burden on interstate commerce or on the Federal Government's management and disposal of its property. Congress might want to remedy such a burden, even if it is not so severe as to be unconstitutional given the leeway afforded the States by the Mineral Leasing Act.[124]

The net effect of Federal, State, and local mineral royalties, fees, and taxes on efficient mineral production and total resource conservation should be carefully investigated as part of a more rational, coordinated approach to Federal mineral land management and, more generally, national fuel and non fuel mineral policy.

2. Magnitude and Disposition of State Revenues Derived From State and Local Mineral Taxes

As was discussed in subsection 1 above, the principal State and local taxes imposed on mineral-related activities are the property, sales, income, license, and severance taxes.

The main sources of tax revenue at the local level are the property and sales taxes. The property tax is almost always assessed and collected at the local level, although the purposes for which the tax may be assessed and the permissible rates of assessment are usually specified by the State legislature, and in some States a State property tax is levied in addition to the local property taxes. The sales tax may be imposed at the local level separately from or in addition to any State sales tax, again as

[122] Federation of Rocky Mountain States, note 34, at 63-70, 74-76, 132. See the detailed discussion in subsec. 2.

[123] Nehring and Zycher, note 34, at 148-149; see also Richards, note 121.

[124] See sec. C.

allowed by the State legislature. If there is only a State sales tax, local governments are sometimes given a fixed percentage of the State sales tax revenues derived from sales in their jurisdictions. Local governments also receive substantial revenue from utility and license fees and charges.

The main sources of tax revenue at the State level are sales, income, license, and severance taxes. Several of the States return a portion of some or all of these taxes to the locality from which they were collected. The sales tax is the most common example: Colorado, for instance, returns three-fourths, while Wyoming has recently increased the portion it returns from one-sixth to one-third. Montana returns a small portion (1.5 percent until 1980, none thereafter) of its coal severance tax to the county in which the coal was produced and allocates one-fourth of the State income tax to support schools in the State. Utah allocates a portion of the State taxes on income, corporations, property, cigarettes, and liquor to each school district. Generally, each State provides substantial assistance to school districts throughout the State. ’z’

Several studies have shown that even those localities most adversely affected by mineral and energy development activity can receive sufficient revenue through State and local taxes to cope with the socioeconomic impacts of that activity.’” Mineral and energy development activity are capital-intensive and generate substantial economic activity in any area in which they are undertaken. In fact, the additional revenue generated as a result of the expansion of the tax base by mineral-related facilities and activity has enabled or will enable most localities to reduce their property tax rates and thus lower the tax burden on permanent residents.

Generally, the problem is not insufficient State and local revenue, but rather ensuring that the revenue gets to the unit of government that needs it in a timely manner. Mineral-related construction and development usually occur in the rural areas of a county outside the cities and towns. The counties and school districts benefit from the expansion of the property tax base, while the cities bear the increased burden on public facilities and services (other than schools and county roads) due to the increased population. Thus, each of the counties and school districts analyzed in the impact studies mentioned above, except the Farmington, N. Mex., school district, had or was projected to have either budget surpluses or reduced property tax rates as a result of increased property tax revenues flowing from mineral-related development. The Farmington school district and the cities and towns studied did not derive similar benefits, since the mineral development lay outside their respective boundaries.

The cities and towns generally rely on sales taxes, utility and license fees and charges, and varying amounts of Federal revenue-sharing and other grants as sources of revenue at least as important as the property tax. Several of the cities and towns

See the studies cited in note 126.

Federation of Rocky Mountain States, note 34, at 63-70; Hickok and Samuelson, Office of Minerals Policy Development, U.S. Department of the Interior, *Economic Impact of Projected Energy Development: Craig and Moffat County, Colorado* (December 1975); Real Estate Research Corporation, *Excess Cost Burden, Problems and Future Development in Three Energy Impacted Communities of the West* (September 1975); Resource Management Systems, *A Description of Potential Socioeconomic Impacts From Energy-Related Developments on Campbell County, Wyoming* (September 1975); Johnson and White, *Colstrip, Montana: The Fiscal Effects of Recent Coal Development and an Evaluation of the Community's Ability to Handle Futher Expansion* (October 1975). All of these studies except the Federation of Rocky Mountain States study were prepared for the Office of Minerals Policy Development of the U.S. Department of the Interior. A recent analysis which generally reaches conclusions similar to those in the case studies done for the Department of the Interior is J. Krutilla, A. Fisher, and R. Rice, *Economic and Fiscal Impacts of Coal Development: Northern Great Plains* (1978).

studied—e.g., Rock Springs, Wyo., and Vernal, Utah—were able to reduce their property tax rate because of increased revenue from sales taxes or other sources resulting from mineral-related activity, Only Gillette, Wyo., faced a serious long-term problem of insufficient local revenue to meet the socioeconomic burden of mineral development. Vernal was relying heavily on Federal grants and assistance rather than local property, sales, or other taxes or fees. In fact, as was noted above, Vernal was reducing its property tax rate. In general, however, the cities and towns, when compared with the counties and school districts, were finding it more difficult to cope with the socioeconomic impacts of mineral development, since they faced the brunt of the population influx but, except through sales taxes, did not share in much of the additional revenue generated by that development.

The potential scope of the problem created by separation of the tax base and the affected unit of government is suggested by projections in one study that cities and towns would need some $600 per year to service each new resident, but that based on revenue sources available to such municipalities they could expect to realize tax revenues attributable to each new resident of only $210 to $450 per year. The study noted that State and local taxes on the mineral developments themselves would provide more than enough funds to make up the deficit, but those funds usually are not available to the municipality.[127]

The distribution problem is not a problem for municipalities only. As was mentioned above, the mineral developments near Farmington, N. Mex,, are situated outside the Farmington school district, which services much of the increased population resulting from those developments. Similarly, the impact study for Colstrip, Mont., noted that many of the construction workers on the mineral projects in the Colstrip school districts lived outside those school districts and even outside the county. Another study of six counties in Montana, North Dakota, and Wyoming expected to be heavily impacted by mineral and energy development projected that in four of the six counties incremental revenues, due to such development, received in 1985 (compared to revenues received in 1974) would be 2 to 6 times greater than incremental budget costs, while in the other two counties incremental budget costs would be 1 to 38 times greater than incremental revenues. The county with the worst budget-revenue imbalance, Sheridan County in Wyoming, could also have the most difficulty in correcting the imbalance, because it results from development in another State rather than just another county in the same State:

> Presumably, many coal miners and plant personnel will select Sheridan (city) as their place of residence while working in the coal fields just across the State line in Big Horn County, Montana. The city and county of Sheridan will be called on to provide the needed social services generated by the employees who work in Montana. Yet Sheridan will not receive any tax benefits from the exploitation of Montana Coal.‘“

Except for interstate impact problems similar to those faced by Sheridan city and county, it is clear that State and local revenues generated by mineral development ac-

[127] Federation of Rocky Mountain States, note 34, at 65.

Northern Great Plains Resources Program, *Socio-Economic and Cultural Aspects Work Group Report* 124-127 (June 1974). Another study affirms the projected *interstate* distribution problem for Sheridan but also projects an *intrastate* problem due to development in neighboring Johnson County in Wyoming. Nehring and Zycher, note 34, at 122.

tivity are usually sufficient in the aggregate to cope with the socioeconomic impact of that mineral development activity, This would probably be the case even if only State and local property, sales, and income taxes were considered. [129] It is surely the case when recently enacted or increased severance taxes are also considered. For example, Montana received about $34 million in 1977 from its severance tax on coal. [130] Projected increases in coal prices and coal production are expected to result in hundreds of millions of dollars of severance tax revenue per year for Montana and other Western States. [131] None of the States that have, like Montana, Colorado. and North Dakota, recently instituted or increased mineral severance taxes have felt it necessary to use more than a small portion of the incremental revenues generated to pay for the socioeconomic impact of the mineral activities being taxed (see below). The problem is the distribution of State and local revenues rather than the sufficiency of those revenues.

Another problem is the timing of receipt of revenue. Public facilities and services must be provided for the population influx associated with mineral development activity, prior to the time revenues are generated by addition of property improvements to the tax rolls or by taxation of production. Moreover, high front-end public expendiures for capital improvements will be required, which may exceed any one year's revenues.

The traditional response to both of these timing problems has been to obtain the front-end money through loans or bonds secured by future tax revenues. But State laws often limit the ability of local units of government to incur such indebtedness. For example, Wyoming limits local city indebtedness to 2 percent of the assessed valuation of property in the city, which is unusually restrictive when compared to 4- to 6-percent limitations elsewhere.[132] Residents of some cities and counties are extremely reluctant to incur any public debt. Most of the cities, school districts, and counties analyzed in the impact studies mentioned above that experienced or will experience front-end financing problems have been unwilling to alleviate those problems through the traditional bonding mechanism.

In certain instances, local units of government may find it difficult to obtain loans or issue bonds at favorable rates because of their limited capital assets. This may be particularly troublesome in rural areas that were sparsely populated and had few public facilities prior to mineral development. However, this does not appear to have been a significant problem for the cities, school districts, and counties analyzed in the impact studies discussed above, which generally were able to obtain financing based on anticipated property or sales tax revenues. Where the limited capital base of the local unit poses a problem, the State itself could provide security or serve as the financing agency.

Generally, however, the States have been unwilling to finance continuing or front-end costs of local units of government unless the local unit has demonstrated that it is unable, and not just unwilling, to finance those costs itself. The State governments apparently feel that most local units can handle the problems themselves, using incre-

[129] See the studies cited in note 126.

[130] Hearings on S. 1493 before the Subcomm. on Regional and Community Development of the Senate Comm. on Envir. & Public Works, Ser. No. 95-H28, 95th Cong., 1st sess. 54 (1977).

[131] See Colorado Legislative Council, note 114, at 10[illegible]; Richards, note 121.

[132] Real Estate Research Corporation, note 126.

mental revenues derived from property and sales taxes on the mineral-related activity, issuance of bonds in anticipation of such revenues, and issuance of bonds for construction of public utilities to be repaid out of fees and charges for the services provided by such utilities.

Thus, the States generally avoid automatic allocation of tax revenues to the local unit in which such revenues were generated, preferring to allocate revenues on a showing of need to overcome particular distribution and timing problems, The exceptions are the traditional sources of local revenue, the property and sales taxes. Even these are subject to limitations and equalization formulas in different States. Montana returns a very small portion— 1.5 percent until 1980 and none thereafter—of its coal severance tax revenue to the county in which the coal was produced. These direct automatic allocations are made without any showing of need and may be more or less than what is actually needed by a particular local unit, ’

The bulk of State assistance to local units of government is provided under discretionary allocations that can be used to overcome the distribution and timing problems associated with automatic allocations. Even these discretionary allocations are limited to a relatively small part of the incremental tax revenue generated by mineral activity in a State.

For example, Colorado has recently amended its mineral taxation laws by imposing severance taxes on the production of metallic minerals, molybdenum [treated distinctly although it is a metallic mineral), and oil shale for the first time and greatly increasing the existing severance tax on coal to a level just below North Dakota’s coal severance tax. Property taxes on metallic mineral properties can be credited against half of the metallic mineral severance tax due, and 87.5 percent of property taxes on oil and gas properties, excluding equipment, can be credited against oil and gas severance taxes due. The revenues from the mineral severance taxes are distributed as shown in table 6.2. [134]

As table 6.2 shows, the Colorado legislature has determined that only 10 to 45 percent (depending on the mineral) of Colorado’s new, incremental severance tax revenues are needed to assist local governments affected by mineral development activity prior to June 30, 1981. No revenues are allocated to the local government fund after June 30, 1981, although the legislature may change the allocation formula prior to then. Larger amounts, decreasing from 40 to 70 percent (depending on the mineral) in fiscal 1978 to 20 to 50 percent in fiscal 1981 and zero percent thereafter, are allocated to the State’s general fund to support current State programs unrelated to local socioeconomic impact. Finally, substantial amounts, increasing from 15 to 40 percent (depending on the mineral) in fiscal 1978 to 35 to 40 percent in fiscal 1981 and 100 percent thereafter, are allocated to a trust fund, which “is to be perpetual and held in trust as a replacement for depleted natural resources. ” The income from the investment of trust funds is to be deposited in the general fund,

As was discussed in subsection 1, the use of mineral severance tax revenues, rather than generally applicable property, sales, and income tax revenues, to fund

See the studies cited in note 126.

[134] Colo. Rev. Stat. 39-29-101 to 39-29-114 (Supp. 1977)

Table 6.2 .—Allocation of Colorado Mineral Severance Tax Revenues
(percent)

	Oil & gas	Coal	Oil shale	Molyb-denum	Other metallics
Fiscal years 1978 and 1979					
General fund	100	40	40	70	40
Trust fund .	—	15	40	20	15
Local government fund.	—	45	20	10	45
Fiscal year 1980					
General fund	100	30	40	60	30
Trust fund, . .	—	25	40	30	25
Local government fund. ., . .	—	45	20	10	45
Fiscal year 1981					
General fund	100	20	40	50	20
Trust fund, ...	—	35	40	40	35
	—	45	20	10	45
	100	100	100	100	100

current (through the general fund) and future (through the trust fund) State programs unrelated to coping with the socioeconomic impact of mineral development is in effect a forced subsidization by mineral producers, and hence consumers across the Nation, of a high level of State spending on behalf of its citizens into the indefinite future. The mineral activity expands the economy and the traditional property, sales, and income tax base of the State, thereby reducing the burden on the individual State citizen. Any incremental socioeconomic burden can usually be handled through the incremental property, sales, and income tax revenue. If those sources are insufficient, a mineral severance tax to meet the deficiency is justified. But any mineral severance tax in excess of the amount required to meet a deficiency in the traditional sources of revenue, generally applicable to all industries, is in essence a penalty or “double dip” imposed on the very industry that is responsible for more jobs and income in the State. It is a tax on consumers across the Nation to subsidize citizens in a particular State, a tax unrelated to any adverse effects of mineral activity and imposed on wealth that would never be produced if the minerals “lost”’ by mining were instead left forever in the ground,

The Colorado mineral severance tax revenues allocated to the local government fund are distributed to the counties and municipalities affected by mineral development in two different ways. Fifteen percent of the local government fund, or 1.5 to 6.75 percent (depending on the mineral) of total severence tax revenues for minerals other than oil and gas, are automatically distributed to the counties and municipalities in proportion to the number of employees of each mine or related oil shale facility who reside in each county’s unincorporated area or in each municipality. Thus, dollars are appropriately distributed to the local units of government that bear the burden of the (mine-related only) population influx rather than those that happen to contain the mine. The remaining 85 percent of the local government fund, or 8.5 to 38.25 percent (depending on the mineral) of total non-oil-and-gas severance tax revenues, is distributed at the discretion of the executive director of the Department of Local Affairs to those local units socioeconomically impacted by mineral and related energy development, to be used by them for the planning, construction, and maintenance of public facilities and the provision of public services. The executive director receives advice from an energy impact assistance advisory committee which, among other things, makes recommendations on the extent of local tax resources available to each local unit of government and the extent of tax effort made by each local unit in solving impact problems.

Montana allocates even less of its severance tax revenues to local impact assistance. The allocation of revenues from the coal severance tax is shown in table 6.3. Article IX, section 5 of the Montana Constitution, which became effective in 1977, requires that at least 25 percent (50 percent after 1979) of all coal severance tax revenues be placed in a trust fund, the principal of which "shall forever remain inviolate unless appropriated by a vote of three-fourths of the members of each house of the legislature. " The income from the trust fund may be appropriated by the legislature for any purpose. The county where the coal is mined automatically receives 1.5 percent (none after 1979) of the coal severance tax revenues, Another 9,75 percent (none after 1979) is allocated for reconstruction of primary and secondary highways adversely affected by coal development (Federal matching funds will provide three-fourths of the sums required for road reconstruction). The minimum 7.225 percent (10 percent after 1979) allocated to the education trust fund is absolutely inviolate under the Montana Constitution, except that income from the fund can be used to support the State's public schools and university system. The 7.5 percent (5 percent after 1979) allocated to the school equalization fund might benefit some affected school districts. The maximum 12,65 percent (8.75 percent after 1979) allocated for 1ocal impact assistance is distributed to local units of government at the discretion of the Coal Board, which must consider the degree of effort by local units to deal with impact problems and must distribute at least one-half of the grants to local units experiencing a population growth of at least 10 percent during any three years since 1972. The Coal Board requires an applicant to show that Federal funds were sought prior to requesting State funds. Unused impact funds are dedicated to the education trust fund. '

Montana's separate resource indemnity trust tax, a severance tax applicable to all minerals, is used to fund a resource indemnity trust fund. The income from fund investments, plus the tax receipts themselves once the fund reaches $100 million, is used to "improve the total environment and rectify damage thereto, " Proceeds from another tax, on sales of electrical energy produced in the State, are placed in the general fund.[136]

Montana has addressed the front-end money problem by authorizing counties that will be substantially and adversely affected by the construction or operation of a major new industrial (including mining) facility to require prepayment, as needed, of three times the estimated property tax due the year the facility is completed. One-fifth of the amount prepaid can be credited against property taxes due in each of the first 5 years of the facility's operation. Voluntary prepayment of taxes for other new mineral-related facilities is encouraged by the provision for reduction of assessed valuation from 30 to 7 percent for the first 3 years of operation if the facility will not create an adverse impact on local services, or if the owner agrees to prepay taxes "sufficient to

Mont. Rev. Code 84-1319, 50-1806(4), 50-1807, 50-1810 (Supp. 1977); hearings on S. 1493, note 130, at 45.

Johnson and White, note 126, at 50-51.

Table 6.3.—Allocation of Montana Coal Severance Tax Revenue (percent)

Fund	1977-79	1980 and thereafter
Natural heritage trust fund	25.0	50.0
School equalization	7.5	5.0
Local Impact and education trust	19.875	18.75
Minimum to education trust	7.225	10.0
Maximum to local Impact	12.65	8.75
Coal area highway improvement	9.75	—
County where coal is mined	1.5	
General county land planning	0.75	0.5
Alternative energy research	1.875	2.5
Renewable resource development	1.875	1.25
Parks, historical & cultural sites	1,875	2.5
General fund	30.0	19.5
Total	100,0	‘1 00.0

satisfy tax requirements caused by the location and construction of the facility during the construction period. [137]

North Dakota distributes its coal severance tax revenue in the same general manner as Colorado and Montana. Twenty percent is allocated automatically to the county in which the coal was produced. Another 35 percent is allocated to a special fund for discretionary distribution by the coal development impact office to local units of government affected by coal development. Fifteen percent is allocated to a trust fund, income from which is deposited in the State’s general fund. Loans, but not grants, can be made to impacted local units from the trust fund. The remaining 30 percent is deposited directly in the general fund. The State also allocates 35 percent of the revenue from a coal conversion privilege (franchise or license) tax to each county containing coal conversion facilities. Each county receiving automatic allocations of severance tax or conversion privilege tax revenues must distribute 30 percent of all such revenues to county school districts in proportion to their attendance, 40 percent to the county general fund, and 30 percent to the incorporated cities in the county in proportion to their population. [138]

Wyoming has a three-tiered severance tax, according to which a) all mineral production is taxed at 2 percent of gross value, b] fossil fuel minerals (coal, oil, gas, oil shale, tar sands) and trona are taxed an additional 2 percent, and c) coal is taxed yet another 2 percent (the tax was phased in over a 5-year period from 1974 to 1978) until total revenues collected under this third tax reach $120 million, at which point the tax terminates. The revenue from the first tax is deposited in the State’s general fund. The revenue from the second tax is deposited in a Permanent Mineral Trust Fund, income from which is deposited in the general fund. The legislature may provide for loans from the fund to local units of government, and use of one-fourth of the fund for such purpose has been authorized (see the next paragraph). The revenue from the third tax is allocated to a special account for discretionary distribution by the Farm Loan Board, through direct grants or pledges of security, to local units of government directly or in-

[137] Ibid., at 47-48, 50; Colorado Legislative Council, note 114, at 104-105.

[138] N. Dak. Cent. Code 57-60-15, 57-60-14, 57-62-01 (Supp. 1977).

directly affected by the production of coal, to assist in financing public water, sewer, highway, road, or street projects, At least 60 percent of the revenue must be used to finance highway, road, or street projects. Local units will not receive assistance for any project unless they show that the project is necessary, that all available sources of local revenue have been or will be fully utilized, and that local revenues are insufficient.[139]

Wyoming also established a Community Development Authority, which was authorized to issue up to $100 million in State bonds. The proceeds were to be used to make loans to local units of government to cover the front-end costs of acutely needed public facilities that could not be provided for through conventional planning or financial sources. Bonds were to be repaid out of the revenues and receipts derived from the facilities, other sources of local revenue, or from a special reserve fund that could be established using one-fourth of the 2-percent severance tax on fossil fuel minerals and trona. The Community Development Authority was also authorized to provide assistance to the private sector housing market in areas impacted by mineral development by making loans—when private financial resources were inadequate to furnish housing needed in such areas—to mortgage lenders, under certain restrictions on the use of such loans and limitations on interest rates that could be charged.[140] Recently, however, the Wyoming court ruled that the Community Development Authority provisions are invalid under the Wyoming constitution.

Wyoming has adopted a number of other measures to increase local revenues (e.g., the local share of the sales tax was increased from one-sixth to one-third) and to provide for distribution of local revenues to those local units that need them. Prominent examples of laws enacted to deal with the distribution problem are the Joint Powers and Joint Facilities of Governments Acts, which allow local units of government—counties, cities, school districts, and other special districts—to pool their revenues to construct and operate public facilities. Thus, a county, which gets the property tax revenue from mineral projects, may now be expected by the majority of its voters (who reside in its cities) to share its wealth with the cities, which bear the burden of the population influx.[141]

In sum, State and local sources of mineral-related revenue seem more than adequate to cope with the environmental and socioeconomic impact of mineral development on Federal and non-Federal (onshore) land. Furthermore, as the preceding discussion indicates, the problems of distribution and timing flow mainly from restrictions and divisions of responsibility imposed by State law and, therefore, are most appropriately handled by the States themselves rather than through Federal intervention.[142]

3. Magnitude and Disposition of Federal Revenues Received Under the Onshore Mineral Disposal Laws and Related Federal Laws

The Mineral Leasing Act of 1920 accounts for almost all the revenue received by the Federal Government under the Federal onshore mineral disposal laws. Over $3.2

[139] Colorado Legislative Council, note 114, at 37-38, 110-111; Resource Management Systems, note 126, at 69-70.

[140] Colorado Legislative Council, at 101, 108-109; Resource Management Systems, at 64-67.

[141] Colorado Legislative Council, at 109-110; Resource Management Systems, at 57-74, especially 57-60 and 70-71.

[142] See also GAO *Socioeconomic Issues Study*, note 40, at 53-59.

billion in revenue had been generated under the Act between 1920 and the end of FY 1976,[143] even though, as is discussed in chapter 4, rentals and royalties were kept at low or minimum levels for most of this period.

Until late in 1976, the Act required that 37.5 percent of all revenues (sales, bonuses, rentals, and royalties) received under the Act be returned to the respective States in which the revenue was generated to be used as each State legislature might direct "for the construction and maintenance of public roads or for the support of public schools or other public educational institutions."[144] The intent behind this requirement was to help the States with the increased demand for and burden on public roads and schools resulting from mineral activity under Federal leases.

From 1920 to June 30, 1976, over $1.3 billion of public domain mineral leasing revenues were distributed to the Western States for road and school purposes. Seven States received in the aggregate almost 97 percent of the distributed revenue, or over $50 million each: Alaska ($124 million), California ($118 million], Colorado ($184 million), Montana ($61 million), New Mexico ($278 million), Utah ($82 million), and Wyoming ($443 million). Each of the seven States received over $1 million in FY 1976: Alaska ($2 million), California ($7 million), Colorado ($34 million), Montana ($5 million), New Mexico ($28 million), Utah [$6 million), and Wyoming ($38 million).[145]

Another 52.5 percent of the public domain mineral leasing revenues was dedicated to construction of irrigation projects to reclaim arid or semiarid western land and render it cultivable under the Reclamation Act of 1902.

Altogether, 90 percent of the public domain mineral leasing revenues was returned directly or indirectly to the Western States. The remaining 10 percent was deposited in the Treasury of the United States as part of the general fund.

Late in 1976 the Mineral Leasing Act of 1920 was amended by increasing the States' direct share of the revenues from 37.5 to 50 percent and decreasing the share dedicated to the reclamation (irrigation project) fund from 52.5 to 40 percent. (Both before and after the amendment, Alaska received directly 90 percent of the revenues generated in Alaska, since the Reclamation Act does not apply to Alaska.) The Federal Government still retains only 10 percent of the revenue.[146]

In addition, Congress, recognizing that the socioeconomic impacts of mineral activity today are not limited to impacts on roads and schools, broadened the permissible use of each State's direct 50-percent share to include "[i) planning, (ii) construction and maintenance of public facilities, and (iii) provision of public service" by the State and its subdivisions, "as the legislature of the State may direct giving priority to those subdivisions of the State socially or economically impacted by development of minerals leased under this Act. " Alaska is not restricted in the use of its 90-percent share.[147]

Congress also made mineral revenues received under the Geothermal Steam Act of 1970 subject to the same 50-40-10 (90-10 in Alaska) distribution formula, including

[143] U.S. Bureau of Land Management, *Public Land Statistics, 1976*, table 114 (1977).

[144] Act of Feb. 25, 1920, § 35, 41 Stat. 437, 450 (1920).

[145] *Public Land Statistics*, note 143, table 120.

[146] Although several laws amended the revenue distribution scheme in 1976, the final comprehensive amendment was subsec. 317(a) of the Federal Land Policy and Management Act of 1976, codified at 30 U.S.C. § 191 (1976).

[147] Ibid.

the same restrictions on use and the same directions on priority of distribution. However, apparently due to a drafting error, the priority of distribution does not extend to areas impacted by geothermal steam development, as the priority applies only to areas "impacted by development of minerals leased under this [1920 Mineral Leasing] Act."[148]

Finally, Congress addressed the front-end money problem—the problem of obtaining funds needed to construct, expand, or improve public facilities or services prior to the time mineral-related revenues are received—by authorizing the Secretary of the Interior to "make loans to States and their political subdivisions in order to relieve social or economic impacts occasioned by the development of minerals leased in such States pursuant to the [Mineral Leasing Act of 1920]."[149] (Note again the probably inadvertent omission of impacts occasioned by the development of geothermal steam under the Geothermal Steam Act of 1970.) The loans, which bear a maximum interest rate of 3 percent, cannot exceed the anticipated Federal mineral revenues (under the Mineral Leasing Act of 1920) to be received during any prospective 10-year period by the loan recipient (loans to Alaska cannot exceed 55 percent of anticipated Federal mineral revenues), must be confined to the uses specified for such Federal mineral revenues (planning, construction, and maintenance of public facilities, and provision of public services), and must be repaid from such Federal mineral revenues to be received by the loan recipient, The Secretary must, after consultation with the Governors of the affected States, "allocate such loans among the States and their subdivisions in a fair and equitable manner, giving priority to those States and subdivisions suffering the most severe impacts, " All loans shall be subject to such terms and conditions as the Secretary determines necessary to assure that the purposes of the loan program will be achieved.

The Mineral Leasing Act of 1920 applies only to public domain land. The Geothermal Steam Act of 1970 applies to public domain and acquired land.[150] More than 92 percent of the Federal onshore land is public domain land,[151] and the Mineral Leasing Act of 1920 and the Geothermal Steam Act of 1970 account for over 90 percent of Federal onshore mineral revenues.[152]

Minerals, other than geothermal steam, on acquired land are leased under a variety of statutes, primarily the Mineral Leasing Act for Acquired Lands of 1947. Revenues from these leases are distributed in the same manner as other receipts from the affected land.[153] Almost all of the acquired land mineral leases are in national forests, and generally 25 percent of all receipts from a national forest are returned "to the State in which such national forest is situated, to be expended as the State legislature may prescribe for the benefit of the public schools and public roads of the county or counties in which such national forest is situated."[154] Total revenues received by the Federal Government in 1976 from all mineral leases on acquired land were just over $17 million, with receipts of over $1 million in only four States: Louisiana ($2.8 million), Mississippi ($1.9 million), Missouri ($4.9 million), and North Dakota ($3.1 million).[155]

[148] Ibid.

[149] Federal Land Policy and Management Act of 1976, § 317(c), codified at 43 U.S.C. § 1747 (1976).

[150] See ch. 2, subsec. D(3) for an explanation of the distinction between public domain and acquired land.

[151] *Public Land Statistics*, note 143, table 7.

[152] Ibid., tables 81, 112, 113.

[153] 30 U.S.C. § 355 (1976) ("ordinary" leasable minerals); Reorganization Plan No. 3 of 1946, § 402, 60 Stat. 1099 (1946) (hardrock minerals).

[154] 16 U.S.C. § 500 (1976).

[155] *Public Land Statistics*, note 143, table 113.

Common-variety minerals such as sand and gravel are sold under the Surface Resources Act of 1955, which provides that all receipts from such sales shall be distributed in the same manner as receipts from the sale of public lands, except that receipts from sales on national forest and other lands administered by the Secretary of Agriculture shall be distributed in the same manner as other receipts from such lands. ’5’ The distribution of receipts from national forest land was discussed in the preceding paragraph. Generally, 5 percent of the net proceeds from the sale of public land are returned to the State in which the land is located “for the purpose of education or of making public roads and improvements.’’[157] Total revenues from common-variety mineral sales on public land were just under $11 million in 1976, with almost $10 million accruing from sales in Alaska, [158]

The only Federal revenue received under the Mining Law of 1872 is the nominal $2.50 or $5 per acre charged for a patent, which would amount to a maximum revenue of just under $20,000 for the 3,881 acres patented in 1976. [159] Presumably, the States receive 5 percent of this revenue because it results from a “sale” of public land.

Almost all of the revenues collected under the Federal onshore mining and mineral leasing laws have been revenues from oil and gas leasing. For example, in FY 1976 oil and gas leases accounted for more than 88 percent of total Federal onshore mineral revenues.[160] In the future, revenues from other minerals, especially coal, will be much more significant in terms of absolute size and relative importance than they have been in the past, for two reasons. First, as is discussed in chapter 4, bonuses and royalties for minerals other than oil and gas have been set at very low levels in the past—usually only a few cents per ton compared to the minimum 12.5 percent of value required for oil and gas—but are currently being raised to much higher levels. The Federal Coal Leasing Amendments Act of 1976 requires a minimum royalty of 12.5 percent of value for all surface-mined coal produced under Federal coal leases issued after August 1976. [161] Second, oil and gas production from onshore Federal land, excepting Alaska, is probably past its peak, while large resources of the other minerals have yet to be tapped.[162]

In addition to the States’ direct and indirect shares in Federal onshore mineral revenues, Federal funds are allocated to the States and their subdivisions through the Payment in Lieu of Taxes Act of 1976 and the Surface Mining Control and Reclamation Act of 1977.

The Payments in Lieu of Taxes Act of 1976 is intended to compensate units of local government for the loss in property tax revenue resulting from the tax immunity enjoyed by Federal land. ’b’ The Act provides for an annual payment to each unit of local government that contains Federal land (a) which is in the National Park System or the National Forest System or is administered by BLM, (b) which is part of a water resource development project of the Bureau of Reclamation or the Army Corps of Engineers, or (c) which is part of a dredge disposal area under the jurisdiction of the Army

[156] 30 U.S.C. § 603 (1976).
[157] 31 U.S.C. § 711(17) (1976); 43 U.S.C. § 391 (1976).
[158] *Public Land Statistics*, note 143, table 81.
[159] Ibid., table 82.
[160] Ibid., tables 81, 112, 113.
[161] 90 Stat. 1087 (1976), codified at 30 U.S.C. § 207(a) (1976).
[162] See app. A.
[163] H.R. Rep. No. 94-1106, 94th Cong. 2d sess. (1976), see sec. C.

Corps of Engineers, Such land is called entitlement land, and it includes almost 92 percent of all Federal onshore land.[164]

Each local unit of government must be paid $0,75 for each acre of entitlement land located within its boundaries (subject to a sliding-scale maximum payment based on the unit's population, ranging from $50 per person for any unit with a population of 5,000 or less to $1 million for a unit with a population of 50,000 or more), less any payments received by the unit during the preceding year under the Mineral Leasing Act of 1920, the Mineral Leasing Act for Acquired Lands of 1947, the Surface Resources Act of 1955 (common-variety minerals), or certain acts providing for distribution of national forest, grazing, and powersite receipts, The per-acre payment cannot be reduced below $0.10 per acre, but no payment can be made to a unit of government if the total payment that would be due would be less than $100. Where entitlement land is located in two local units concurrently—for example, a town and a county—the payment for that land must go to the geographically smaller unit. The payments may be used for any governmental purpose.

Because the per-acre payments are made directly to the local units of government, they provide an assured source of revenue on which those local units can depend for financing of public facilities and services required as a result of activity on nearby Federal land (although such activity, if private, is itself taxable by the local units—see section C). To assure a stable source of revenue, Congress provided for deductions from the per-acre payments only for Federal mineral (and certain other) revenues actually received by the local units, since it recognized that the 50-percent share of Federal mineral revenues returned to the State governments, although meant to be used to relieve local socioeconomic burdens caused by Federal mineral development, is rarely devoted to that purpose.[165] Unfortunately, however, the limitation on deductions further encourages the States to withhold Federal mineral revenues from the local units. Federal mineral revenues that are not withheld by a State are deducted from the per-acre payments to the local units and hence are unnecessarily lost to the State, whereas the withholding of Federal mineral revenues does not hurt the local units as long as the sums withheld amount to less than the equivalent of $0.65 (the $0.75 maximum minus the $0.10 minimum) for each acre of Federal land in each local unit. The local units will simply receive those sums from the Federal Government as a payment in lieu of taxes instead of receiving them from the State government.

Projected total annual payments under the Payments in Lieu of Taxes Act exceed $100 million. The biggest gainers would be the 11 contiguous Western States and Alaska, which would each receive over $3 million annually: Alaska ($5 million), Arizona ($9 million), California ($11 million), Colorado ($11 million), Idaho ($9 million), Montana ($9 million), Nevada ($6 million), New Mexico ($1 1 million), Oregon ($5 million), Utah ($7 million), Washington ($4 million), and Wyoming ($5 million).[166]

The Surface Mining Control and Reclamation Act of 1977 provides for annual grants to any State to help it develop, administer, and enforce its statewide reclama-

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[164] 31 U.S.C. §§ 1601-1607 (1976); *Public Land Statistics*, note 143, table 8.

[165] S. Rep. No. 94-1262, 94th Cong., 2d sess. 9, 15 (1976); H.R. Rep. No. 94-1106, 94th Cong., 2d sess. 12 (1976); see hearings on S. 1493, note 130, at 51, 77, 229-230, 289.

[166] H.R. Rep. No. 94-1106, 94th Cong., 2d sess. 19-30 (1976).

tion program for Federal and non-Federal land disturbed by coal mining. The grants may cover up to 80 percent of a State's total costs during the first year, 60 percent during the second year, and 50 percent each year thereafter. Moreover, the State may receive a grant for 100 percent of the funds that would have been spent by the Federal Government in administering Federal reclamation requirements on Federal land (including land containing reserved Federal mineral interests) if the State elects to enforce such requirements itself.[167]

The Surface Mining Control and Reclamation Act also provides for Federal and State abandoned mine reclamation funds, consisting primarily of revenue derived from a reclamation fee of $0.35 per ton of surface-mined coal and $0.15 per ton of underground-mined coal, or 10 percent of the gross value of the coal, whichever is less, except for lignite coal, for which a fee of $0.10 per ton, or 2 percent of the value, is imposed.[168] The fee is imposed on all coal mined in the United States, and it was projected at the time the fee was enacted that it would yield approximately $250 million per year.[169]

Fifty percent of the reclamation fees collected annually in any State must be allocated to that State's abandoned mine reclamation fund. The State fund must be used to reclaim land mined for coal and abandoned or otherwise left in an inadequate reclamation status prior to 1977; but if all such land in a State has been reclaimed, the State may use its 50-percent share of the reclamation fees for construction of specific public facilities in communities impacted by coal development if the State certifies, and the Secretary of the Interior agrees, that there is a need for such facilities and that impact funds available under the Mineral Leasing Act of 1920 or the Payments in Lieu of Taxes Act are inadequate for such construction,[170] Any funds not expended within 3 years are transferred to the general fund of the U.S. Treasury.

Since the Western States until recently have had very little coal mining, they have few abandoned, unreclaimed coal mines. They will therefore almost immediately be able to use their 50-percent share of the Federal reclamation fee (which is in addition to any State-imposed reclamation fee) for construction of public facilities needed in communities impacted by coal development. After establishing the need for specific facilities, they are entitled to use the funds to construct such facilities merely by showing that the impact funds available under the Mineral Leasing Act of 1920 or the Payments in Lieu of Taxes Act are inadequate for such construction, They need not show that funds derived from State and local property, income, sales, license, and severance taxes also are inadequate. They need not show that front-end loans against future Federal mineral revenues are inadequate (such loans, although tied to Leasing Act revenues, are authorized by the Federal Land Policy and Management Act rather than the Leasing Act itself). They may not even have to show that total revenues received under the Leasing Act and the Payment in Lieu of Taxes Act are inadequate; it may suffice to show that the portion of such total revenues allocated by a State for impact assistance is inadequate. As is discussed more fully below, the States generally allocate little if any of their share of Federal mineral revenues to local impact assistance.

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[167] 30 U.S.C. § 1295 (Supp. I 1977); see ibid., §§ 1273(c), 1291(4).
[168] Ibid., §§ 1231, 1232.
[169] H.R. Rep. No. 95-218, 95th Cong., 1st sess. 145 (1977).
[170] 30 U.S.C. § 1232(g)(2) (Supp. I 1977).

Finally, the mineral-producing States receive general Federal revenue-sharing funds as well as grants or loans under specific Federal assistance programs for construction of transportation, health, pollution control, housing, recreational, and other facilities and for provision of services required by Federal projects.[171]

The increased bonuses and royalties for leasable Federal minerals, coupled with the increase (from 37.5 to 50 percent) in the producing States' direct share of the revenue collected by the Federal Government, will result in substantially increased revenue for States such as Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming, which are experiencing or expecting dramatic increases in Federal mineral production. Even before the increases in royalties and the States' share, each of these States except North Dakota received $5 to $38 million of Federal mineral revenue in FY 1976.[172] These same States plus other Western States will also continue to benefit from Federal irrigation projects funded by another 40 percent of the Federal mineral revenues (Alaska receives the 40 percent directly since it does not benefit from the Reclamation Act).

The national government will receive only 10 percent of the Federal mineral revenues, Citizens of the non-Western States will not likely benefit even from this 10 percent, because it is probably equivalent to or less than the costs of administering the Federal mineral leasing laws. Moreover, the Federal land management agencies themselves will not benefit directly from the 10 percent retained by the Federal Government, since that 10 percent is deposited as miscellaneous receipts in the general fund of the U.S. Treasury. Funds for administering the Federal mineral laws are independently allocated by Congress, and those funds in the past have been grossly inadequate to provide the staff and services required for effective administration of the laws.[173]

The primary goal of payment requirements under the Federal mineral laws should be assurance of efficient and equitable mineral and nonmineral resource use and management.[174] Yet almost no payments are required to be made for damage to or loss of nonmineral resources owned by the Federal Government,[175] and none of the revenues received from mineral value payments are used to compensate for such damage or loss. This leads not only to underpricing and hence inefficient use of Federal mineral and nonmineral resources, but also to an understandable inclination on the part of Federal surface management agencies to prohibit or discourage mineral activities.[176]

The 40 percent of mineral revenues dedicated to construction of irrigation projects in the Western States under the Reclamation Act of 1902 does not assure efficient and equitable resource use and management on Federal land, but rather constitutes a subsidy of farming interests in the Western States by the general public, which owns the Federal mineral resources.

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171 See, e.g., *GAO Socioeconomic Issues Study*, note 40, at 44-47. See also the sources cited in note 126.

172 See the text associated with note 145.

173 See, e.g., U.S. National Aeronautics and Space Administration, *Onshore Lease Management Program Study for the U.S. Geological Survey* (December 1974); U.S. Geological Survey, *Conservation Division Task Force Report on the Onshore Lease Management Program Study* (May 1975); U.S. General Accounting Office, *Acreage Limitations on Mineral Leases Not Effective*, RED-76-117, June 24, 1976; U.S. General Accounting Office, *Modernization of 1872 Mining Law Needed to Encourage Domestic Mineral Production, Protect the Environment, and Improve Public Land Management*, B-118678, July 25, 1974; Senzel, *Revision of the Mining Law of 1872*, Pub. No. 95-11, Senate Comm. on Energy & Nat. Res., 95th Cong., 1st sess. 22-23 and n. 18 (Comm. Print 1977).

174 See ch. 4, subsec. E(1).

175 See ch. 5, subsecs. D(6) and E(6); subsec. D(1) of this chapter.

176 See ch. 5, sec. G.

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The 50 percent (90 percent in Alaska) of mineral revenues returned directly to the mineral-producting States would promote efficient and equitable resource use if those funds were necessary and actually used to prevent or reduce the adverse socioeconomic impacts of mineral activity on Federal land. But, as was discussed in subsection 2, the States can obtain, and most of the major mineral-producing States do obtain, more than adequate revenue to cope with such impacts through State and local mineral-related taxes. The States do not need the Federal revenues to cope with such impacts. If they actually use the Federal revenues for impact purposes, State mineral revenue that otherwise would or could have been used for such purposes are freed for general State spending programs. Thus, either way, the general public through the Federal Government ends up subsidizing State spending programs unrelated to coping with the socioeconomic impacts of developing Federal minerals.

Moreover, the States rarely use the Federal mineral revenues to assist the local units of government, which bear almost all the socioeconomic impact. Congress itself, as noted above, recognized this fact when it passed the Payments in Lieu of Taxes Act, although ironically this Act even further discourages State disbursements of Federal mineral revenues to local units by providing for deduction of such disbursements from the per-acre payments under the Act to the local units. [177]

Colorado probably has had some of the most generous provisions for distributing its share of Federal mineral revenues to impacted local units of government, yet even the Colorado provisions allocate only a small portion of the Federal mineral revenues to such units. Before 1977, two-thirds of the State's share of Federal mineral revenues other than revenues from oil shale leasing were returned directly to the county from which the revenues were derived, but no single county could receive more than $200,000 per year. In 1977, the direct allocation to the producing counties was reduced to 50 percent of the State's share (excluding oil shale revenues), subject to the same $200,000-per-year limitation. [178] Because of the $200,000 limitation, some major producing counties receive much less than 50 percent of the State's share of Federal mineral revenues derived from production within their boundaries. For example, Colorado received $11,845,528 and $1,204,109 as its share of Federal mineral revenues attributable to Rio Blanco and Moffat counties, respectively, in 1977,[179] but each county received only $200,000, or less than 2 percent and 17 percent, respectively. Although no other counties reached the $200,000 limitation, the State in the aggregate allocated only 12.5 percent of its $15,823,766 share of non-oil shale Federal mineral revenues to the counties.

The balance of the counties' 50-percent share in excess of the $200,000 per-county-limitation, plus another 25 percent of the State's non-oil shale Federal mineral revenue, is paid into the State's public school fund to be used for the support of public schools throughout the State. Fifteen percent of the State's non-oil shale Federal mineral revenue is allocated to the local government mineral impact fund for discretionary distribution by the executive director of the Department of Local Affairs. The executive director receives advice from an energy impact assistance advisory commit-

[177] See the text following note 165.

[178] Colo. Rev. Stat. 34-63-102 (Supp. 1978).

[179] Data supplied by U.S. Bureau of Land Management, Division of Finance, Washington, D.C., March 1978.

tee which, among other things, makes recommendations on the problems and needs of local units, the extent of local tax resources available to each local unit, and the extent of tax effort made by each local unit in solving impact problems. Priority in the distribution of sums allocated to the public school fund and the local government mineral impact fund is supposed to be given to those public schools and local units socioeconomically impacted by the development, processing, or energy conversion of minerals leased under the Federal Mineral Leasing Act of 1920. The remaining 10 percent of the State's non-oil shale Federal mineral revenues is allocated to the Colorado water conservation board construction fund.[180]

Colorado's share of the Federal oil shale leasing revenues is deposited in a special fund controlled by the general assembly (State legislature). The legislature has stated that it will make appropriations from the fund to State agencies, school districts, and other local units affected by development and production of energy resources from oil shale lands, primarily for use by such entities in planning for and providing facilities and services necessitated by such development and production and secondarily for other State purposes,]”’ As of August 1977, Colorado had received approximately $74 mill ion in Federal oil shale leasing revenues, of which about $14 million had been granted or loaned to local units impacted by energy development on the western slope of the Rocky Mountains.[182]

Other States have not allocated any of their share of Federal mineral leasing revenues for impact assistance.

The Coastal States do not receive any portion of the Federal offshore mineral leasing revenues, even though these States can only tax the onshore facilities related to offshore production, not the offshore mineral facilities or the offshore mineral production itself, and yet bear the burden of population influxes caused by the construction and operation of such offshore facilities. Paradoxically, the Coastal and Inland States receive directly 50 percent (90 percent for Alaska) of the Federal onshore mineral leasing revenues, and indirectly through the reclamation fund another 40 percent, even though they can full tax the onshore mineral facilities and production and receive more than adequate revenue from such taxes to pay for the socioeconomic impact of the mineral activitv.

The distribution of Federal onshore mineral revenues raises serious equity issues, as only the Western States benefit from it although the Federal minerals are a national resource. The distribution is made without any showing of need (such a showing is extremely unlikely given the States' distribution of their own and the Federal mineral revenues) and at the expense of the Federal land management agencies and citizens of other States.

The inequity is compounded by the provision in the Surface Mining Control and Reclamation Act that allows the Western States to use funds, collected for the purpose of reclaiming abandoned coal mines, to construct public facilities needed in communities impacted by coal development. The States are not required to show that funds derived from State mineral-related taxes are inadequate to finance such facilities. They

[180] Colo. Rev. Stat. 34-63-102 (Supp. 1978).
[181] Ibid., 34-63-104.
[182] Hearings on S. 1493, note 130, at 231

may not even be required to show that Federal funds they received but did not allocate for impact purposes under the Federal Mineral Leasing and Payments in Lieu of Taxes Acts are inadequate to finance such facilities.'" Thus, the Western States may appropriate abandoned mine reclamation funds, at the expense of other States scarred by abandoned, unreclaimed mines, and use such funds instead of State mineral revenues that otherwise would have been needed to construct the facilities, thereby freeing the State revenues for general State spending programs. Once again, Federal revenues are subsidizing the Western States' general budgets.

Yet, the Western States continue to seek additional sources of Federal funding to cope with the socioeconomic impact of mineral activities, even while refusing to commit more of their own mineral-related revenues to that purpose.[184]

In sum, the Federal Government is less careful with its money than the Western States themselves, which, as has been discussed, automatically allocate very little of their (State or Federal) mineral revenues to impacted areas, but rather require such areas to show they have used all available local and Federal revenues before any discretionary State assistance is provided.

F. Summary and Options

This section summarizes the material discussed in the previous sections of this chapter by presenting three major options for consideration. The options are presented in ascending degree of the amount and character of change involved when compared with the existing systems—no changes at all, moderate adjustments to the existing systems, and major adjustments. The options, other than the ''no change' option, are presented in skeletal form in table 1 at the end of the executive summary. In each option, an attempt is made to address questions of efficiency and equity arising from the current distribution of administrative responsibilities and mineral-related revenues,

Option 1. The Existing Systems ("No Change" Option)

The institutional setting of Federal onshore mineral land management—that is, the division of authority horizontally among the Federal agencies and vertically between the Federal and State governments—is as critical as the substantive content of the laws. The historical development of the mineral laws and their administration has resulted in coordination difficulties along both dimensions.

Along the horizontal dimension, the traditional separation of mineral resource disposal and management from multiple-use management of nonmineral resources under the Federal land laws has been carried over into the administration of the mineral laws themselves. The mineral disposal and management function has been lodged in two agencies in the Department of the Interior. It has thereby been separated from the management of the various nonmineral resources by surface management agencies

[183] See the text associated with and following note 170.

[184] See, e.g., hearings on S. 1493, note 130.

such as the Forest Service and the Fish and Wildlife Service. Furthermore, the mineral leasing function entrusted to the Department of the Interior has itself been split into mineral (economic and engineering) aspects and nonmineral (surface impacts) aspects, with responsibility for mineral aspects given to USGS and responsibility for nonmineral aspects given to BLM. The new office of Surface Mining has a significant role in both the mineral and nonmineral aspects of coal mining operations. BLM is solely responsible for the mineral aspects of Mining Law activities, but it shares responsibility with some surface management agencies for the nonmineral aspects.

Because minerals are bound up in the land, mineral resource management invariably affects nonmineral resource management and nonmineral resource management often affects mineral resource management. During the era of extensive land disposal, these interrelationships were not of serious concern to most people, Given the current policy of retention and multiple-use management of Federal land, however, the formal separation of mineral resource management from nonmineral resource management and the formal distinction between "economic" (mineral-related) and "multiple-use" (nonmineral-related) aspects of mineral management itself quickly break down in practice, causing substantial coordination problems and preventing integrated management of Federal land resources.

These problems have been perceived by USGS and BLM, which have moved to joint responsibility for many aspects of mineral leasing on land under BLM's jurisdiction, despite the formally mandated separation of functions, However, in the creation of the Department of Energy by a new administration, the artificial distinction between "economic" and "multiple-use land management" aspects of fuel mineral leasing was incorporated in the Department of Energy Organization Act, which transferred the "economic" aspects from the Department of the Interior to the Department of Energy. Now, two separate departments, rather than two agencies in the same department, must contend with this distinction and its adverse consequences for integrated land management.

Some recognition of the intimate connection between mineral resource management and overall land management has been provided by the requirement, in all recent mineral leasing laws, that mineral leases may be issued only with the consent of the surface management agency, and subject to such conditions as it may include to ensure adequate utilization of the land for the purposes for which it was acquired or is being administered. But this requirement as yet applies to only a few minerals and a few land categories, (Although there is no such formal requirement for land under BLM's jurisdiction, the same effect is achieved, because BLM is the mineral leasing agent for all Federal land as well as surface manager for its own land.)

The surface management agencies generally are not given any legal role in supervising compliance with surface use restrictions applied to mineral activities, although they have the expertise and are best located to enforce such restrictions, (The principal exception is the Forest Service's enforcement of surface use restrictions applied to mineral activities under the Mining Law in the national forests.) Enforcement is rather the responsibility of USGS (except for surface impacts of coal mining operations, which are the responsibility of the Office of Surface Mining), which has a mineral-related expertise and mission, and often has neither an office near nor familiarity with the area under lease.

Along the vertical dimension of the institutional framework, the coordination problems are even more complex. Mineral activities on Federal land can have substantial effects on local and State economies and ways of life, which under our Federal system of government are the primary concern and responsibility of local and State governments.

Generally, the existing mineral laws strike a reasonable balance between Federal and State regulatory jurisdiction over private mineral activities on Federal land. The laws explicitly or implicitly allow the States to impose more stringent restrictions than those imposed by the Federal Government, as long as the State restrictions do not conflict with the Federal ones and do not disrupt Federal land management.

There are, however, some problems with respect to State regulation of mineral activities on Federal land. The most obvious are the anachronistic provisions in the Mining Law for a) State specification of procedures for locating and maintaining claims and b) State insertion of development conditions in patents. Less obvious, but potentially troublesome, are the provisions in the Surface Mining Control and Reclamation Act of 1977 that a) allow private owners of the surface overlying Federal coal to veto surface mining of such coal (and hence extract the value of the federally owned coal as well as the value of the privately owned surface as the price for not exercising the veto) and b) allow the States to take over enforcement of Federal reclamation standards on Federal land (even though many State enforcement programs are underfunded, understaffed, and vulnerable to conflicts of interest).

More serious issues are raised by State taxation of mineral activities on Federal land and by the distribution of Federal revenues generated under the mineral laws.

State severance taxes and other mineral-related taxes based on the gross amount or value of production are in effect gross royalties and can have the adverse anticonservation effects on mineral and nonmineral resources associated with gross royalties. The tax levels in some States are so high that they may prevent mining of some Federal mineral deposits and may cause mining of only the high-grade portions of other deposits. They also may inflate the prices paid by consumers and reduce Federal mineral revenue.

None of the Federal revenues generated under the mineral laws are retained by the Federal agencies administering the laws to pay for the costs of such administration, which is often substantially underfunded. None of the revenues are turned over to the surface management agencies to be used to repair damage to surface resources or to replace resources lost as a result of mineral activities. Only 10 percent of the revenues is retained by the Federal Government to be deposited in the general fund of the Treasury. The remaining 90 percent is channeled by law to the Western States, either directly through payments to the States themselves or indirectly through the Reclamation Fund to subsidize irrigation projects.

The Federal mineral revenues, and additional Federal funds derived from fees imposed on surface coal miners by the Surface Mining Control and Reclamation Act, are turned over to the Western States to enable them to cope with the adverse socioeconomic impacts of mineral activities on Federal land, But the funds are made available without any showing of need, and, in fact, the major mineral-producing States receive more than adequate revenue from State mineral-related taxes to cope with adverse socioeconomic impacts. (Generally, the problem is not insufficient State revenue, but rather ensuring that such revenue reaches the local unit of government that needs it, in a timely manner.) The Federal revenues thus subsidize the general budgets of these few States at the expense of citizens across the Nation.

Option 2. Moderate Adjustments to the Existing Systems

Horizontal coordination among Federal agencies could be improved by extending the requirement of consent by the surface management agency to the issuance of a mineral lease from the few situations in which it now applies to all mineral leases (and to mining claims if access under the Mining Law is also made discretionary] and by giving the surface management agency joint or sole responsibility for enforcing the surface use restrictions on a mining claim or mineral lease.

Vertical coordination between the Federal and State levels of government could be improved by eliminating State authority under the Mining Law to specify procedures for locating and maintaining claims and to insert development conditions in patents, by requiring Federal surface management agencies to perform "backup" inspections of reclamation of surface-mined Federal coal land when the State has taken over responsibility for enforcement of reclamation, and by encouraging Federal and State efforts to develop coordinated planning and permitting procedures.

In addition, rentals or other payments by mineral explorers or producers designed to compensate for damage to or loss of nonmineral values could be turned over to the Federal surface management agency rather than to the State, with a stipulation that such payments be used to restore or replace the damaged or lost nonmineral values. The 10 percent of the Federal mineral revenues now placed in the Federal general fund, or such smaller or larger percentage as seems appropriate, could be retained instead by the agency or agencies responsible for administering the mineral laws, in order to provide more adequate funding for such administration.

The remainder of the Federal mineral revenues could be allocated to the States affected by mineral activities on Federal lands, but only to the extent needed to cope with adverse socioeconomic impacts that cannot be handled by the States themselves through their own mineral taxation systems, The balance of the revenues not allocated to the Federal agencies or the States could be placed in the Federal general fund.

Option 3. Major Adjustments

At the Federal level, more integrated management of mineral and nonmineral resources on Federal land could be promoted by revoking the recent transfer of certain fuel mineral leasing functions from the Department of the Interior to the Department of Energy, and by making each surface management agency fully responsible for administration of the Federal mineral laws on land under its jurisdiction. The roles of USGS, BLM (on land not under its jurisdiction), and the Department of Energy would be reduced to those of advisors and coordinators on issues within their expertise, unless a surface management agency should ask them to take a more active role (for example, agencies administering small, isolated tracts of land might want to have BLM administer the mineral laws on such land).

Finally, all grants of Federal mineral revenues to the producing States could be abolished. States would have to use the revenues derived from their own mineral-taxing powers to cope with the adverse socioeconomic impacts of mineral activities. Thus, they would not be able to make the Federal minerals bear a disproportionate share of the costs of coping with impacts caused by mineral activities on non-Federal as well as on Federal lands, Federal loan programs could be adopted to provide funds needed for planning and construction by impacted communities prior to receipt of the substantial revenues anticipated from State taxes on mineral production.

Appendixes

Appendix A

The Role of Onshore Federal Land With Respect to Production of Essential Mineral Commodities

A. Introduction

This appendix summarizes the present importance and future potential of onshore Federal land with respect to supplies of some selected essential mineral commodities.

At the outset of this assessment it was recognized that it would be a very large and time-consuming task to try to analyze and report in detail on the contribution onshore Federal land does or could make to an assured and efficiently priced supply of all essential minerals. Rather, it was decided to analyze only enough different minerals to give representative coverage of the various types of essential minerals covered by the principal Federal laws governing mineral activities on onshore Federal land.

The applicable Federal laws are summarized in chapter 3 of this report. Principally, they are the Mining Law of 1872, the Mineral Leasing Acts of 1920 and 1947, and the Geothermal Steam Act of 1970. -' In general, the Mining Law applies to metallic mineral deposits (for example, copper, silver, and uranium) and deposits of most nonmetallic minerals (for example, fluorite). The Mineral Leasing Acts apply to the fuel minerals, except uranium, and to the fertilizer and chemical minerals, The Geothermal Steam Act applies only to geothermal steam and associated resources, Minerals subject to the Mining Law are generally referred to as "locatable" or "hardrock" minerals, while those subject to the Mineral Leasing Acts or the Geothermal Steam Act are referred to as "leasable" minerals.

The criteria used to select representative essential minerals for analysis are described in section B below. The list resulting from these criteria contains five fuel minerals, four fertilizer or industrial minerals, and five (non fuel, nonfertilizer, nonindustrial) metallic minerals. Of these, seven minerals (coal, copper, nickel, phosphate rock, silver, sodium carbonate, and uranium) have a relatively high potential for occurrence on onshore Federal land, six (geothermal steam, fluorspar, lead, natural gas, petroleum, and potash) have a more moderate potential, and one (iron ore) has only limited, but possibly locally important, potential. Even minerals with less Federal land potential may take on added significance when viewed within the context of national needs and the reliability of imports.

[1] Essential in the sense that industry requires an assured supply in order to perform its functions.

[2] Common varieties of sand, stone, gravel, pumice, pumicite, or cinders are governed by the Materials Disposal Act of 1947 and the Surface Resources Act of 1955, 30 U.S.C. §§ 601-604 (1970).

The findings and other information presented in this appendix are supplied only for the general orientation of the reader and are not meant to be definitive or complete. Exhaustive analyses of the variety of available forecasts of supply and demand balances, import dependence, and similar issues are not provided. The data on the occurrence of each mineral with respect to Federal land are also not exhaustive, The data for a comprehensive study simply were not available, and the resources and time allotted for this part of the assessment did not permit the development of such basic data. Furthermore, national conservation goals for minerals do not exist. Therefore, it is not possible to prepare meaningful forecasts of future national requirements for minerals that incorporate conservation in any systematic way. Nevertheless, it is hoped that the data in this appendix facilitate a general understanding, through analysis of representative minerals, of the role of onshore Federal land with respect to production of essential mineral commodities.

B. Criteria for Selection of the Study Minerals

As stated above, time and resource limitations for this assessment made it necessary to select only a few essential minerals for detailed presentation of demand and supply forecasts and the potential on Federal land, It was felt that the minerals chosen should be: 1) representative of the various groups of minerals, other than common-variety minerals, covered by the principal laws governing access to minerals on onshore Federal land; 2) occur, or have a potential for occurrence, on Federal land in sufficient quantities to make a significant contribution to meeting current and projected domestic requirements;[3] and 3) be subject to a continuing high level of demand by domestic industry with a limited potential for recycling or substitution in basic uses.

C. Application of Selection Criteria to Arrive at Study Minerals

The criteria listed in section B above were not applied rigorously or quantitatively to arrive at the study minerals, Rather, they were applied in a somewhat subjective manner by a small group of minerals specialists who believed that it was necessary only to select a representative list of minerals that would illustrate the role Federal land does or could play in meeting domestic U.S. requirements for essential mineral commodities. Once they had been selected, the study minerals were to be subjected to a more rigorous analysis of their potential on Federal land in relation to domestic requirements. Thus, the selections were made on the basis of personal knowledge supplemented by a brief review of the available general literature,

1. Representation of the various groups of minerals covered by the principal Federal minerals laws. The essential noncommon-variety minerals can be divided roughly into four groups: fuel, fertilizer, industrial, and (nonfuel, nonfertilizer, nonin-

[3]The terms "requirements," "demand," "needs," and "consumption" are used more or less interchangeably in this report, not in any strict technical economic sense, but to indicate the degree to which, under the various forecasting assumptions, future requirements for essential minerals might be significantly larger or smaller than future estimated supplies.

dustrial) metallic minerals. Almost all the fuel and fertilizer minerals are "leasable" minerals covered by the Mineral Leasing Acts or the Geothermal Steam Act. Almost all the industrial and metallic minerals are "locatable" or "hardrock" minerals covered by the Mining Law,

The leasable fuel minerals are geothermal steam, coal, natural gas, petroleum, oil shale, natural asphalt, and bitumen. The leasable fertilizer minerals are phosphate and potash. The leasable industrial minerals are sulfur (in Louisiana and New Mexico only) and sodium compounds. There are no leasable metallic minerals other than sodium (except under special leasing acts for acquired land).

As there are at most two leasable minerals in each of the three nonfuel mineral groups (fertilizer, industrial, and metallic), all the nonfuel leasable minerals were retained as candidate study minerals under criterion 1. Geothermal steam was retained as a fuel mineral because it has its own special leasing act, Coal, natural gas, and petroleum were retained as representative fuel minerals under the Mineral Leasing Acts. Oil shale, natural asphalt, and bitumen were eliminated, as they (a) are primarily sources of petroleum substitutes and demand for their products tracks the demand for petroleum, (b) are subject, like geothermal steam, to technological and economic uncertainties, and (c) involve problems in extraction (for example, fragmented ownership, intensive use of large tracts, strip mining, population influx, water consumption, and pollution) similar to those of Federal coal. In sum, geothermal steam, petroleum, natural gas, and coal are adequate representatives of the leasable fuel minerals.

The only locatable fuel mineral is uranium. There are no locatable minerals that are primary fertilizer ingredients. All the industrial and metallic minerals that are not listed above as leasable are locatable.

Uranium was retained as a candidate study mineral under criterion 1, as it is the only locatable fuel mineral. A representative list of locatable industrial and metallic minerals was taken from a report on critical materials, prepared by the U.S. Council on International Economic Policy, that includes "all the major non-fuel raw materials in world trade as well as minor ones known to be important to national security or industrial processes."[4] The list includes 17 locatable minerals: aluminum, chromium, cobalt, columbium, copper, fluorspar, iron ore, lead, manganese, mercury, nickel, platinum group, tin, titanium, tungsten, vanadium, and zinc. Of these, only one, fluorspar, is a nonmetallic industrial mineral. Silver was added to the candidate study mineral list because it is important to an entire industry—photography—and has been produced in substantial quantities from western land.

2. **Reported known large deposits or significant potential for occurrence on Federal land in relation to domestic requirements.** Data about the occurrence of mineral resources on Federal land were taken from estimates of potential resources published by the U.S. Geological Survey (USGS) in 1973[5] and from information on past or present

[4] U.S. Council on International Economic Policy, *Special Report: Critical Imported Materials* 23 (1974).

[5] U.S. Geological Survey, *United States Mineral Resources*, Prof. Paper 820 (1973).

reserves and production reported by the USGS and the U.S. Bureau of Mines.[9] In the absence of more specific data, it was assumed that a high level of occurrence in the Western States and/or Alaska indicates a significant potential on Federal land.

All the leasable minerals other than sulfur selected under criterion 1 have been reported to have a significant level of occurrence on Federal land. Sulfur was eliminated under criterion 2 as a study mineral because its current and projected onshore domestic supply comes from production on non-Federal land or as a byproduct of processing other minerals.

Both the locatable fuel mineral (uranium) and the locatable nonmetallic industrial mineral (fluorspar) selected under criterion 1 have been reported to have a significant potential for occurrence on Federal land in relation to the Nation's domestic requirements.

Of the locatable (nonfuel, nonfertilizer, nonindustrial) metallic minerals selected under criterion 1, only copper, lead, silver, tungsten, vanadium, and zinc are currently being produced in substantial quantities, in relation to domestic demand, from regions with large amounts of Federal land. For silver and vanadium, however, most of this production from Federal land regions is as byproducts of other mineral production: silver from copper, lead and zinc ores, and vanadium from phosphate and uranium ores. Silver was chosen as representative of these byproduct ores, and vanadium was eliminated from the candidate study mineral list.

There are substantial estimated resources of aluminum (alunite and dawsonite), cobalt, columbium, iron ore, mercury, nickel, the platinum group, and titanium in Federal land regions in relation to domestic requirements. Of these resources, however, only cobalt, columbium, iron ore, nickel, and the platinum group are reported to occur in sufficient quantity and quality in Federal land areas in relation to identified resources elsewhere to serve as significant potential additions to domestic supply. Furthermore, cobalt and platinum would be produced largely as byproducts of copper and nickel production. Therefore, only columbium, iron ore, and nickel were retained in the candidate study mineral list.

Because chromium, manganese, and tin are reported to have minimal potential for occurrence on Federal land in relation to current and projected domestic requirements, they were also eliminated from the candidate study mineral list.

3. Subject to a continuing high level of demand by domestic industry with a limited potential for recycling or substitution in basic uses. All the minerals, except columbium, selected under criteria 1 and 2 also pass this criterion. There are a number of substitutes for columbium, so it was eliminated from the study mineral list.

The fuel minerals are substitutable for one another to a certain extent, but the magnitude of the current and projected demand for energy in the United States is so great that it will be necessary for the fuel minerals to complement rather than compete

[9] U.S. Bureau of Mines, *Commodity Data Summaries, 1976* (1976); U.S. Bureau of Mines, *Minerals Yearbook, 1973, Vol. II, Area Reports: Domestic* (1976); U.S. Geological Survey, Conservation Division, *Federal and Indian Lands Coal, Phosphate, Potash, Sodium, and Other Mineral Production, Royalty Income, and Related Statistics, Fiscal Year 1975* (1976); U.S. Geological Survey, Conservation Division, *Federal and Indian Lands Oil and Gas Production, Royalty Income, and Related Statistics, Calendar Year 1975* (1976).

with one another in the near- and mid-term. Therefore, none of the selected fuel minerals were eliminated under criterion 3,

4. **The Final List.** The purpose of the criteria was to select only a representative number of minerals from the various groups covered by the principal Federal mineral laws. The initial application of the three criteria resulted in the selection of four leasable fuel minerals (coal, natural gas, petroleum, and geothermal steam), both leasable fertilizer minerals (phosphate and potash), and one leasable industrial mineral (natural sodium carbonate, the most significant sodium compound on Federal land in relation to domestic demand). There are no leasable nonindustrial metallic minerals.

The initial application of the selection criteria also resulted in the selection of seven locatable metallic minerals (copper, iron ore, lead, nickel, silver, tungsten, and zinc), the only locatable fuel mineral (uranium, which is also a metallic mineral), and one locatable industrial mineral (fluorspar). There are no locatable minerals that are primary fertilizer ingredients.

The resulting list seemed reasonably short and representative, except for the large number of locatable metallic minerals. It was decided to reduce the number of locatable metallic minerals from seven to five. Tungsten was eliminated because its geographic distribution is approximately parallel to that of copper, which is subject to a higher level of demand. Zinc was eliminated because its geographic distribution is approximately parallel to that of lead, which is the more significant resource on Federal land owing to its occurrence on Federal acquired land in Missouri.

The final list of study minerals broken down into the four basic groups follows:

- Fuel minerals—coal, geothermal steam, natural gas, petroleum, and uranium;
- Fertilizer minerals—phosphate and potash;
- Industrial minerals—fluorspar and natural sodium carbonate; and
- Metallic minerals—copper, iron ore, lead, nickel, and silver.

Other minerals specialists might have selected a different list of representative minerals based on different criteria or on disagreement with the way the criteria were applied. However, the purpose of the exercise was not to produce a definitive list, but to reduce the large number of mineral commodities to a short list through a rough but rational process in order to be able to illustrate, through a subsequent brief analysis of each commodity, the role that Federal land does or could play in meeting domestic requirements for essential mineral commodities. It was felt that the list of minerals compiled through the selection process described in this section would satisfactorily serve that purpose.

D. Methods Used to Analyze the Study Minerals

Each of the mineral commodities selected through the process described in the preceding sections is analyzed in section F. The analysis for all but three[7] of the minerals covers the following specific topics:

- Uses, substitutes, or alternatives,
- Demand/supply outlook,
- Geographic distribution of resources, and
- Potential of Federal land.

The methods used to fill in the details of the topics are described briefly here,

1. Uses, substitutes, or alternatives. Information on these topics was taken from reports of the U.S. Bureau of Mines and condensed for presentation in this report.[8] This information is collected from industry by the Bureau; it is regularly updated and published annually.

The potential for the employment of substitutes for any given mineral is taken into account by the Bureau in the preparation of forecasts of demand/supply balances (see below) for that mineral. Consequently, no independent attempt was made to develop estimates of the future effect of current research or market forces on the possibilities for substitutions,

2. Demand/supply outlook. Although it is an inherent characteristic of forecasting that uncertainty increases over time, comparisons of the projected demand and supply for the study minerals should be useful in providing insight into the likelihood and degree of future problems,

Forecasts of domestic demand[9] and supply for the years 1985 and 2000 are provided for the study minerals, The forecasted demand given is for "primary'" O mineral commodities; the forecasted supply is for domestic mine (or well) production, that is, primary supply. A summary table of historic supplies from all sources (primary, recycled, reconditioned, etc.) is given for 1965, 1970, and 1974. However, forecasts of demand are given only for primary (that is, new) materials in order to indicate the level of need for either increases in mine production or increases in imports when compared with forecasts of primary supply,

All forecasts are the result of evaluations and syntheses of available studies and projections, rather than original research.

For the demand side of the demand/supply balance, the forecasts of the U.S. Bureau of Mines have been used[11] because they are based on the contingency forecast-

[7] There has been a departure from the full format in three cases, where instead a brief summary of supply and demand and Federal land potential has been given. Iron was summarized because it was found upon more detailed analysis to have very limited potential for occurrence on Federal land in relation to its potential on non-Federal land. Similarly, lead has a limited relative potential on the 93 percent of Federal onshore land found in the 11 contiguous Western States and Alaska; only the Federal acquired land in Missouri is known to have a substantial lead resource. Finally, geothermal steam is such a newly exploited resource domestically that detailed supply and demand projections would not be very meaningful.

[8] U.S. Bureau of Mines, *Mineral Facts and Problems, 1975 Edition*, Bull. 667 (1976); U.S. Bureau of Mines, *Commodity Data Summaries, 1976* (1976).

[9] See note 3.

[10] As used here, primary mineral commodities are new materials, not recycled, reconditioned, or reused, which have been produced from deposits of naturally occurring materials in the Earth's crust.

[11] U.S. Bureau of Mines, *Mineral Facts and Problems, 1975 Edition*, Bull. 667 (1976).

ing approach, are generally comprehensive and consistent, and have a continuing historic basis lacking in other forecasts. In the contingency forecasting approach, values are assigned by the Bureau on the basis of constructed scenarios that describe, in all relevant ways, the nature of the future operating environment. The demand forecasts are presented by the Bureau, in most cases, as ranges; high, low, and most likely future levels are given for the year 2000, while for 1985 only a forecast of the most likely level is given.

For the supply side, the forecasts of primary minerals were also taken mainly from reports of the Bureau of Mines. " These forecasts are based on probable trends in demand, pricing, and the availability of domestic and imported mineral supplies. Such factors as technological change, substitution or interchangeability, and the impact of foreign demand are taken into account. In some cases, estimates of future supply were modified on advice from individual mineral commodity specialists of USGS.

3. **Geographic distribution of resources.** Data for this topic were obtained from a variety of sources, generally from publications of USGS. The general source was USGS Professional Paper 820, unless otherwise indicated in the discussion of a particular mineral (see section F).

4. **Potential of Federal land.** The goal of this task was to provide an estimate of the role that Federal land may be expected to play in the domestic supply of essential minerals to the end of this century. Toward this end available geologic information on the occurrences of mineral resources was combined with Federal land ownership patterns. The complicated structure of land ownership and mineral rights, plus the limitations and gaps in existing geologic data, however, permitted at most only a broad, order-of-magnitude view of mineral and Federal land relationships. ' Consequently, the findings of this section should be viewed with caution, as representing only very rough estimates, and not as definitive statements with a measurable range of probability.

Generally, the assessment of mineral potential on Federal land was restricted to the 11 contiguous Western States" and Alaska. On occasion, significant mineral resources within Federal land in other States were also described (for example, the copper and nickel resources of Minnesota and the lead resources of Missouri).

Qualitative estimates of mineral resources on Federal land were made by overlaying geological and mineral resource maps on maps of Federal land distribution.[15]

Ibid. It should be noted that certain inconsistencies appear in the historic data on supply and demand reported by different Bureau publications. The data reported in the *Mineral Facts and Problems* and *Minerals in the U.S. Economy* series have been cross-checked, analyzed, and reconciled by the Bureau, whereas the data in the *Commodity Data Summaries* series reflect quick straight reporting. Consequently, special care should be taken in attempting to correlate the data presented in this appendix with data in the *Commodity Data Summaries* series. Especially in the case of imports and secondary supplies for some minerals, the latter source seems to significantly understate historic data.

A quantitative, statistical approach to estimating the mineral potential of onshore Federal land was investigated, but was found to be unsuitable. Such an approach (called "geostatistics") uses statistical techniques to correlate occurrences of minerals within large, continuous, well-explored areas to occurrences within other large, continuous, but mostly unexplored areas. See, e.g., M. Allais, "Method of Appraising Economic Prospects of Mining Exploration Over Large Territories: Algerian Sahara Case Study," 3 *Management Science* 285 (1957); D. P. Harris, "Operations Research and Regional Mineral Exploration," 238 *AIME Transactions* 450 (1967). However, the onshore Federal lands are distributed irregularly and are interspersed with State and private lands according to no consistent pattern. Furthermore, surface and mineral ownership is often split and fragmented. Under such circumstances, the geostatistical approach is inappropriate.

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Maps used were from the U.S. Bureau of Land Management, the U.S. Geological Survey, the U.S. Forest Service and other government agencies such as State planning commissions.

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Metallogenic provinces and mineral belts recognized by J. A. Noble[16] were also compared with land distribution patterns. In making an estimate of resources on Federal land, account was taken of the fact that many of the known hard-rock mineral deposits in the Western States are on patented land, that is, land once in the Federal public domain but now privately owned according to the provisions of the Mining Law of 1872. These deposits were counted as Federal resources since they were discovered on Federal land. Undiscovered resources were assumed to exist in the vicinity of the known deposits and on that basis were estimated to have the same degree of Federal ownership as the known resources. Some undiscovered resources undoubtedly exist in unexplored areas, but estimates of probable ownership of these are, of course, very difficult.

The map overlay approach produced results that necessarily were highly qualitative. The available information, with but a few exceptions, was insufficient for a quantitative assessment of mineral potential on Federal land. Land and mineral ownership is highly fragmented, and ownership of the surface is often split from ownership of the subsurface. Mineral deposits are three-dimensional, while mapped data is usually presented in only two dimensions. Land status changes daily, while maps are updated infrequently. Maps occur in varying detail, scale, and quality. Many areas are not adequately mapped in terms of either land status or mineral potential. In light of all these problems, any quick assessment of Federal land mineral potential must be both very approximate and quite subjective.

E. Mineral Resources Classification System

In discussing the potential for mineral resources on Federal land, various terms are used to indicate the state of knowledge about the resources. The terms used were taken from the joint U.S. Bureau of Mines/U.S. Geological Survey system of classification of mineral resources. ” The terms and the relationships between them are illustrated in figure A-1 and briefly described below.

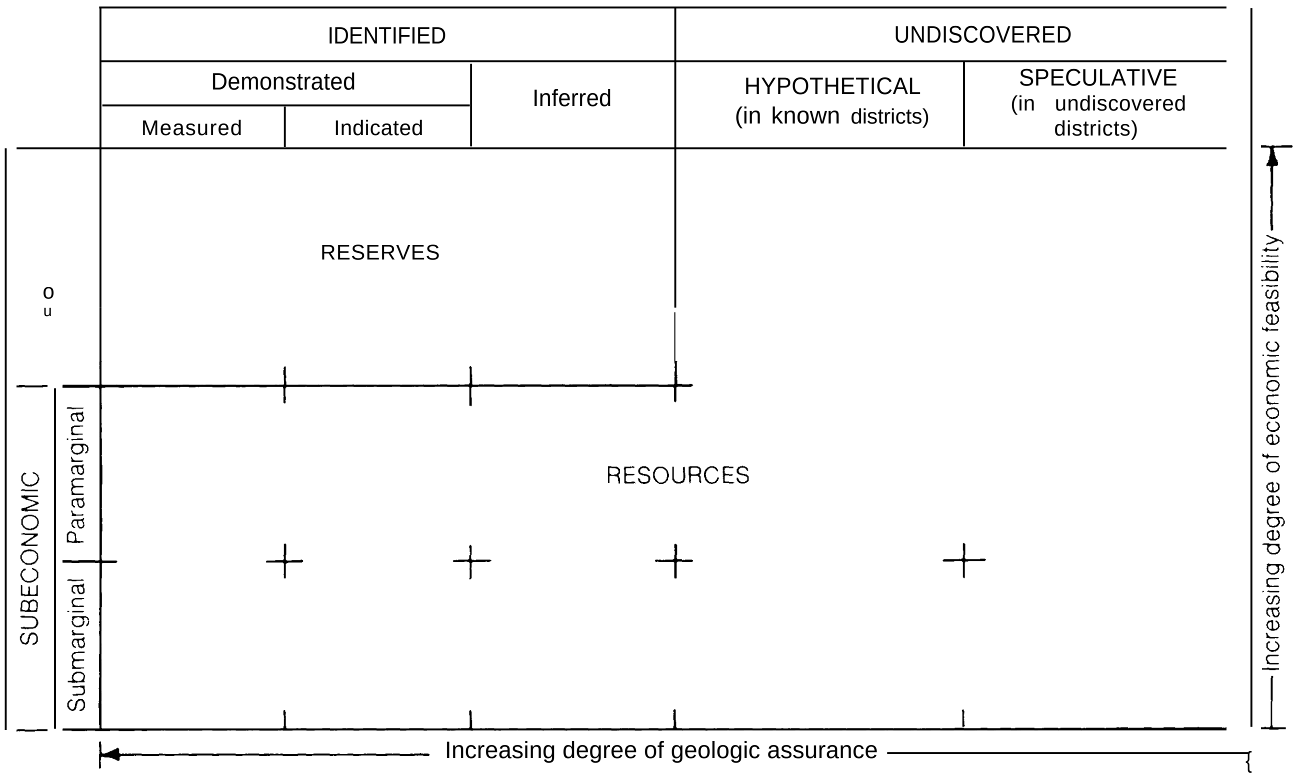
- **Identified Resources:** Specific bodies of mineral-bearing material, the location, quality, and quantity of which are known from geologic evidence and, if they are in the demonstrated category, are supported by engineering measurements,
  - —Reserve: That portion of the identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination. The term ore is used for reserves of some minerals.
  - —ldentified Subeconornic: Identified resources that may become reserves as a result of changes in economic, technologic, and legal conditions.

[16] J. A. Noble, "Metal Provinces in the Western United States," 81 *Geological Society of America Bulletin* 1607 (1970).

[17] U.S. Bureau of Mines and U.S. Geological Survey, *Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey*, USGS Bull. 1450-A (1976).

These terms were used for all of the study minerals except uranium. Estimates of resources of uranium are prepared by the Energy Research and Development Administration (now the Department of Energy), which uses its own classification system.

Figure A-1 .—Classification of Mineral Reaources



- **Undiscovered Resources:** Bodies of mineral-bearing material surmised to exist on the basis of broad geologic knowledge and theory. Exploration that confirms their existence and reveals quantity and quality will permit their reclassification as reserves or as identified subeconomic resources.

  —Hypothetical Resources: Undiscovered resources that may reasonably be expected to exist in a known mining district under known geologic conditions.

  —Speculative Resources: Undiscovered resources that may exist either as familiar types of deposits in a favorable geologic setting where no discoveries have been made or as unfamiliar types of deposits that remain to be recognized.

Measured, indicated, and inferred resources include both reserves and identified subeconomic resources. They are defined as follows:

- **Measured:** Identified resources for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill holes and for which grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, and mineral content are well established. The computed tonnage and grade are judged to be accurate within limits, which are stated, and no such limit is judged to be different from the computed tonnage or grade by more than 20 percent.

- **Indicated:** Identified resources for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on the basis of geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade to be established throughout.
- **Inferred:** Identified resources for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. Continuity or repetition is assumed on the basis of geologic evidence, which may include comparison with deposits of similar type, Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred reserves or resources should include a statement of the specific limits within which the inferred material may lie.

F. Individual Mineral Commodity Summaries

In this section, summaries of data available in 1975 for each of the 14 selected study minerals are presented according to the methods and format described in section E. Data available in 1975 were used because this part of the assessment was conducted in 1975 and early 1976. ” The data have not been updated in this appendix, as the purpose of the summaries has never been to provide a definitive analysis of the individual mineral commodities, but rather an idea of the role Federal land does or could play in supplying those commodities,

1. Coal

U.S. resources, ” which are of growing importance in the national energy supply picture, are widespread and abundant, with about 70 percent of total remaining resources within the 11 Western States and Alaska. An estimated 40 percent of the Western and Alaskan resources are on Federal land; an estimated 35 percent of total U.S. coal resources are on Federal land.

a. **Uses, Substitutes, or Alternatives.** Coal is a major component of the Nation’s total energy supply. Other significant fuel sources for power generation include

Unless otherwise indicated, data on total resources of a mineral commodity and the geographic distribution of those resources are from U.S. Geological Survey, *United States Mineral Resources*, Prof. Paper 820 (1973) (hereinafter cited as USGS Prof. Paper 820); supply and demand historical data and projections are from U.S. Bureau of Mines, *Mineral Facts and Problems, 1975 Edition* (1976), supplemented for the energy minerals by U.S. Bureau of Mines, *United States Energy Through the Year 2000 (Revised)* (1975],

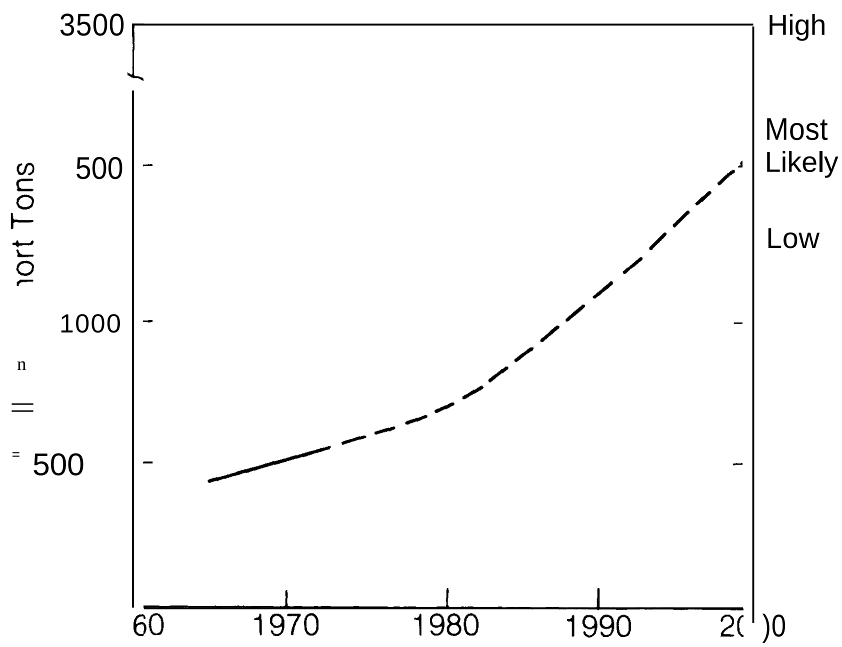
As used herein, "coal resources" refers to total remaining identified and hypothetical resources of lignite and bituminous (including sub-bituminous) coal. Bituminous coal is widespread in the lower 48 States and Alaska; lignite is important only in the Western States. Anthracite has been excluded because it is important only in Pennsylvania, which contains a minimal amount of Federal land.

uranium, oil, and natural gas. However, the extent to which uranium will substitute for coal is highly uncertain because of constraints of capital costs, licensing, and public acceptance. Oil cannot be considered as a substitute for coal in the future; rather liquids derived from coal are viewed as future substitutes for oil. A similar situation exists with gas as a substitute for coal, complicated by a more variable supply situation.

Coal is also essential to the primary metal industries, where it is used in the production of metallurgical-grade coke. In addition, coal has the potential to become a major source of supply of some organic chemicals and of gaseous and liquid fuels.

b. **Demand Outlook.** Domestic demand for coal is expected to increase significantly through the year 2000 (see figure A-2).

Figure A-2.— Bituminous Coal and Lignite Demand Outlook



Forecast Assumptions

High: Most likely demand plus an additional 1.8 billion tons for extensive synfuel production.

Low: No commercial synfuel production.

Most Likely: Continued GNP growth averaging 3.5 percent per year; continued slow growth in population averaging less than 1 percent per year; strip mining permitted under regulations requiring environmental protection; more efficient use of energy by industry; some commercial synfuel production before the year 2000.

c. Supply Outlook. As illustrated in table A-1, historically the United States has been self-sufficient in the supply of coal.

To meet the projected most likely demand in the year 2000, coal production will have to be tripled (see figure A-3).

Production at this projected rate, however, will consume only about 10 percent of the identified coal resources of the United States currently deemed available for mining (see table A-2).

Figure A-3. —Bituminous Coal and Lignite Supply Outlook

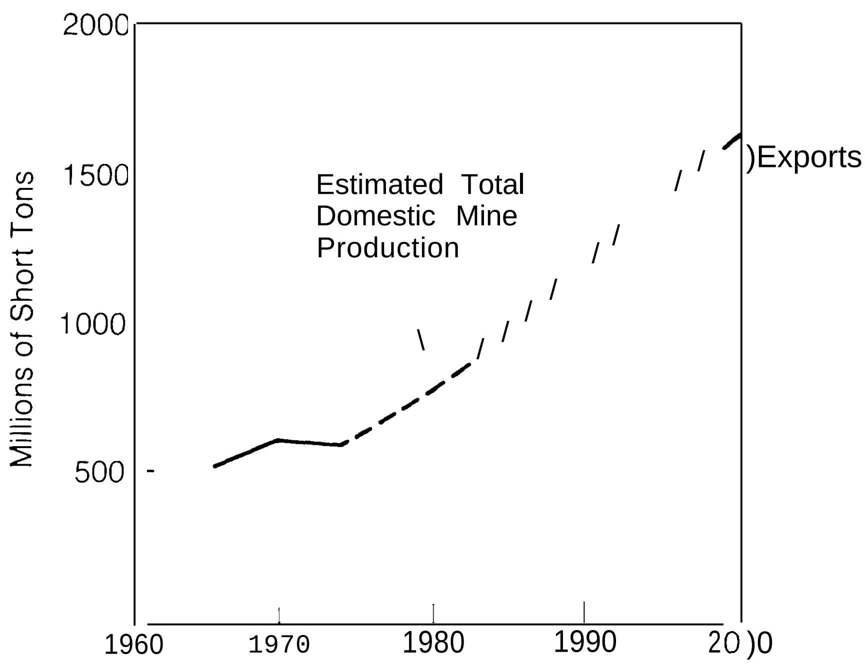


Table A-1 .—Bituminous Coal and Lignite Supply (Millions of Short Tons)

	1965	1970	1974
Domestic U.S. Mine Production	512	603	603
Minus Exports	(50)	(71)	(60)
Plus Imports	—	—	2
Industry Stocks, January 1	78	82	103
TOTAL Coal Supply	540	614	648

Table A-2.—Resources of Coal (Including Anthracite)

Identified:	1,730 billion tons, of which only about 424 billion tons are currently estimated to be economically and legally available for mining; average recovery rate is approximately 50 percent. Of the 1,730 billion tons, an estimated 130 billion are in Alaska.
Hypothetical:	1,849 billion tons, of which an estimated 1,130 billion are hypothetical coal resources in Alaska.

Source: P Averitt, Coal Resources of the United States, January 1, 1974, U S Geological Survey Bull 1412 (1975)

d. Geographic Distribution of Resources. U.S. coal resources are widespread and abundant. About 46 percent of the total remaining identified coal resources (and about 88 percent of total hypothetical coal resources) are in Alaska and the Western States. The approximate distribution of remaining identified coal resources, including anthracite, is as follows:[20]

North Dakota	20.3%
Montana	16.800
Illinois	8,4%
Wyoming	7.90/0
Alaska	7.5%
Colorado	7.4%
West Virginia	5.8°A
Pennsylvania	4.8%
Kentucky	3.7%
New Mexico	3.5%
Ohio	2.4%
Indiana	2.0%
Missouri	1.8%
Utah	1.3%
Arizona	1.2%
Kansas	1.1%
Others	4.1%

e, Potential of Federal Land. It is estimated that about 43 percent of Alaska's total coal resources (identified and hypothetical) are on Federal land. A significant portion of these resources lies within Naval Petroleum Reserve No. 4,[21] Approximately55 to 60 percent of the combined total coal resources in Colorado, Montana, NewMexico, Utah, North Dakota, South Dakota, Wyoming, and Arizona are on Federal land.[22] This land is principally crop and open rangeland. Much of the Federal coal resource, particularly in Colorado, Montana, North Dakota, and Wyoming, underlies privately owned surface.[23]

2.Copper

Copper is basic to industrial production. Abundant resources of this mineral have been identified, mainly in States with extensive Federal landholdings.

a. **Uses, Substitutes, or Alternatives.** Copper has high electrical and heat conductility, is relatively resistant to corrosion, and has high strength and malleability. Although aluminum can be substituted for copper in power transmission, and steel and plastic can be substituted in construction, copper remains uniquely suited for use in generators and motors and in electronic and general wiring applications.

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[20] P. Averitt, *Coal Resources of the United States, Jan. 1, 1974*, U.S. Geological Survey Bull. 1412 (1975).

[21] Derived from Alaska Division of Geological and Geophysical Surveys, *Coal*, Open File Report 51 (1975).

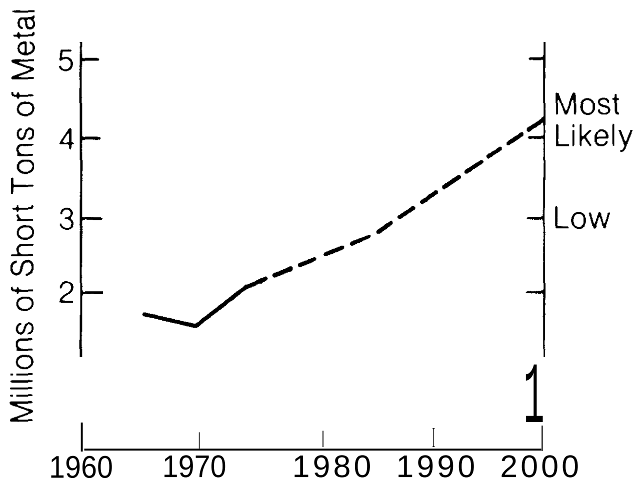
[22] P. Averitt, note 20, at 72.

[23] Cf. U.S. Bureau of Land Management, *Public Land Statistics*, 1975, table 17 (1976).

b. **Demand Outlook.** Historically, U.S. copper consumption has grown at a gradual but steady rate, correlating closely with increases in gross national product and population. Between 1975 and 2000, demand for primary copper is expected to continue to expand as illustrated in figure A-4.

c. **Supply Outlook.** In the past, levels of copper consumption in the United States have been met largely by domestic production, supplemented by supplies from secondary sources (recycled scrap) and imports (see table A-3).

Figure A-4. —Primary Copper Demand Outlook



Forecast Assumptions

High: Heavy reliance on coal and uranium for power generation; increased solar heating; underground power distribution systems.

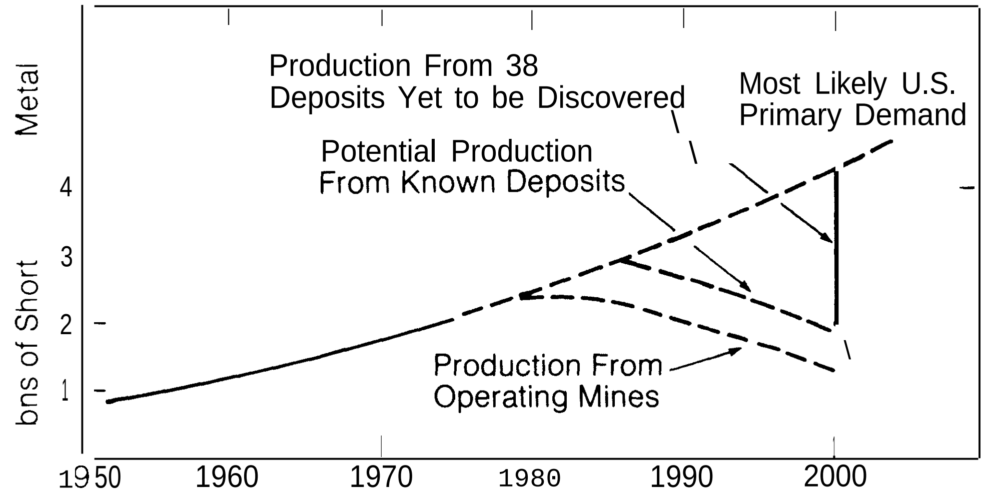
Low: Replacement of copper with aluminum; introduction of advanced power generation systems not requiring use of generators; use of cryogenic techniques in power transmission.

Table A-3.—Copper Supply
(Thousands of Short Tons)

	1965	1970	1974
Domestic U.S. Mine Production	1,336	1,521	1,421
Copper from Secondary Sources (Recycled Scrap)	513	504	483
Government Stockpile Releases	120	—	252
Minus Exports (Refined)	(325)	(221)	(127)
Plus Imports (Mainly Peru, Chile, South Africa)	513	376	548
Industry Stocks, January 1	467	541	456
TOTAL Copper Supply	2,624	2,721	3,033

Taking into account the depletion rate of reserves, the following will be required in order to reach most likely future demand levels if reliance is placed solely on production from known domestic reserves: (i) development of the equivalent of 14 new deposits (each producing 50,000 tons of copper per year) by 1985, and (ii) development of 44 such deposits by 2000 (see figure A-5 and table A-4). Within the latter group, 38 deposits have yet to be identified. Some of these 38 may be developed from currently known but subeconomic resources. Discovery of the remainder depends on the success of mineral exploration efforts within the next 10 to 15 years.

Figure A-5. —Primary Copper Supply Outlook



Source D P Cox, U S Geological Survey, Written communication, 1975

Table A-4.— Resources of Primary Copper

Identified:	90 million tons of reserves in 37 operating mines, plus 30 million tons in 20 known deposits.
Hypothetical and Speculative:	220 million tons in undiscovered deposits.

Sources D P Cox, U S. Geological Survey, written communication, 1975; USGS Prof. Paper 820,

d. **Geographic Distribution of Resources.** Copper reserves are located mainly in Arizona and New Mexico. The present distribution by groups of States is as follows:[24]

Arizona New Mexico	80%
Utah Nevada	9%
Montana Michigan Other	11%

Future discoveries will probably be concentrated in those five Western States shown above, with Arizona offering the greatest potential. New discoveries of important deposits in Alaska, Washington, Idaho, and Wyoming suggest that these States may contain large resources as well.

[24] D. P. Cox, U.S. Geological Survey, written communication, 1975.

e. Potential of Federal Land. Analysis of Federal land distribution and known areas of mineral potential was inconclusive because of insufficient resource data. Most known deposits lie in States with large Federal landownership. The deposits tend to be in enclaves of former Federal land, which passed into private ownership on the discovery of valuable mineral deposits under the Mining Law of 1872. Furthermore, they tend to be clustered in old established mining districts. The areas having the greatest potential for new discoveries lie in unpopulated regions in the West. Much of this land is federally owned.

3. Fluorspar (Fluorine)

This industrial mineral is important to the aluminum, iron and steel, chemical, and glass industries. Fluorspar resources are found largely in Kentucky, Illinois, Tennessee, the Western States, and Alaska. Fluorspar resources in the Western States are mostly on Federal land.

a. **Uses, Substitutes, or Alternatives.** Fluorspar is the main source of fluorine, which is used in the electrolytic process for making aluminum. Fluorine is used as a flux in making iron and steel and is also a basic element in the production of certain chemicals (fluorocarbon compounds), ceramics, and glass. There is no substitute, practically speaking, for fluorspar in its most important uses.

b. **Demand Outlook.** U.S. demand for fluorine has approximately doubled between 1963 and 1973. It is expected to continue to increase, although at a much lower rate of growth. The precise rate of growth will be related to technological change in the chemical industry and the use of direct reduction methods in steelmaking. Figure A-6 illustrates the projected demand for fluorine.

c. **Supply Outlook.** Over the past 10 years, annual domestic mine production of fluorspar has remained relatively constant. Consequently, growth in fluorine consumption has been largely met by increased imports (see table A-5).

Even with a significant increase in the supply of fluorine obtained as a byproduct of phosphate production,[25] there does not appear to be sufficient domestic fluorspar resources to satisfy forecasted demand (see figure A-7 and table A-6). A similar supply problem may also develop worldwide before the year 2000.

d. **Geographic Distribution of Resources.** Identified significant fluorspar resources are in Illinois, Kentucky, Texas, Tennessee, New Mexico, Nevada, Utah, Colorado, Idaho, Montana, and Alaska. Approximately 20 percent of the U.S. total resources is in the Western States.[26]

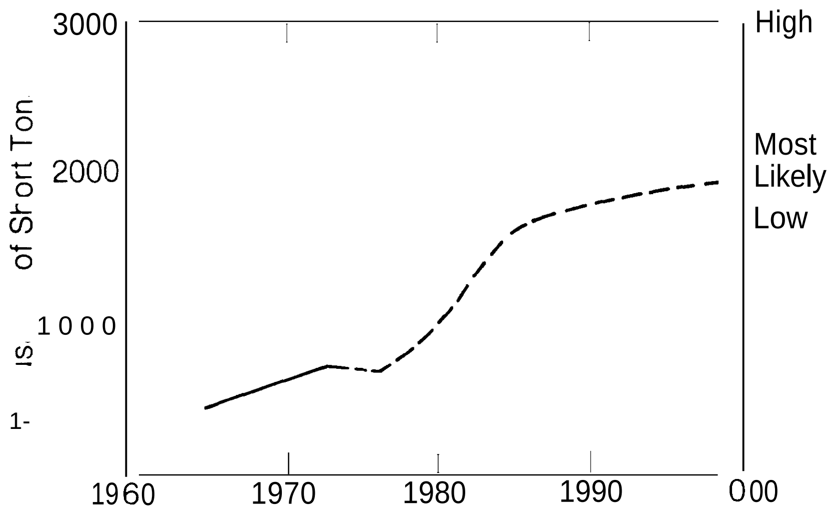
e. **Potential of Federal Land.** It was not possible to estimate fluorspar resources on Federal land because of insufficient resource data.

Although the largest U.S. fluorspar resources occur in Illinois, Kentucky, and Tennessee, significant potential for new discoveries exists in the Federal land of the Western States and Alaska. Map studies indicate that identified resources are located

[25] High-grade phosphate rock contains as much as 4 percent fluorine (see "Fluorine" in the USGS Prof. Paper 820).

[26] Ralph Van Alstine, U.S. Geological Survey, written communication, 1975.

Figure A-6.— Fluorine Demand Outlook



Forecast Assumptions

High: Present chemical uses continue to grow and new fluorocarbon products are developed; high growth in use of basic oxygen furnace as reduction method in steelmaking.

Low: Increased replacement of fluoro-carbon compounds by other chemicals; high growth in use of direct reduction methods in steelmaking; salvage of some fluorine used in aluminum production.

Table A-5.— Flourine Supply
(Thousands of Short Tons of Fluorine)

	1965	1970	1974
Domestic U.S. Mine Production of Fluorspar	109	121	91
By-Product of Phosphate	—	—	46
Government Stockpile Releases	—	48	—
Minus Exports	(4)	(7)	(3)
Plus Imports (Primarily from Mexico)	310	501	601
Industry Stocks, January 1	174	131	148
TOTAL Fluorine Supply	589	794	883

Figure A-7.—Fluorine Supply Outlook

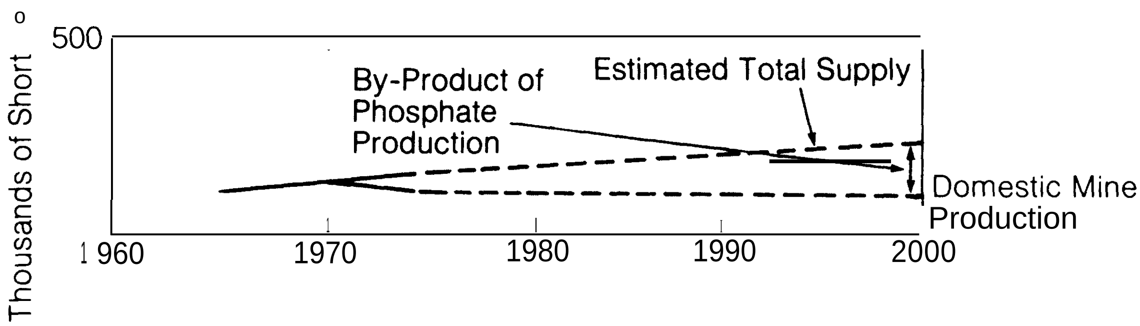


Table A-6.—Resources of Fluorspar

Identified:	25 million tons of fluorspar ore (approximately 8.3 million tons of processed fluorspar recoverable with an average fluorine content of approximately 45 percent).
Hypothetical and Speculative:	45 million tons of hypothetical fluorspar resources (approximately 15 million tons of processed fluorspar recoverable with an average fluorine content of approximately 45 percent).

mainly in national forest land along the Continental Divide, as well as in Texas, New Mexico, Colorado, Idaho, and Montana. In addition, all of the resources in California and Nevada are on Federal land, with one district in each State being within a national forest, Deposits in Alaska, Arizona, Utah, and Washington occur mainly on Federal land, and about one-third of these deposits lies within national forests.

4. Geothermal Energy

As stated in the Geothermal Steam Act "geothermal steam and associated geothermal resources" means (i) all products of geothermal processes, embracing indigenous steam, hot water, and hot brines; (ii) steam and other gases, hot water, and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any byproduct derived from them. This section, however, will deal only with the heat, or heat transfer, aspects of resources of geothermal energy.

Geothermal energy contributes only a very small part of domestic energy supply; however, estimates of resources on Federal land indicate that it could provide an important source of energy in the future.

a. **Uses, Substitutes, or Alternatives.** The principal use of geothermal energy in the United States is in the generation of electricity. At present, only one commercial generating project uses geothermal energy. Located at the Geysers, Calif., it provided approximately one-tenth of one percent of the Nation's total electricity in 1974. [27] Geothermal energy is also used directly in the heating and cooling of buildings, in the heating of hothouses and soil for agricultural purposes, and in product processing. Production of freshwater by self-desalination of geothermal fluids has been proposed for the Imperial Valley of southern California, If this proves to be feasible the geothermal waters of the Imperial Valley may prove to be a significant source of additional freshwater supply for the Southwest United States.

Substitutes for geothermal energy are the fossil fuels and uranium, as well as solar and other nonmineral energy sources.

b. **Demand Outlook.** The potential importance of geothermal energy depends both on the extent of the resource and the development of technologies for harnessing it.

Except for localized heating applications, the primary use for geothermal energy is generating electricity. Because of rapid heat losses during transportation, geothermal fluids must ordinarily be utilized within about a mile of their extraction point. Since most areas with geothermal potential are located far from industrial centers, geothermal generating plants would probably be sited at some distance from such centers, It has been estimated that in order to justify the expense of building transmission lines, a geothermal reservoir must have the ability to support a geothermal complex of at least 200 megawatts (MW). Future demand, therefore, will depend somewhat on the size of discoveries. However, there has been very little experience in geothermal exploration and evaluation, so that any estimation of future demand must be based on the tenuous grounds of overall forecasts of future energy requirements and the potential promise of geothermal energy. The U.S. Bureau of Mines has estimated that installed geothermal electrical-generating capacity might reach 3,000 MW by 1985 and 10,000 MW by the year 2000. The installed capacity in 1976 amounted to only 500 MW, all at the Geysers in California.

c. Supply Outlook. Serious environmental and operating problems could limit the potential of geothermal energy. Some of the problems are land sinking because of withdrawal of large amounts of hot water, destruction of equipment by highly corrosive and harmful compounds, plugging up of equipment by heavily mineral laden brines, and large quantities of waste fluids that must be disposed of without polluting water supplies for normal uses.

Research is being carried out to find ways to cope with the problems and to increase geothermal capacity. The Geysers area is estimated to have an ultimate capacity of about 2,500 MW, five times its present capacity. The Bureau of Mines reports that there are 38 geothermal areas, in seven Western States, which are under lease or exploration. There are near- or medium-term plans to install only about 2,100 MW of additional generating capacity, almost all of which would be at the Geysers.[28] This

[27] U.S. Federal Trade Commission, Bureaus of Competition and Economics, *Report to the Federal Trade Commission on Federal Energy Land Policy: Efficiency, Revenue, and Competition*, Ser. No. 94-28 (92-118), Senate Comm. on Int. & Ins. Affairs, 94th Cong., 2d sess. 687 (Comm. Print 1976).

[28] U.S. Bureau of Mines, *Projects to Expand Fuel Sources in Western States*, Info. Circ. 8719 (1976).

amount added to current capacity falls short of the estimate of 3,000 MW of total installed capacity by 1985 cited above.

The useful heat recoverable from identified geothermal systems with present or near-current technology and with prices at or double present prices exists almost entirely in the hydrothermal convection systems of the Western States and Alaska and in the geopressured zones of the gulf coast. Estimated recoverable electric power from these resources, assuming present and near-current technology, but without regard to cost, is shown in table A-7 (sizable resources in Mt. Lassen and Yellowstone National Parks are not included).

Table A.7—Recoverable Geothermal Resources (Annual Megawatts (MW) for 30 Year Production Plan)

Hydrothermal Convection Systems	
Identified:	11,700 reserves, plus over 15,000 in paramarginal and submarginal resources.
Hypothetical and Speculative:	126,700
Geopressured Zones	
Identified:	19,000 from thermal energy, plus 11,900 in mechanical energy; all onshore.
Hypothetical and Speculative:	Over 250,000 in unassessed parts of the gulf coast (onshore and offshore) and other geopressured environments.

Source U S Geological Survey, Assessment of Geothermal Resources of the United States—19 75, Circle 726, Tables 27 and 28 (Plan 3) (1 975)

d. **Geographic Distribution of Resources.** In general, the average heat content of rocks is considerably higher in the Western United States than in the East. The hydrothermal convection systems in the Western States and Alaska, not including the sizable systems in Mt. Lassen and Yellowstone National Parks, account for 46 percent of the Nation’s recoverable onshore geothermal resources in terms of electric power potential; the geopressured zones of the gulf coast account for the remainder (see table A-7).

The most attractive identified convection systems are those with predicted reservoir temperatures above 1500 C. The approximate distribution of such systems according to heat content is as follows:[29]

California	47.6%
Wyoming	33.7%
Nevada	5.4%

[29]U.S. Geological Survey, Assessment of Geothermal Resources of the United States – 1975, Circ. 726 (1975).

New Mexico	4.6°/0
Oregon	3.7%
Idaho	3.3%
Utah	0.9%
Alaska	0.4%
Washington	0.3%
Arizona	O.1%

This percentage breakdown includes the geothermal systems in Mt, Lassenand Yellowstone National Parks. The Mt. Lassen system constitutes 3 percent of the California resource above 150°Canal 25 percent of the resource above 200°C(the remaining 75 percent being in the Geysers area). The Yellowstone systems constitute 100 percent of the Wyoming resource above 150°C.

e. Potential of Federal Land. The U.S. Geological Survey has identified more than 100 known geothermal resource areas, encompassing over 3 million acres, on Federal land. Another 98 million acres have been identified as prospectively valuable. At the end of 1975, there were 548 Federal geothermal leases encompassing close to 1 million acres.[30]

The hydrothermal convection geothermal systems, which occur in the western public land States, account for 46 percent of the recoverable geothermal resources of the United States in terms of electric power potential, even excluding the 35 percent (by heat content) of the Nation's hydrothermal convection resources in Mt. Lassen and Yellowstone National Parks (which are closed to mineral development).

One study has reported that approximately 56 percent of the Nation's known geethermal resources is estimated to be on Federal land.[31]

5.Iron Ore [32]

The 'United States is potentially self-sufficient in iron ore. Our iron ore resources, primarily concentrated in the Lake Superior region, appear adequate to meet projected demand. Domestic production capacity is being used to supply only about 70 percent of domestic demand owing to the commercial advantages of using foreign high-grade ores to supplement domestic production. Imports in excess of exports during the past 5 years have averaged 29 percent of total domestic iron ore consumption.

The iron and steel industry is extremely "transportation oriented" with regard both to sources of raw materials and to existing markets for iron and steel products. Locations having adequate water supplies, proximity to markets, and low transportation costs for the three bulk raw materials required for steelmaking—coking coal, iron ore, and limestone—have the greatest economic advantageas sites for ironmaking and steelmaking facilities. These factors have favored the growth of the industry in the eastern and central regions of the Nation, and it is there that the bulk of future growth in demand is expected to occur. The iron and steel industry of the Western States,

[30] U.S. Geological Survey, Conservation Division, *Federal and Indian Lands Oil and Gas Production, Royalty Income, and Related Statistics, Calendar Year 1975*, at 33 (1976).

[31] Federal Trade Commission Report, note 27, at 687.

[32] USGS Prof. Paper 820, supplemented by H. Klemic, U.S. Geological Survey, written communication, 1976.

based principally on domestic ores and scrap metal from the Western States, also has potential for continued growth as demands in that region increase and as additional raw material sources there are developed.

The Western States and Alaska contain about 10 billion tons of identified iron ore resources, but less than 1 billion tons of this amount is considered to be reserves. About 70 percent of the resources are on Federal land. Additional iron ore resources are likely to be discovered in the Western States, but an estimate of their magnitude is not available.

6. Lead

Demand for lead in the United States from 1974 to 2000 is forecast to grow at an average annual rate of 1.6 percent. This anticipated growth rate is based essentially on continued growth in demand for automotive batteries, and on expected growth in demand for batteries for electric-powered vehicles and standby power. Consumption of lead in gasoline additives is expected to decline about 60 percent from the 1973 level. Domestic mine production is expected to increase steadily to maintain the level of self-sufficiency achieved in recent years. Ore reserves are more than adequate to meet cumulative lead requirements to the year 2000.

About 86 percent of total identified domestic lead resources are located in the Central and Eastern States; specifically, the larger resources are in southeast Missouri, located on and adjacent to the Mark Twain National Forest. Several areas in the forest, not covering the identified resources, are believed to have good potential. Approximately 14 percent of the U.S. lead resources are in the Rocky Mountain, Northwestern, and Western States. The largest western lead resources are in the Coeur d'Alene district of the Rocky Mountains and the Great Basin.

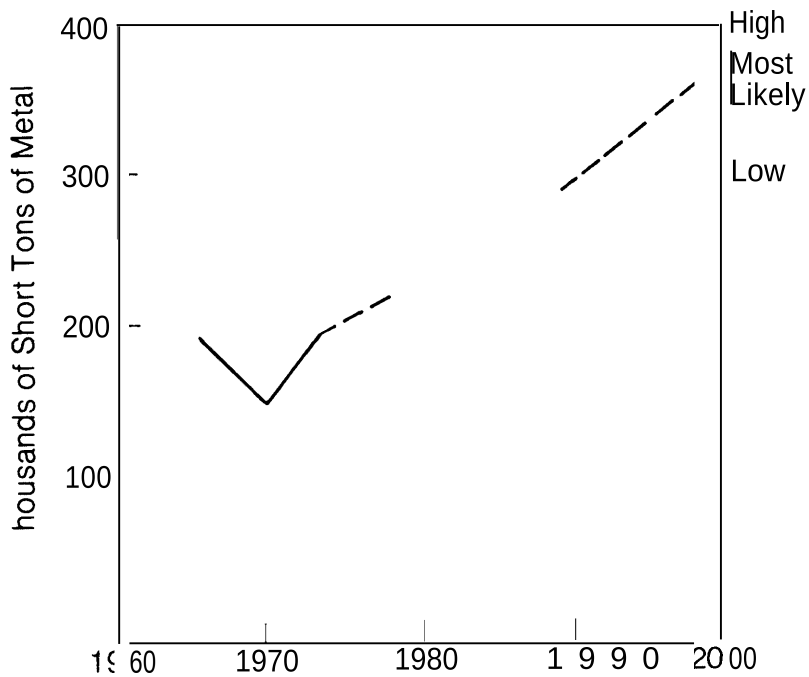
7. Nickel

Nickel is an industrial metal important to many industries. Almost all new potential nickel sites are on Federal land.

a. **Uses, Substitutes, or Alternatives.** Nickel's importance rests in its ability to impart resistance to corrosion and to improve mechanical and high-temperature properties of other metals, The primary use of nickel is as an alloy in materials used to contain or transport corrosive chemicals. Although substitute and alternative materials are available for nickel in almost all of its uses, the products derived from these other materials are either more costly or of lower quality in terms of chemical and physical resistance to corrosion than the equivalent nickel-based products. Moreover, most of the best metallic substitutes—namely, chromium, manganese, cobalt, and platinum-are not produced in any appreciable quantity in the United States.

b. **Demand Outlook.** Although primary consumption of nickel has fluctuated, a steady rate of growth is forecasted (see figure A-8).

Figure A-8. Primary Nickel Demand Outlook



Forecast Assumptions

High: Expansion of developing technologies requiring nickel, such as oil shale processing: coal gasification, and desalinization industries; increased mechanization in industries and increased demand for metals of superior quality.

Low: Increased substitution of plastic and titanium for coatings in the chemical, petroleum and superalloy manufacturing industries.

c. Supply Outlook. In the past, levels of nickel consumption in the United States have been met largely by imports, supplemented significantly by secondary (recycled) nickel, and to a lesser extent by domestic production (see table A-8).

It is anticipated that imports will assume a much more significant role in the future. In the United States there is only one operating mine—at Riddle, Ore. This deposit is expected to be depleted in 15 years. With the closing of the Riddle operation, one of three supply scenarios may develop over the next 25 years, as illustrated in

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figure A-9. In scenario I, the most likely future supply situation assumes the development of one new mine in Minnesota, with an average annual production of 25,000 tons of nickel. Scenario II, the low range of the forecast, assumes that no new mines would open and the United States would become 100-percent dependent on imports for primary nickel supplies. Scenario III, the high side of the supply forecast, assumes development of six new mines in Minnesota (within the next 10 to 15 years) each with a capacity of 25,000 tons of nickel per year. The implication of this third scenario is that imports could be reduced to approximately one-half the scenario II level.

Estimated domestic resources of primary nickel are shown in table A-9.

Table A-8.—Nickel Supply
(Thousands of Short Tons)

	1965	1970	1974
Domestic U.S. Mine Production	14	16	14
Nickel from Secondary Sources (Recycled Scrap)	51	49	64
Government Stockpile Releases	16	2	5
Minus Export	(6)	(6)	(4)
Plus Imports (Mainly from Canada)	163	156	221
Industry Stocks, January 1	17	32	71
TOTAL Nickel Supply	255	249	371

Table A-9.—Resources of Primary Nickel

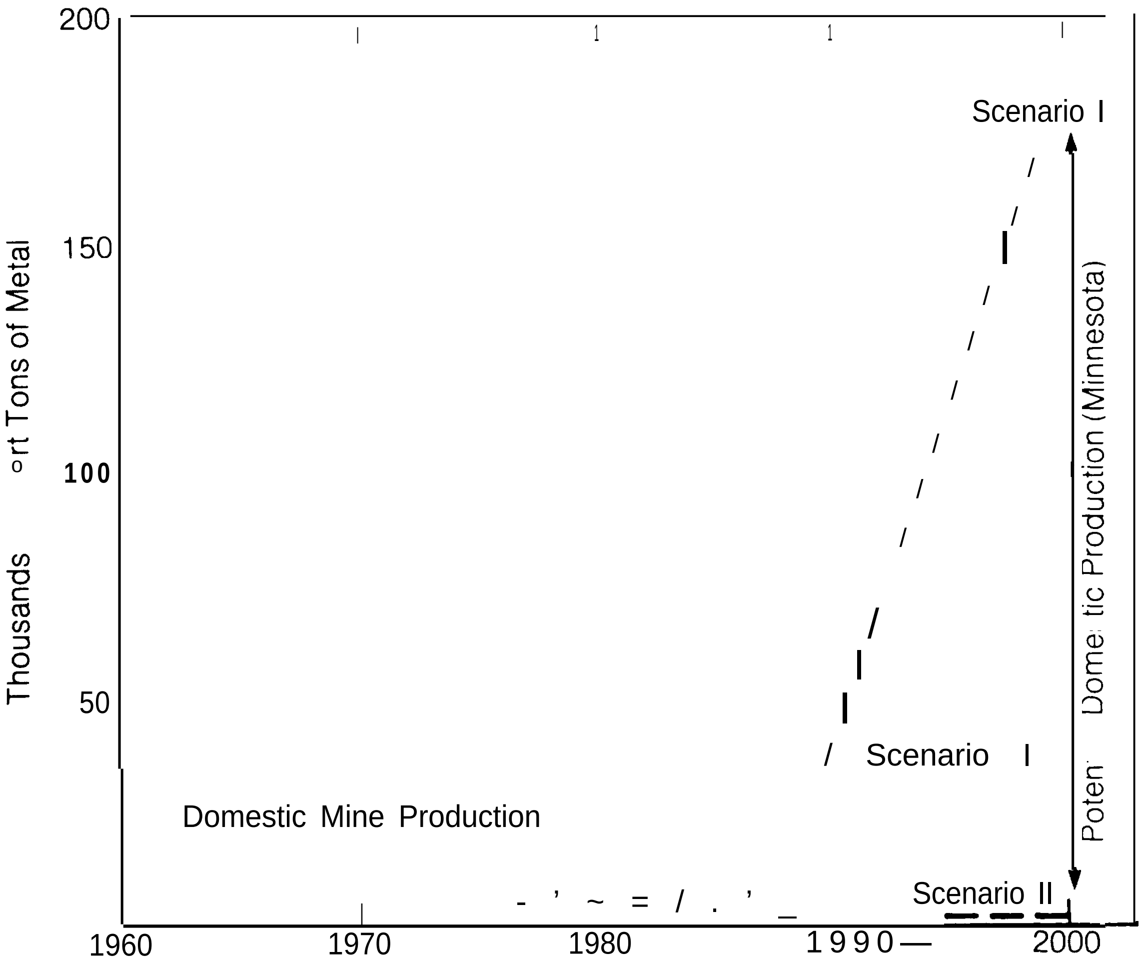
Identified:	2.6 to 14.7 billion tons of nickel-sulfide ore (5 to 20 million tons of contained nickel), plus 100 million tons of nickel-laterite ore (0.76 million tons of contained nickel). The estimated nickel-sulfide resources are tentative modifications of the data in USGS Prof. Paper 820 based on the Bonnichsen data cited in Figure A.9.
Hypothetical and Speculative:	Not given in sources used.

d. **Geographic Distribution of Resources.** Identified nickel resources in the United States (nickel sulfide and nickel laterite deposits] in terms of contained nickel are distributed as follows:

Minnesota	88.0%
Alaska	3.6%
California and part of Oregon	2.7%
Montana	2.4%
Oregon (Nickel Mountain)	1.0%
Washington	1.0%
Maine	0.6%
Other	0.7%

Minnesota is the most promising area for exploration. The estimated size of this State’s nickel resources is enormous. Alaska, Oregon, California, and Washington also have potentially significant nickel resources.

Figure A-9 .—Primary Nickel Supply Outlook



Scenario I (Most Likely): One new domestic mine with 25,000 tons of annual production.

Scenario 11: No new domestic mines.

Scenario Ill: Six new domestic mines, each with 25,000 tons of annual production.

Source: Scenarios independently developed, based on data in U.S. Bureau of Mines, *Mineral Facts and Problems, 1975 Edition* (1976), and B. Bonnichsen, *Copper and Nickel Resources in the Duluth Complex, Northern Minessota*, Minnesota Geological Survey Info. Circ. 10 (1974).

e. **Potential of Federal Land.** All of the identified resources in Minnesota are in the Superior National Forest. As similar geologic structure extends northward, additional resources of perhaps a comparable magnitude may fall within the Boundary Waters Canoe Area. All of Alaska's identified resources are on Federal land. The largest deposit is in the Glacier Bay National Monument. The other two major deposits are in the Tongass National Forest. About 85 percent of the identified deposits of nickel in California and Oregon (other than Nickel Mountain) are located mostly in national forest areas, including the Trinity, Cleveland, and Siskiyou National Forests.

8. Petroleum and Natural Gas

Alaska, the Pacific Coastal States, the western and northern Rocky Mountains, west Texas, and eastern New Mexico contain almost two-thirds of identified U.S. onshore crude oil resources and approximately two-fifths of identified U.S. natural gas resources. Alaska alone contains about 29 percent of identified U.S. onshore crude oil resources and about 14 percent of identified natural gas. About half of Alaska's undiscovered potential crude oil and natural gas resources are estimated to be on Federal land. Approximately 28 and 31 percent of the identified crude oil and natural gas resources, respectively, in the 11 Western States are on Federal land.

a. **Uses, Substitutes, or Alternatives.** Petroleum and natural gas are essential to the Nation's energy supply. Historically, natural gas has been a cheaper fuel than oil. Petroleum is vital to the transportation sector and petrochemical industry.

Synthetic liquid hydrocarbons (syncrude) and synthetic natural gas (substitute natural gas or SNG) may one day be substituted for petroleum and natural gas. Several complex pilot processes have been developed to produce syncrude and SNG from coal. Syncrude and syngas may also be developed from oil shale. However, the costs for all these processes at present and the time required to develop a commercial-sized industry seem to prohibit any major contribution of synthetic substitutes over the next 25 years.

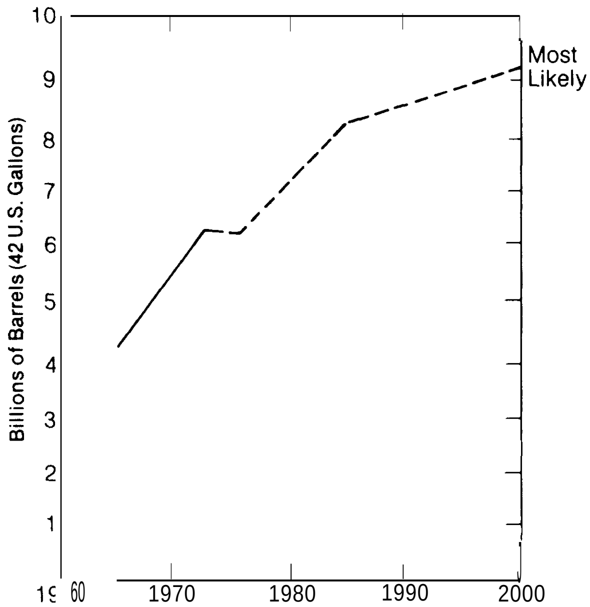
Coal can substitute for both petroleum and natural gas in the production of steam for generation of electricity and heating, Nuclear and solar energy are also alternative sources of power generation. However, there is still considerable use of natural gas and oil to generate electricity and to heat large building complexes. Coal chemicals can also serve as substitutes for a variety of petrochemicals.

b. **Demand Outlook.** Historically, the demand for petroleum and natural gas has steadily increased, with the demand for natural gas increasing less rapidly than it had in the past. In the years since 1973, consumption has been a function of supply availability as well as the rate of substitution of coal and uranium as sources of energy. This relationship is expected to continue in the future (see figures A-10 and A-1 1).

The relative share of petroleum and natural gas in the total energy picture is expected to decline. Petroleum supplied 45.9 percent of total U.S. energy in 1972. This share is forecasted to decrease to about 43 percent by 1985 and about 32 percent by the year 2000. Similarly, natural gas, which supplied 32 percent of total U.S. energy in 1972, is expected to supply approximately 20 and 17 percent of the total energy in 1985 and 2000, respectively,

c. Supply Outlook (Onshore and Offshore). Cumulative petroleum demand for the period 1974 to 2000 could well be approximately 200 billion barrels, if stringent energy conservation is not followed. Total onshore and offshore domestic reserves plus

Figure A-1 O. —Petroleum Demand Outlook

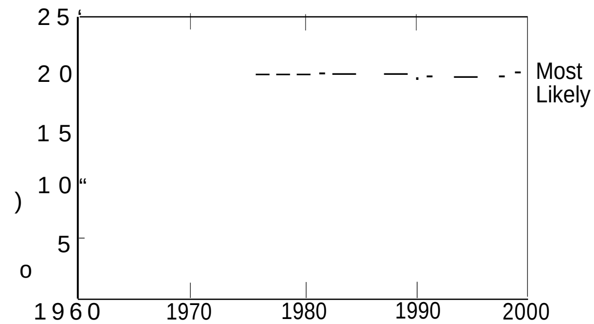


Forecast Assumptions

Most Likely: Continued growth in GNP averaging approximately 3.5 percent per year; continued slow growth in population averaging less than one percent per year; supply limitations explicitly taken into consideration; 1974 prices; more efficient use of energy by industry.

NOTE: According to information provided to OTA in March 1979 by the Department of Energy (DOE), the DOE Base Case Projections show approximately 7 billion barrels of petroleum consumption in the year 2000.

Figure A-1 1. —Natural Gas Demand Outlook



Forecast Assumptions

Most Likely: Same as in Figure A-10.

NOTE: According to information provided to OTA in March 1979 by the Department of Energy (DOE), the DOE Base Case Projections show 20 trillion and 21 trillion standard cubic feet of natural gas consumption in the years 1985 and 2000 respectively.

undiscovered recoverable resources are estimated to be on the order of 135 billion to 223 billion barrels of petroleum (see table A-10).

It is unlikely that domestic petroleum demand can be met from domestic supplies during the forecast period, even if strong energy conservation measures are implemented and the rate of finding and developing reserves is increased. The rate of exploration and development has not been sufficient in recent years to maintain domestic production even at the level achieved in 1970 when about 23 percent of consumption was filled by imports (see table A-11).

Annual production of natural gas is forecasted to approximately meet the projected annual demand, if the rate of finding and developing reserves can be sustained at pre-1970 levels. The demand forecast, which reflects the expected supply of natural gas, estimates cumulative demand for the period 1974 to 2000 to be approximately 575

Table A-1 O.—Recoverable Resources of Petroleum

Identified:	74 billion barrels of reserves (56 onshore crude oil, 6 offshore crude oil and 12 onshore and offshore natural gas liquids).
Hypothetical and Speculative:	61-149 billion barrels of undiscovered recoverable resources (37-81 onshore crude oil, 10-49 offshore crude oil and 11-22 onshore and offshore natural gas liquids).

Source U S Geological Survey, Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States, Circ 725 (1975) The estimated ranges for undiscovered resources were derived by Monte Carlo simulation techniques and are not additive The low end of each range IS estimated to be 95 percent certain, the high end IS estimated to be only 5 percent certain Ibid at 26-27

Table All .—Petroleum Supply
(Billions of Barrels (42 U.S. Gallon))
(Onshore and Offshore)

	1965	1970	1974
Domestic Production of Crude Oil	2.8	3.5	3.2
Domestic Production of Natural Gas Liquids	0.4	0.6	0.6
Processing Gain	0.1	0.1	0.2
Minus Exports	(0.1)	(0.1)	(0.1)
Plus Imports	0.9	1.2	2.2
Industry Stocks, January 1	0.8	1.0	1.0
TOTAL Petroleum Supply	4.9	6.3	7.1

trillion cubic feet. Such a demand would require not only all of the identified U.S. recoverable resources, but also a large amount of the estimated undiscovered natural gas resources (see tables A-I2 and A-13).

Table A-1 2. —Recoverable Resources of Natural Gas

Identified:	439 trillion cubic feet of reserves (335 onshore and 104 offshore).
Hypothetical and Speculative:	322-655 trillion cubic feet of undiscovered recoverable resources (264-506 onshore and 42-181 offshore).

Source Same as table A-1O

Table A-l3 .—Natural Gas Supply
(Trillions of Standard Cubic Feet)
(Onshore and Offshore)

	1965	1970	1974
U.S. Domestic Production (Dry)	16.0	21.9	21.6
Transfer Out, Extraction Loss	(0.8)	(0.9)	(0.9)
Minus Exports	—	(0.1)	(0.1)
Plus Imports	0.5	0.8	1.0
Industry Stocks, January 1	2.3	2.9	3.9
TOTAL Natural Gas Supply	18.0	24.6	25.5

d. **Geographic Distribution of Resources.**[33]

(1) Petroleum. About 63 percent of the identified onshore crude oil resources in the United States are in four western regions and Alaska; the distribution of these resources is as follows:

Alaska . . . . , ... 28.8%
West Texas and eastern New Mexico ... , ... 19.1%
Pacific Coastal States . . . . , ... , ... , ... , ., . 7.3%
Northern Rocky Mountains. . . . . , ., . . . 5.2%
Western Rocky Mountains ... , , ... 2.2%
Other . . . . , ... 37.4%

[33] U.S. Geological Survey, *Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States*, Circ. 725 (1975).

Alaska and these four western regions also have potential for additional onshore discoveries of crude oil reserves; these areas contain an estimated 44 percent of total U.S. undiscovered recoverable crude oil resources.

(2) Natural Gas. Alaska and the Western States are estimated to contain about 38 percent of total identified U.S. onshore natural gas resources. The distribution is as follows:

West Texas and eastern New Mexico	14.3 %
Alaska	13.8%
Western Rocky Mountains	36%
Northern Rocky Mountains	3.6°/0
Pacific Coastal States	2.6%
Other	62.1 °/0

The "Other" category for both petroleum and natural gas includes the western Gulf Basin, midcontinent Michigan Basin, eastern Interior, Appalachians, eastern Gulf, and Atlantic Coastal Plain.

e. Potential of Federal Land. Only rough estimates of resources of petroleum and natural gas on Federal land were possible because of the quality of resource information available.

Less than 1 percent of identified Alaskan onshore crude oil and natural gas resources are on Federal land, principally Naval Petroleum Reserve No. 4. An estimated 55 percent of the undiscovered onshore resources of crude oil in Alaska might be present on all categories of Federal land including Petroleum Reserve No. 4, which has the highest potential of the Federal land in Alaska. An estimated 50 percent of Alaska's undiscovered onshore gas resources are on Federal land, including Naval Petroleum Reserve No. 4.

Of the onshore petroleum and natural gas resources in the 11 Western States, an estimated 28 percent of the identified petroleum, 31 percent of the identified natural gas, 42 percent of the undiscovered petroleum, and 39 percent of the undiscovered natural gas are or might be on Federal land, primarily rangeland and national forest land.

In addition to the Nation's domestic onshore resources of liquid petroleum, there is a very large oil shale deposit located in the Green River Basin of the Rocky Mountains, a relatively concentrated area of approximately 25,000 square miles (about 16 million acres) extending over parts of Colorado, Utah, and Wyoming. Of this 25,000 square miles, 17,000 square miles are believed to contain about 600 billion barrels of synthetic crude oil in high-grade oil shale and perhaps 1,200 billion barrels of oil in lower grade oil shale. It is estimated that 72 percent of the oil shale land is under Federal control. Eighty percent of this federally controlled land contains high-grade oil shale deposits. The likelihood of oil shale production depends on the price of substitutes (imported and domestically produced crude oil), developments in oil shale technology, the availability of water, and the solution of environmental problems (especially air quality and disposition of the spent oil shale).[34]

[34] Federal Trade Commission Report, note 27, at 469-471.

9. Phosphate Rock

As a source of phosphorus, phosphate rock is essential to the fertilizer industry. There are sufficient domestic resources to meet U.S. demand at least for the next 25 years. About half of the phosphate resources are in the Western States and in Alaska, in areas having a relatively high proportion of Federal land.

a. **Uses, Substitutes, or Alternatives.** The principal use of phosphate rock is in the manufacture of fertilizers. There is no substitute for phosphorus as a plant nutrient. Phosphates are also used in the manufacture of detergents, animal feed supplement, and insecticides and in the electroplating and polishing of metals. There may be some substitutions for these nonfertilizer end uses. The rate and amount of substitution, however, will vary as a function of price, stability of supplies, and environmental considerations.

b. **Demand Outlook.** The consumption of phosphate rock has grown at a relatively strong rate in the past, closely correlated with increases in population and living standards (per capita food consumption). In the future, demand will depend on the same economic factors, as well as on the adequacy of technology for the control of detergent phosphates in waste water.

The domestic demand outlook for phosphate rock is shown in figure A-12. In addition, it is estimated that the United States will continue to export phosphate fertilizer in a proportion similar to that prevailing today (see table A-14).

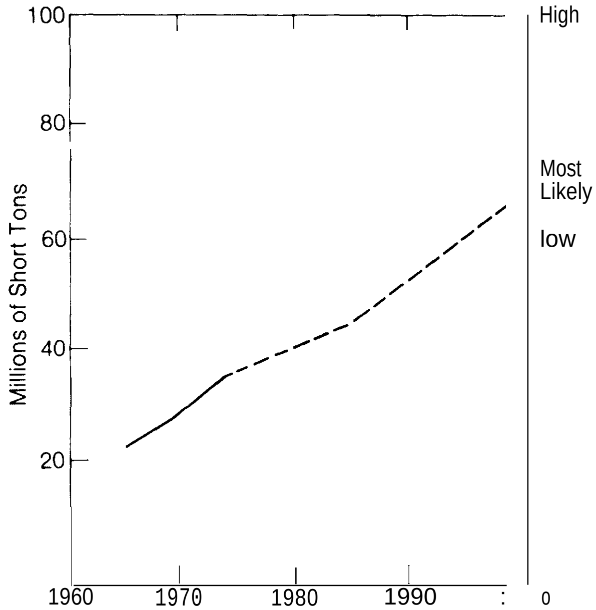
c. Supply Outlook, Over the past decade, domestic supplies of phosphate rock have steadily increased to meet growing demand (see table A-14). The small volume of imports consists principally of low fluorine phosphate, used as an animal feed supplement, from Aruba and Curacao.

Over the next 25 years, U.S. phosphate rock resources (see table A-15) will probably be sufficient to meet the U.S. demand. However, whether U.S. mines will produce a sufficient supply is a question of price sensitivity and environmental restrictions on mining.

Morocco currently contains the bulk of the world's resources of high-grade, easily minable phosphate rock and has expanded its control to include some of the resources of the Spanish Sahara. Consequently, Morocco has the potential ability to exert influence on world prices, particularly after 1990. Therefore, whether or not the United States will produce all of its own phosphate needs will depend somewhat on the competitiveness of Moroccan phosphate prices.

The "most likely" forecast for domestic phosphate rock production (see figure A-13) indicates a steady growth in domestic mine output over the next 10 years, with a gradual leveling off during the remainder of the decade, as domestic supply is replaced by increased imports. However, issues relating to potential damage to the environment from phosphate mining may restrict phosphate production, particularly in the Southern Atlantic Coast States.

Figure A-1 2 .–Phosphate Rock Demand Outlook



Forecast Assumptions

High: High growth rate in population and food requirements.

Low: Slower rate of growth in population and food requirements.

Table A.14.– Phosphate Rock Supply
(Thousands of Short Tons)

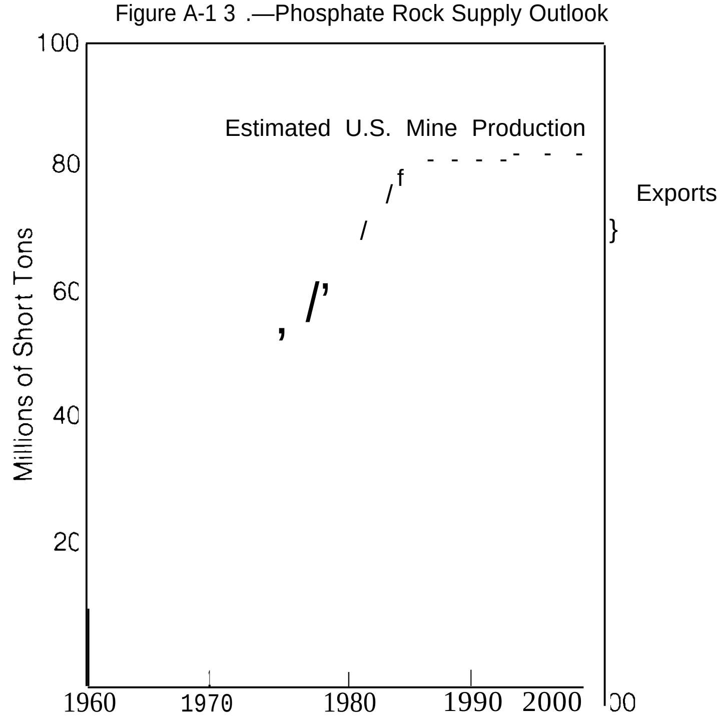
	1965	1970	1974
Domestic U.S. Mine Production	29,482	38,739	45,686
Minus Exports	(7,323)	(1 1,738)	(1 3,897)
Plus Imports	148	136	182
Industry Stocks, January 1	6,123	13,697	7,595
TOTAL Phosphate Supply	28,430	40,834	39,566

Table A-1 5 .—Resources of Phosphate Rock

Identified	2.9 billion metric tons of reserves, plus 10.5 billion metric tons of additional identified resources.
Hypothetical and Speculative:	25.1 billion metric tons of hypothetical resources.

Sources. USGS Prof. Paper 820, supplemented by U S. Geological Survey, Phosphate Resources in Southeastern Idaho (1975), and J B Cathcart, U S Geological Survey, written and oral communications, 1975

Figure A-1 3 .—Phosphate Rock Supply Outlook



d. **Geographic Distribution of Resources.** Identified phosphate rock resources are divided almost equally between the Southeastern and Western States. Southeastern Idaho contains about 35 percent of U.S. reserves.

The distribution of identified U.S. phosphate rock resources by area is as follows:

Idaho Montana Utah Wyoming }	57.1 0/0
Florida Georgia North Carolina South Carolina I	41 .9%
Tennessee Kentucky Alabama 1	1.0%

e. Potential of Federal Land. Quantitative estimates of phosphate resources located on Federal land are not available. However, map studies indicate that all of the existing mines and 25 percent of the outcrop areas in Utah are on Federal land. About 50 percent of the outcrop areas in Montana, Wyoming, and Idaho are also on Federal land, Portions of these areas are in the Caribou National Forest and possibly other national forests with sites under study for proposed wilderness areas. Large phosphate resources (perhaps as much as 1 billion tons) are estimated to be present in the Osceola National Forest in Florida, but due to environmental concerns there is considerable resistance to the development of these resources.

A large resource of phosphate rock, estimated to be about 1 billion metric tons [hypothetical resources category), is believed to be present in Alaska. Of the phosphate-bearing areas in Alaska, it is estimated that 35 percent are on national forest land, 30 percent are within the Arctic National Wildlife Refuge, and 15 percent are within proposed additions to the national park, wildlife refuge, and forest systems.

10. Potash

Potash is the common term used to describe potassium compounds. It is frequently used to mean the equivalent potassium oxide content of those compounds. Potash is an essential source of potassium for the fertilizer industry. An estimated 47 percent of total potash resources are located on Federal land.

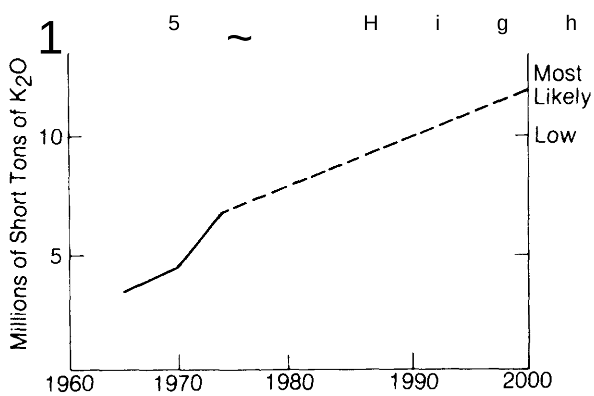
a. **Uses, Substitutes, or Alternatives.** Potassium is one of the three major nutrients essential to plant growth, and there is no alternative to the use of potash as a fertilizer. It is possible to substitute some sodium compounds for potassium compounds in certain chemical applications. Such substitutions, however, are rarely necessary because the supply of potassium is more than adequate. No increased substitution of other materials for potassium is expected.

b. **Demand Outlook.** Demand for potash has increased steadily over the past 10 years as domestic fertilizer use (expressed in pounds of potash per capita] has increased. This trend is expected to continue, with the variation in the forecast range depending upon growth in gross national product, conversion of poorer quality soils to agricultural use, and substitution and technologic change within the chemical industries (see figure A-14).

c. Supply Outlook. There are enough recoverable domestic potash resources to enable the United States to be self-sufficient over the forecast period (see table A-16).

Canada (specifically, the Province of Saskatchewan, which is the source of all Canadian potash) supplies a very large part of the total potash consumed in the United States because of the price competitiveness of that country's producers (see table A-17), Recent actions by the Provincial Government of Saskatchewan suggest that the province intends to seek control of its potash industry through the purchase of some or all of the potash mines there. Legislation was introduced in November 1975 to allow the provincial government to expropriate the property of any company with which it could not negotiate a purchase agreement. [35] However, it is too early to assess the impact of this development.

Figure A-14. —Potash Demand Outlook



Forecast Assumptions

High: Increased fertilization of pasture land; increased use of potash in various forms for cooling uranium fuel elements, driving turbines and abating air pollution.

Low: Farm use and GNP do not grow as expected; sodium chemicals substituted for potassium chemicals.

Table A-1 6 .—Resources of Potash

Identified:	450 million tons in "known reserves, " plus 569 million tons in "inferred reserves. "
Hypothetical and Speculative:	Not given in source used.

Source U S Bureau of Mines, the United States Position and Outlook in Potash, info Circ. 8487 (1970)

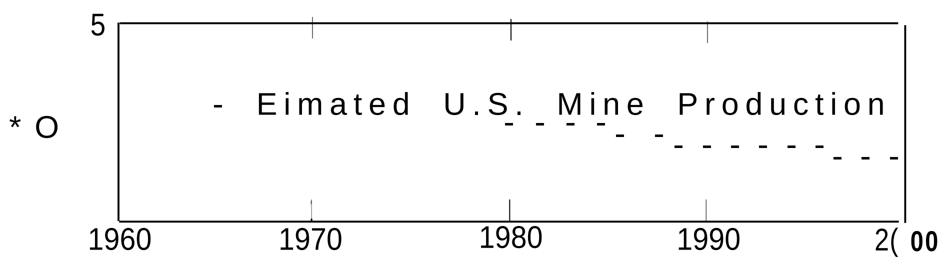
Table A-1 7.—Potash Supply
(Thousands of Short Tons of K_2O)

	1965	1970	1974
Domestic U.S. Mine Production	3,140	2,729	2,552
Minus Exports	(648)	(544)	(787)
Plus Imports (Mainly from Canada)	1,108	2,605	4,326
Industry Stocks, January 1	295	392	206
TOTAL Potash Supply	3,895	5,182	6,297

[35] *Wall Street Journal*, Dec. 4, 1975, at 27.

The supply outlook for domestic potash is shown in figure A-15.

Figure A-1 5 .—Potash Supply Outlook



SOURCES Mineral Facts and Problems 1975. supplemented by W F Keyes U S Bureau of Mines written and oral communications 1976

d. **Geographic Distribution of Resources.**[36] Most identified potash resources are in the Western States, principally in New Mexico, Utah, and Colorado, The distribution of "known reserves" is as follows:

Utah Colorado	76.7%
New Mexico	18.9%
California	4.4%

The distribution of "inferred reserves" is as follows:

New Mexico	70.3%
Utah Colorado	29.7%

e. Potential of Federal Land. Approximately 47 percent of the "known" potash reserves are on Federal land, some of which are located partially in the Manti-La Sal National Forest.

Of the "inferred" potash reserves, approximately 40 percent are on unreserved Federal land, principally grazing land, 15 percent on military land, and a small percent in national parks,

11. Silver

Silver is an industrial metal that is important to a wide range of industries. Almost all of the silver resources in the United States are in eight Western States and Alaska, all of which have a high degree of Federal landownership.

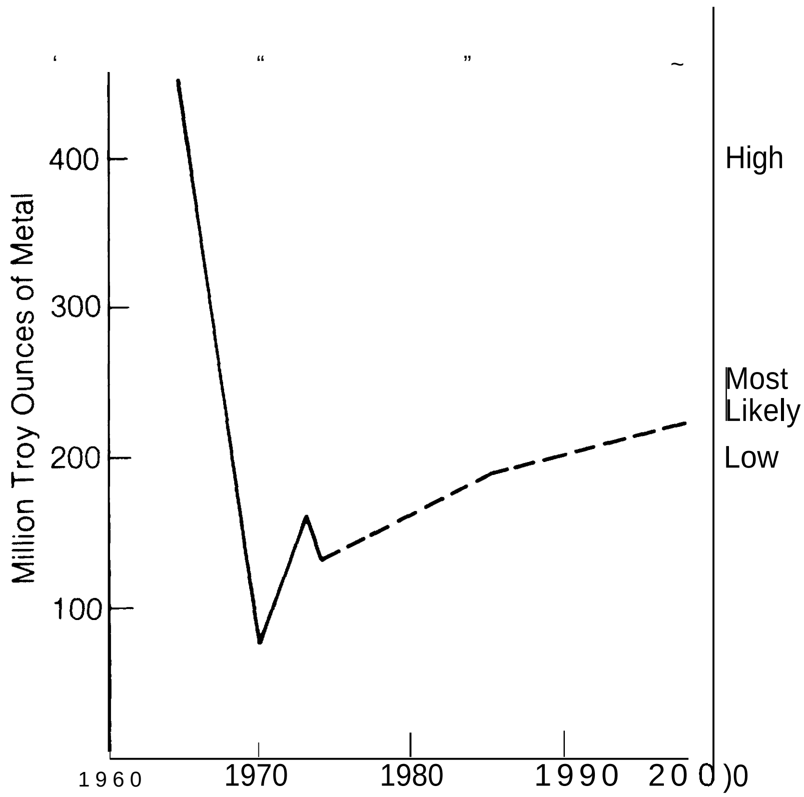
a. Uses, **Substitutes, or Alternatives.** Silver is very malleable, can be highly polished, and has the highest thermal and electric conductivity of any metal. The major silver-consuming sectors are silverware, jewelry, and arts; photography; refrigeration appliances and equipment; batteries; electrical and electronic equipment; and coinage. Stainless steel is a lower cost substitute for silver in cutlery and dental work. Semiconductors may substitute for silver in transistor switching devices.

[36] U.S. Bureau of Mines. *The United States Position and Outlook in Potash*, Info. Circ. 8487 (1970).

b. **Demand Outlook.** Over the past 10 years, primary silver demand has fluctuated widely (see figure A-16), This is due in large part to the substantial decrease in silver used for coins (from 320 million troy ounces in 1965 to 1 million troy ounces in 1974). On the other hand, the use of silver in the production of jewelry, photographic and electrical equipment, appliances, and other manufactured goods has been steadily growing. This growth is expected to continue over the next 25 years.

Because in the United States this metal is generally produced as a byproduct or coproduct of copper, lead, and zinc, the demand for these other minerals becomes a

Figure A-16 .—Primary Silver Demand Outlook



Forecast Assumptions

High: Strong growth in automation, communication, electrical equipment and other end-use demand.

Low: Increased use of substitutes (e.g., stainless steel) and reduced per unit consumption through technological change (e.g., photography and energy-intensive appliances).

factor in the future domestic supply of silver. (Copper and lead are discussed individually in other parts of this section.)

c. Supply Outlook. U.S. mineral deposits wherein silver is the main constituent have in general been mined out and are no longer productive except in a few major districts. Major prospecting programs for these kinds of deposits, such as have occurred in northern Idaho in recent years, could expand this source.

Over the next 25 years, most silver will most likely be developed as a byproduct from the following sources, assuming no radical jump in price that might make several other types of deposits attractive: copper porphyry deposits, copper-zinc-lead replacement deposits and vein clusters, massive sulfide deposits, lead-zinc replacement deposits, copper deposits in sandstones and shales, and nickel and magnetite deposits.

If the highest demand for silver were realized, the United States would be required to draw approximately 5.4 billion ounces of silver from world reserves because there would not be sufficient domestic reserves to meet this projected demand (see tables A-I8 and A-19). A large free world deficit of silver production in recent years, however, makes reliance on domestic resources and on better recovery from scrap and used film of increasing importance.

As shown in figure A-17, the domestic supply of primary silver is forecast to remain relatively stable between 1975 and the year 2000.

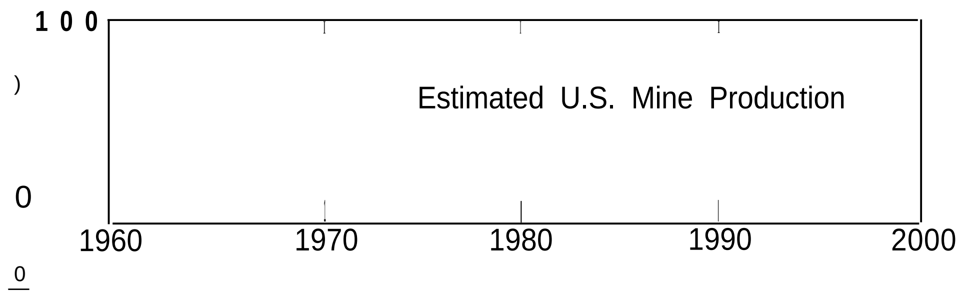
Table A-18.—Silver Supply
(Millions of Troy Ounces)

	1965	1970	1974
Domestic U.S. Mine Production	40	45	34
Secondary (Refined Scrap)	34	56	54
Minus Exports	(40)	(28)	(18)
Plus Imports, Ore and Concentrates	47	36	30
Plus Imports, Refined	7	33	92
Industry Stocks, January 1	Available	86	56
Commodity Exchange Stocks, January 1	3	113	92
Net U.S. Treasury Release	401	31	1
TOTAL Silver Supply	492	372	341

Table A-1 9.—Resources of Primary Silver

Identified:	1.4 billion troy ounces as by-product, plus 765 million troy ounces as main product.
Hypothetical and Speculative:	3.4 billion troy ounces of hypothetical resources, including deposits in which silver would be a by-product.

Figure A-17 .—Primary Silver Supply Outlook



d. **Geographic Distribution of Resources.** Most of the U.S. silver resources are in eight Western States and Alaska. The approximate distribution of identified and estimated hypothetical silver resources is as follows.

Nevada ... , ... , ... , ... , ... , ...	21.19i0
Idaho . . . . , ...	19.40/o
Montana ., ., ...	17.7%
Utah. , ., ...	15.9%
California ... , ..., ...	11.50%
Colorado	6.2%
Arizona	3.5%
New Mexico.	2.8%
Other	Less thanl%

In 1974, 90 percent of domestic silver production came from these eight Western States and Alaska.

e. Potential of Federal Land. Analysis of the distribution of public land with respect to known areas of silver potential was inconclusive because of insufficient resource data. However, most of our identified silver resources are on Federal land or patented claims. In Alaska, although current silver production is from patented claims, most potential silver provinces are on Federal land, mainly in the Chugach and Tongass National Forests. Generally, more than half of the potential silver provinces in Arizona, California, Colorado, Idaho, Missouri, Nevada, New Mexico, and Washington are on Federal land, including national forest land and rangeland. In Montana and Utah there are much smaller percentages of potentialsilver provinces on Federal land.

[1] *Mineral Facts and Problems*, 1975, supplemented by A. V. Heyl, U.S. Geological Survey, written communication, 1976. The Arizona estimate does not include silver in copper porphyries; the "Other" category includes Alaska, but does not include silver in southeast Missouri lead and zinc, Michigan copper, or Minnesota nickel.

12. Sodium Carbonate (or Soda Ash)

Sodium carbonate is used principally by the glass, chemical, paper and pulp, and detergent manufacturing industries. Domestic resources of natural sodium carbonate are abundant. They are all located in Western States, mostly on Federal land.

a. **Uses, Substitutes, or Alternatives.** Trona is the principal source of natural sodium carbonate or "soda ash, " which in turn is a major industrial chemical used in the manufacture of glass, chemicals, paper and pulp, soap, detergents, water softeners, and other products. Caustic soda is used extensively as a soda ash substitute, particularly in the aluminum industry.

b. **Demand Outlook.** For the past 10 years, domestic consumption of soda ash has grown slowly but steadily. It is forecast that total demand will continue to climb at a rate that will depend on various technologies and growth factors for the primary end-use industries (see figure A-18).

c. Supply Outlook. It is estimated that the trona deposits now being mined in southwestern Wyoming could supply national needs for more than several thousand years at the present rate of consumption (see tables A-20 and A-21). Synthetic soda ash, derived from limestone and salt, is expected to eventually disappear because of rising fuel and labor costs as well as pollution problems (see figure A-19).

d. **Geographic Distribution of Resources.** The distribution of United States natural sodium carbonate resources is as follows:

Southwestern Wyoming trona resources .,. . . . . .,.	72.5%
Northwestern Colorado nahcolite resources ,.	26.2%
California (Searles and Owens Lakes)	1.0%
Western playa lakes .,.	0.3%

e. Potential of Federal Land. About 60 percent of the trona resource in southwestern Wyoming is on Federal land that is principally used for grazing. About 90 percent of the nahcolite resource in the Piceance Creek basin in northwestern Colorado is on Federal land largely used for grazing. Searles and Owens Lakes in California are on private land.

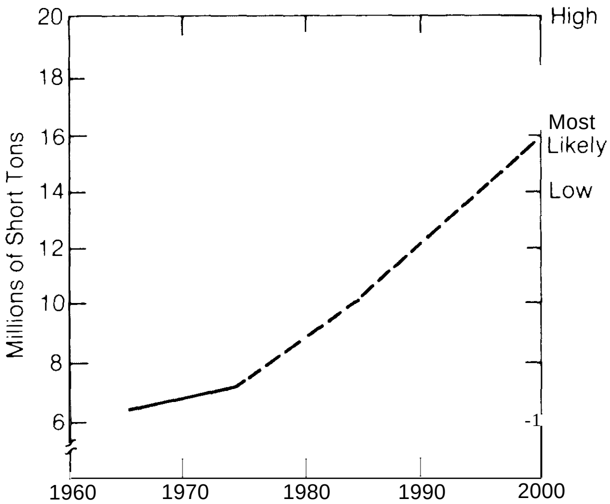
13. Uranium

Uranium probably will be essential to future energy supplies. Almost all U.S. uranium reserves at a price of $30 per pound, * and 70 percent of potential uranium resources of this same price category, are in Western States. About one-half of these resources are on Federal land.

a. **Uses, Substitutes, or Alternatives.** Uranium, a radioactive metal and nuclear fuel, is an important source of energy for generating electricity. Plutonium also maybe used as fuel in reactors. A non-naturally occurring isotope of uranium, bred from thorium, could also be used as reactor fuel. Advanced reactors may eventually reduce the demand for uranium.

*See note added in proof, table A-23

Figure A-18. —Sodium Carbonate Demand Outlook (Both Natural and Synthetic)



Forecast Assumptions

Range in high-low variances due to variances in projected sodium carbonate demand by glass manufacturers and sodium carbonate, chemical and paper Industries.

Figure A.19.— Sodium Carbonate Supply Outlook (Both Natural and Synthetic)

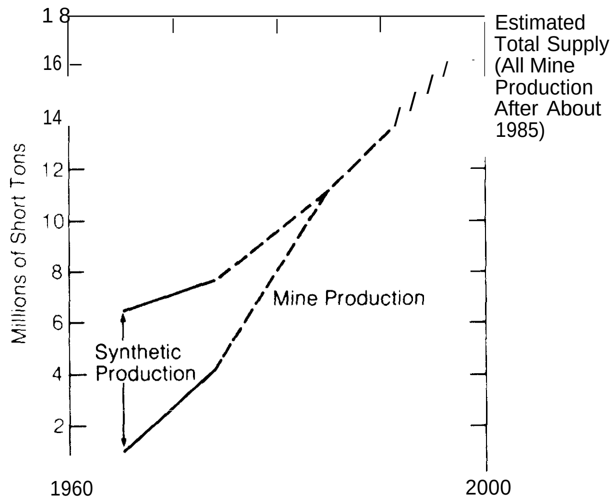


Table A-20.–Sodium Carbonate Supply (Thousands of Short Tons)

	1965	1970	1974
U.S. Natural Production	1,494	2,678	4,059
U.S. Synthetic Production	4,926	4,393	3,502
Minus Exports	(277)	(336)	(564)
Plus Imports	—	—	35
Industry Stocks, January 1	644	178	105
TOTAL Sodium Carbonate Supply	6,787	6,913	7,137

Table A-21 .—Resources of Natural Sodium Carbonate

Identified:	53.1 billion tons of sodium carbonate in trona in beds more than 3 feet thick (this trona, which is in southwestern Wyoming, contains impurities and is about 62.5 percent sodium carbonate), plus
	19.2 billion tons of sodium carbonate in nahcolite (nahcolite is about 60 percent sodium carbonate), plus
	0.7 billion tons of sodium carbonate in Searles and Owens Lakes, California.
Hypothetical and Speculative:	0.2 billion tons of potential sodium carbonate in small playa lakes in the western states,

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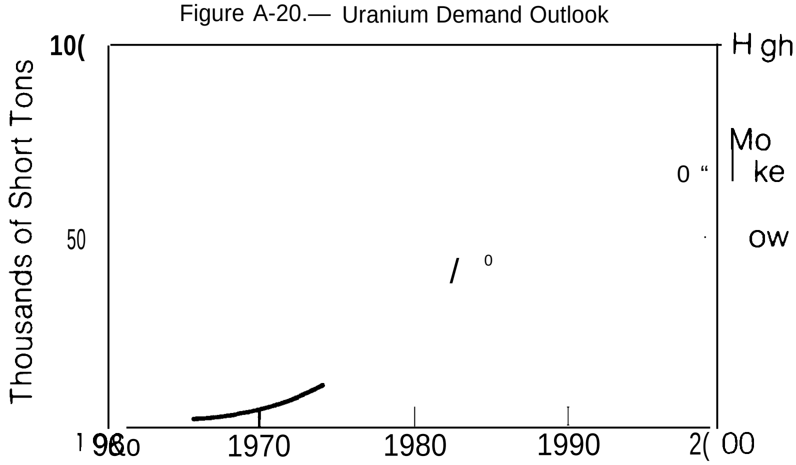
b. **Demand Outlook.** U.S. consumption of uranium has been gradually increasing over the past few years and the growth rate is expected to continue to climb as more nuclear reactors are constructed (see figure A-20). The rate at which new reactors are built, however, has been affected by delays and siting difficulties arising from licensing procedures, community opposition, and capital constraints.

Figure A-20.— Uranium Demand Outlook



Forecast Assumptions

High, Low and Most Likely forecasts are based on variations in degree of public acceptance of nuclear power, degree of energy conservation, extent of lead times for reactor licensing and construction, and success of exploration.

NOTE, According to information provided to OTA in March 1979 by the Department of Energy, 67.7 thousand short tons of natural U_3O_8 will be required to meet domestic enrichment demand in the year 2000, based on a planning case of 325 GW (e) of nuclear power. The calculated demand assumes no recycling, 0.200/0 tailings assays, and a plant factor of 750/0.

c. **Supply Outlook.** As shown in table A-22 domestic mine production of uranium has grown over the last 9 years, keeping pace with U.S. demand.

Although reserves of uranium may not be adequate for much beyond the year 2000, large undiscovered resources are believed to exist (see table A-23), and recent

Table A-22 .—Uranium Supply
(Thousands of Short Tons)

	1965	1970	1974
Domestic Mine Production	8.8	10.9	9.8
Industry Stocks, January 1	4.4	9.2	21.7
Government Stockpile Releases	0.2	0.6	1.0
TOTAL Uranium Supply	13.4	20.7	32.5

Table A-23.—Resources of Uranium
(Thousands of Short Tons of U_3O_8 at $30 Per Pound)

Reserves:	640 not including by-product uranium from phosphate and copper production.
Undiscovered Resources:	2,920 consisting of 1,060 probable, 1,270 possible and 590 speculative.

Source: U.S. Energy Research and Development Administration, Grand Junction Office, *National Uranium Resource Evaluation, Preliminary Report* (1976). (ERDA's uranium resource classification terminology, which is followed in this table, varies from the USGS/USBM terminology used elsewhere in this appendix). For another perspective on uranium resource estimates, which are controversial, see National Academy of Sciences, *Mineral Resources and the Environment, Supplementary Report: Reserves and Resources of Uranium in the United States* (1975).

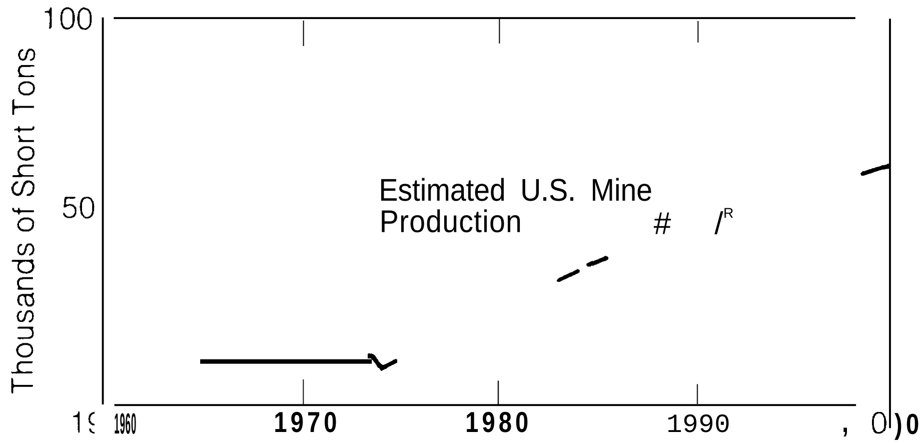
NOTE According to Information provided to OTA In March 1979 by the Department of Energy, estimated uranium resources at $50 per pound of U_3O_8 on January 1, 1978, were 890 thousand short tons of reserves, 1,395 thousand short tons of probable resources, and 565 thousand short tons of speculative resources.

price trends indicate there will be sufficent incentives to explore for and develop these resources.

A secondary supply of uranium and plutonium could come from reprocessed fuel. However, there are presently no plans to begin reprocessing,

The uranium supply outlook is shown in figure A-21.

Figure A-21 .— Uranium Supply Outlook



d. **Geographic Distribution of Resources.**[38] The regional distribution of reserves estimated to be available at a price of $30 per pound is as follows;

Colorado Plateau.	50.90/0
Wyoming Basins	36.49%
Gulf Coastal Plains	6.9°A
Northern Rockies,	3.1 %
Colorado and Southern Rockies	1.4%
Great Plains.	1.0%
Basin and Range and other regions	0.3%

The Colorado Plateau and Wyoming Basins are estimated to account for approximately 70 percent of the probable resources (40 and 30 percent, respectively). The Colorado Plateau and Wyoming Basins also account for 56 percent of the possible uranium resources and 23 percent of the speculative uranium resources at the $30 price level. The share these two regions represent of total potential resources (probable, possible, and speculative) is about 55 percent.

e. **Potential of Federal Land.** Based on the State-by-State uranium reserve data released by the Atomic Energy Commission in 1974, it has been estimated that at least one-half of the Nation's uranium reserves of the $8 category is within Federal land in

[38]U.S. Energy Research and Development Administration. Grand Junction Office, *National Uranium Resource Evaluation. Preliminary Report* (1976).

Colorado, New Mexico, Utah, and Wyoming. A detailed study of the distribution of the estimated uranium reserves at $30 per pound of U_30_8 and their relationship to Federal land has not been made. Therefore, it is not known whether the proportion of reserves on Federal land remains the same at the $30 price level as at the $8 price level. The Federal land on which uranium resources are found includes several national forests—Uncompahgre, Cibola, Manti-La Sal, and Shoshone National Forests. The Shoshone National Forest has sites under study for possible wilderness areas. Small amounts of uranium are also found in the Dinosaur National Monument and on military land.

Appendix B

Statistical Data on the Availability of Federal Onshore Land for Mineral Activity in 1975

A. Introduction

One of the most significant and visible constraints on mineral activity on onshore Federal land has been the removal by statute or administrative action of substantial tracts of that land from availability under the Federal mineral disposal laws.

Existing agency records make it very difficult to obtain an overall picture of the amount of acreage that has been removed from availability for mineral activity. The primary source of data on Federal land management is the annual Public Land Statistics published by the U.S. Bureau of Land Management (BLM). This BLM document, however, does not contain cumulative figures on mineral land availability. It lists only the gross acreage of withdrawal and revocation actions during the fiscal year and does not indicate what sorts of activities, if any, have been precluded on the withdrawn land. (Withdrawals are used to transfer jurisdiction over Federal land from one agency to another as well as to preclude certain activities such as location of mining claims or issuance of mineral leases.) It also does not indicate whether the withdrawals and revocations overlap other existing withdrawals.

The information necessary to produce an accurate aggregate analysis exists only in raw form in local agency land records, and neither BLM nor any other agency has any program or procedures for gathering, compiling, and analyzing such information, which would seem to be indispensable for comprehensive minerals and land management.

At the present time, therefore, any attempt to construct an overall picture of Federal mineral land availability must rely on whatever data is available or can be constructed from secondary sources. For example, the statistical data in this appendix were obtained by: analyzing gross acreages reported for various Federal agencies in BLM's Public Land Statistics and internal agency documents (the sources usually conflict); identifying relevant statutes and regulations and analyzing their effect on agency land; searching for data on acreages affected by each statute in Public Land Statistics, hearings or any other source that came to light; and tracking down agency personnel who could provide rough estimates of acreages in various land categories.

Although every effort was made to obtain the most accurate information available and to account for overlaps, the final data reported in this appendix were often based on rough estimates and assumptions. These estimates and assumptions are explained and the sources for all data are cited in order to facilitate comparison with other recent surveys of Federal mineral land availability. [1]

Finally, it should be noted that the figures reported are only approximate and do not capture the finer details of mineral land availability. For example, some of the acreage listed as unavailable in 1975 was actually dotted or perhaps even blanketed with outstanding mineral leases or mining claims that predated the removal of the land from availability for mineral activity. As of June 30, 1974, mineral leases and prospecting permits covered 82,6 million acres of public domain[2] and 8.4 million acres of acquired land, [3] or a total of 91 million acres of onshore Federal land. Only very rough estimates were possible of the acreage covered by outstanding mining claims in 1975, since there was no requirement that such claims be reported to the Federal Governmerit. [4] Assuming 3 million nonoverlapping claims in 1975, [5] all covering the maximum allowable acreage (about 20 acres for both lode and placer claims), approximately 60 million acres were covered by mining claims in 1975. These claims, if valid on the date the land was removed from availability for further acquisition of mineral rights, can continue to be developed. The same is true for the mineral leases and prospecting permits.

Conversely, some of the land listed as available with moderate or slight restrictions for mineral activity in 1975 was closed or highly restricted for development of some or all minerals as a result of published policies or ad hoc decisions by local land management officials to reject lease applications or discourage mining claimants in certain areas.' Although the data in this appendix account for formal and informal land management policies and actions that are applied fairly uniformly throughout the Nation to a discrete category of land (for example BLM natural areas), no attempt was made to account for the numerous local policies and decisions applied to areas of land not identified with any discrete national category.

The data in this appendix, insofar as possible and unless otherwise noted, reflect land status during 1975. The compilation of the data was undertaken in 1975 and early 1976 as one of the first tasks of this assessment. There has been no attempt to update the appendix by keeping track of changes since then.

B. Authority for and Methods of Removing Federal Onshore Land From Availability for Mineral Activity

Federal onshore land has been made unavailable for mineral activity through statute, formal withdrawal orders by the Executive, administrative land classification

[1] Bennethum and Lee, "Is Our Account Overdrawn?" *Mining Congress J.*, September 1975, at 33-48 (hereinafter cited as Bennethum and Lee); U.S. Department of the Interior, *Mining and Minerals Policy, 1976*, at 81-93 (1976).

[2] U.S. Bureau of Land Management, *Public Land Statistics, 1975*, tables 72 and 78 (1976) (hereinafter cited as *Public Land Statistics*).

[3] Ibid., table 77.

[4] Annual reporting, beginning in 1979 for claims located prior to Oct. 21, 1976, is now required by sec. 314 of the Federal Land Policy and Management Act of 1976, 90 Stat. 2769, 43 U.S.C.A. § 1744 (Supp. 1977).

[5] The Public Land Law Review Commission estimated that there were 5.5 million mining claims as of 1970. Public Land Law Review Commission, *One Third of the Nation's Land* 130 (1970). A more recent estimate placed the total at over 10 million. Bennethum and Lee, note 1, at 35, figures 1 and 2.

[6] For example, the policy decision not to lease certain coal beds in BLM's Buffalo Creek Planning Unit in Montana, adopted as part of the land management plan for the unit and published in U.S. Bureau of Land Management, Billings District Office, *Buffalo Creek Unit, Land Use Decisions, June 30, 1973*, at 1-3 (1973).

actions or State or private applications that result in segregation or withdrawal under a particular public land law, or the exercise of administrative discretion in implementing the Federal mineral laws.

Congress has not provided for development of some minerals on certain categories of land (for example, hardrock minerals on most acquired land that is not under the jurisdiction of the Forest Service) and has affirmatively acted to exclude certain other categories of land (for example, national parks, townsites, the National Petroleum Reserve in Alaska, and, in 1984, wilderness areas) and even entire States (for example, Alabama, Michigan, Oklahoma, and Wisconsin) from the operation of one or more of the Federal mineral laws.

Congress has also delegated to the executive branch the authority to withdraw land from mineral activity for specified purposes (for example, reclamation projects, national monuments, and wildlife refuges in national forests), or "temporarily" (until revoked by the Executive or Congress) for any public purpose. The latter general grant of authority was made in the Pickett Act of 1910, which, however, did not authorize the withdrawal of land from exploration for and development of the metalliferous hardrock minerals,[7]

Since at least the middle of the 19th century, the Executive has asserted an implied authority to withdraw land from all mineral activity. The authority was initially used to establish lighthouses, military posts, and Indian reservations. But it has since been utilized to accomplish withdrawals for almost every sort of land use. The exercise of the authority was upheld by the Supreme Court in 1915 in the famous Midwest Oil case, based on an implied acquiescence by Congress in the long-continued exercise of the authority.[8]

President Taft, uncertain of the validity of the implied authority, had requested Congress in 1909 to provide statutory authority for temporary withdrawals. The result was the Pickett Act of 1910, discussed above. Ever since the Act's passage, there has been a debate concerning whether it was meant to abolish or limit the President's implied withdrawal authority. In 1941, after a flurry of correspondence between the Secretary of the Interior and the Attorney General, the latter issued an opinion stating that the Pickett Act did not affect the Executive's implied authority to make permanent withdrawals from all forms of mineral activity.[9] However, the debate continued. In 1958, Congress passed the Engle Act to limit the exercise of the implied authority with respect to withdrawals for defense purposes; after 1958, any new withdrawal for defense purposes (rather than for civil projects) of more than 5,000 acres in the aggregate for any one project could be made only by an act of Congress.[10]

The implied power was exercised so often in the period between 1910 and 1976 that, had a case arisen challenging its validity, it doubtless would have been sustained on the ground that Congress again had implicitly acquiesced in its exercise. Moreover, in 1971 Congress explicitly directed the Secretary of the Interior to use the President's

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[7] 43 U.S.C. §§ 141, 142 (1970), repealed by Federal Land Management and Policy Act of 1976, § 704(a), 90 Stat. 2792 (1976).

[8] *United States* v. *Midwest Oil Co.*, 236 U.S. 459 (1915).

[9] 40 Op. Att'y Gen. 71 (1941). For a complete exposition of the history of the implied withdrawal authority, see Wheatley, *Study of Withdrawals and Reservations of Public Domain Lands* (1969), a study done for the Public Land Law Review Commission (hereinafter *PLLRC Withdrawals Study*).

[10] 43 U.S.C. § 156 (1970).

implied authority to withdraw certain land under the Alaska Native Claims Settlement Act (ANCSA). ’l

Congressional acquiescence ended, however, in 1976 when Congress expressly repealed the President’s implied authority insofar as it was based on congressional acquiescence.[12] Congress also repealed the President’s more limited explicit authorization under the Pickett Act.[13] Both were replaced with an express grant of authority to the Secretary of the Interior to make temporary, but renewable, withdrawals affecting all minerals.[14]

Land is also made unavailable for mineral activity by the segregative effect of applacations for withdrawal, State or private land selections, agency classifications, and private entries or applications under applicable public land laws. The land applied for is segregated from mineral activity (pending final action on the application, but for no longer than 2 years if the application is for a withdrawal)]’ to the extent that the proposed withdrawal, entry, or other action would preclude such activity.

In addition to formal withdrawals and segregations, various informal land management controls are used to restrict access to minerals on Federal land. Mineral leasing is a discretionary activity—the Department of the Interior can simply refuse to lease any or all mineral land. Furthermore, for acquired land, Interior must obtain the consent of the land management agency (for example, the U.S. Forest Service) prior to issuing a mineral lease. [16] Even on public domain land, Interior will not usually lease land under the jurisdiction of another agency if the other agency objects, even though consent is not required.

Mining locations, unlike mineral leasing, are a statutory right on any public domain (but not acquired) land not formally withdrawn or segregated from mineral development. However, although the right to locate claims cannot be denied, access can be restricted through regulation of mining activities to protect surface resources, including specification of the mode and route of access (for example, by helicopter), and through delays or refusals to grant permits for powerlines, processing plants, and other mining-related facilities.

Decisions not to lease certain minerals in certain areas or to impose specific restrictions on mining or mining-related activities are sometimes published in general form in regulations, land use plans, or agency manuals. Just as often, however, the decision is neither generalized nor published, but rather made in an ad hoc fashion, effectively insulated from outside review.

[11] 43 U.S.C. § 1616(c) and (d) (Supp. V 1975); S. Rep. 92-581, 92d Cong., 1st sess. 44 (1971) (conference report).

[12] Federal Land Policy and Management Act of 1976, § 704(a), 90 Stat. 2792 (1976). The President may still possess an inherent constitutional withdrawal power. See generally *PLLRC Withdrawals Study*, note 9.

[13] Federal Land Policy and Management Act of 1976, § 704(a), 90 Stat. 2792 (1976).

[14] Ibid., § 204, 43 U.S.C.A. § 1714 (Supp. 1977).

[15] Ibid.

[16] 30 U.S.C. § 352 (1970); Reorganization Plan No. 3 of 1946, § 402, 60 Stat. 1099 (1946).

C. Tabular Summary by Land Use Category of the Availability of Federal Onshore Land

The three tables in this section summarize the data developed and discussed in the following sections on the availability for mineral activity of various categories of Federal onshore land in 1975.

All relevant Federal onshore land is included in each table.[17] There were 703.8 million acres of public domain land and 56.7 million acres of acquired land owned by the Federal Government in 1975.[18] The Government also had reserved ownership of all minerals in 39.4 million acres and of certain of the fuel and fertilizer minerals in another 23.9 million acres of public domain that had been conveyed to private parties as of 1975.[19] Altogether, then, the Government controlled access[20] to all the minerals in 799.9 million acres (743.2 million public domain, 56.7 million acquired) and to all or some of the fossil fuel and fertilizer minerals in 823.8 million acres (767.1 public domain, 56.7 million acquired.)

Table B.l covers the 823.8 million acres of Federal onshore land for which the Government controlled access to all or some of the nonmetallic fuel and fertilizer minerals (coal, oil, gas, oil shale, native asphalt and bitumen, geothermal, phosphate, and potash) plus sodium and (in Louisiana and New Mexico only) sulfur,

Table B.2 covers the 799.9 million acres of Federal onshore land for which the Government controlled access to the "hardrock" or "locatable" minerals (all minerals other than the nonmetallic fuel and fertilizer minerals, sodium, sulfur if in Louisiana or New Mexico, and common varieties of sand, stone, gravel, pumice, pumicite, and cinders).

Table B.3 is similar to table B.2. The only difference is that table B.3 covers hardrock mineral activity on the 743,2 million acres of public domain only, while table B.2 covers hardrock mineral activity on public domain and acquired land. Table B.3 is included to facilitate comparison of the data in this appendix with data compiled by other recent surveys of Federal mineral land availability,[21] which limited themselves to public domain insofar as hardrock minerals were concerned.

Each of the three tables classifies land as either formally closed to mineral activity, highly restricted, or subject to moderate or slight restriction. The "formally closed" classification includes land explicitly closed to mineral activity by statute (for example, National Petroleum Reserve No. 4 and almost all national parks in 1975) or by a published land order (for example, wildlife, military, or oil shale land). The "highly restricted" classification includes land which, while formally open to mineral activity, is restricted by statutory conditions (for example, powersites), statutory and ad-

[17] Indian land is not included as Federal land in this report. Certain Federal land administered by the Bureau of Indian Affairs for particular Native uses is included. See sec. E.

[18] *Public Land Statistics*, table 7. The Government does not own some or any of the minerals in at least 10 million acres of its acquired land. See U.S. Forest Service, *Mineral Area Management on National Forest System Lands* 25 (1974). Nevertheless, the 10 million acres have been kept in the tabulation since the Government controls the surface and can greatly affect access to the non-Federal minerals.

[19] *Public Land Statistics*, table 17.

[20] See note 18.

[21] See the surveys cited in note 1.

Table B.1 .—Availability of Federal Onshore Land for Development of Fossil Fuel and Fertilizer Minerals

Status in 1975*
(Millions of acres)

Designated use	Formally closed	Highly restricted	Moderate or slight restriction
Military	22.9 (2.8%)	—	—
Indian (nonreservation)	0.9 (0.1%)	—	
National parks, etc.	24.6 (3.0%)	—	
National recreation areas	1.4 (0.2%)	0.2 (0.0%)	0.4 (0.0%)
Historic and archeologic	?	?	—
Fish and wildlife	1.9 (0.2%)	29.4 (3.6%)	—
Endangered species	?	?	—
National forest wilderness	—	11.6 (1.4%)	
National forest wilderness study	—	15.2 (1.8%)	—
National forest roadless			42.5 (5.2%)
BLM roadless	0.1 (0.0%)	2.0 (0.2%)	22.8 (2.8%)
Wild and scenic rivers	0.1 (0.0%)	0.9 (0.1%)	—
Irrigation projects	—	7.6 (0.9%)	—
Stockraising and agricultural	—		65.8 (8.0%)
Water supply and control	7.8 (0.9%)	1.5 (0.2%)	
Powersites	—	15.2[a] (1.8%)	—
Pipeline corridors	5.3 (0.6%)	—	—
ERDA and TVA	2.1 (0.3%)	0.9 (0.1%)	—
Petroleum and oil shale reserves	23.9 (2.9%)	3.7 (0.5%)	0.1 (0.0%)
Geothermal	—	1.1 (0.1%)	
Surface occupancy	5.4 (0.7%)	0.5 (0.1%)	—
Statewide withdrawals			1.0 (0.1%)
Forest Service general			104.6 (12.7%)
BLM general	—	0.6 (0.1%)	136.9 (16.6%)
Subtotal non-ANCSA	96.4 (11.7%)	81.4 (9.9%)	374.1 (45.4%)
Alaska Native selections	49.2 (6.0%)	—	30.8 (3.7%)
Alaska State selections	39.1 (4.7%)	—	16.4 (2.0%)
ANCSA d-1	71.4 (8.7%)	—	
ANCSA d-2	65.0 (7.9%)	—	
Subtotal ANCSA	224.7 (27.3%)	—	47.2 (5.7%)
Total	321.1 (39.0%)	81.4 (9.9%)	421.3 (51.1%)

*The Alaska situation was changed in late 1978 by major new executive withdrawals that resulted in no increase (over prior ANCSA withdrawals noted in this table) in the land formally closed to development of the fossil fuel and fertilizer minerals. See section O of this appendix.
[a]9.0 overlaps stricter ANCSA withdrawals and is not included in totals.

ministrative conditions (for example, wilderness areas or certain reclamation projects), or administrative conditions (for example, BLM's primitive and natural areas) to such an extent that mineral activity is greatly discouraged, although it sometimes does occur. The ‘‘moderate or slight restriction” classification includes all other Federal onshore land, which is generally open to mineral activity, although there will usually be some requirement to mitigate the mineral activity's impact on the surface resources of the land, or the land may be closed with respect to a few minerals (for example, land open to location of metalliferous minerals only is classified as being moderately restricted for hardrock mineral activity),

Table 6.2. —Availability of Federal Onshore Land for Development of Hardrock Minerals Status in 1975*
(M Ill ions of acres)

Designated use	Formally closed	Highly estricted	Moderate or Slight restriction
Military	22.9 (2.9%)	—	
Indian (nonreservation)	0.9 (0.1%)	—	
National parks, etc	17.5 (2.2%)	7.1 0.9%)	
National recreation areas	1.4 (0.2%)	0.2 0.0%)	0.4 (o 0°0)
Historic and archeologic	?	?	
Fish and wildlife	30.0 (3.8%)	1.3 0.2%)	
Endangered species	?	?	
National forest wilderness		11.6 (1.5%)	
National forest wilderness study	—	15.2 (1.9%)	
National forest roadless		—	425 (5.3%)
BLM roadless	0.1 (0.0%)	2.0 (0.2%)	228 (2 9°0)
Wild and scenic rivers	0.9 (0.1 0₀)	0.1 (0.0%)	
Irrigation projects.	4.9 (0.6%)	2.7 (0.3°0)	
Stock raising and agricultural	—	—	41 9 (5 2°0
Water supply and control	7.8 (1.0%)	1.5 (0.2°0)	—
Powersites	—	15.2[a] (1.9%)	
Pipeline corrdors	2.9 (0.4%)		24 (o 30'0
ERDA and TVA ., .,	3.0 (0.4%)		
Petroleum and 011 shale reserves	27.4 (3.4%)		0.3 (O.O°O
Geothermal	1.1 (0.1%)	—	—
Surface occupancy	5.4 (0.7%)	0.5 (0.1%)	
Statewide withdrawals.	04 (o 0°0)		0.6 (0.1 'o
Forest Service general.			1046 (13.1 'o
BLM general	0.6 (0.1%)		136.9 (17. 1'o
Subtotal non-ANCSA	127.2 (15.9%)	48.4 (6.1%)	3524 (44.00.
Alaska Native selections	49.2 (6.2%)		30.8 (3.9°0
Alaska State selections	—		55,5 (6.9%)
ANCSA d- 1	30.0 (3.7%)		41,4 (52%)
ANCSA d-2	65.0 (8.1%)		
Subtotal ANCSA	144.2 (1 8.0°0)		1277 (16.0°0)
Total.	271.4 (33.9°0)	484 (6.1%)	4801 (60.0°0)

*The Alaska situation was changed in late 1978 by major new executive withdrawals that, according to rough estimates provided to OTA by the BLM's Alaska Native Claims Office, resulted in a net increase (over prior ANCSA withdrawals noted in this table) of approximately 13 million acres (1.6%) in the land formally closed to hardrock mineral activity. See section O of this appendix.
[a]9.0 overlaps stricter ANCSA withdrawals and is not included in totals.

D. Military

All lands withdrawn or reserved for the military, except naval petroleum, oil shale, or coal reserves, are subject to the operation of "the applicable public land mining and mineral leasing laws," except "where the Secretary of Defense, after consultation with the Secretary of the Interior, determines that such disposition or exploration is inconsistent with the military use of the lands so withdrawn or reserved."[22] However, the applicable public land mineral leasing laws in 1975 excluded from their coverage any acquired lands set apart for military or naval purposes, as well as the

[22]43 U.S.C § 158 (1970).

Table B.3.—Availability of Federal Public Domain for Development of Hardrock Minerals Status in 1975"
(Millions of acres)

Designated use	Formally closed	Highly restricted	Moderate or slight restriction
Military	16.3(2.2%)		—
Indian (nonreservation) ., ...	0.1(0.0%)		—
National parks, etc.	12.5(1.7%)	7.1(1.0.%)	—
National recreation areas ., ., .	1.4(0.2%)	0.2(0.0%)	0.4(0.1'%)
Historic and archeologic	7	?	—
Fish and wildlife	26.1(3.5%)	1.3(0,2%)	—
Endangered species		?	—
National forest wilderness	—	11,4(1.5%)	—
National forest wilderness study ., ...	—	15.1(2.0%)	—
National forest roadless . . . . .,	—		42,5(5.7%)
BLM roadless . .	0.1(0.0%)	2.0(0.3%)	22,8(3.1%)
Wild and scenic rivers	0.9(0,1%)	0.1(0.0%)	—
Irrigation projects.	3.0(0.4%)	2.7(0.4%)	—
Stockraising and agricultural . .	—	—	41.9(5.6%)
Water supply and control . . .	0.7(0.1%)	1.5(0.2%)	—
Powersites	—	15.2a(2.0%)	—
Pipeline corridors.	2.9(0.4%)		2.4(0.3%)
ERDA and 1 VA	1.4(0.2%)	—	—
Petroleum and 011 shale reserves	27,4(3.7%)		0.3(0.0%)
Geothermal	1.1(0.1%)		—
Surface occupancy	4.9(0.7%)	0.5(0.1%)	-
Statewide withdrawals.	0.4(0.0%)		0.6(O.1%)
Forest Service general, ...,	—		77.9(10,5%)
BLM general . ., ...,	0.6(O.1%)	—	134.6(18,1%)
Subtotal non-ANCSA.	99.8(13.4%)	48.1(6.5%)	323.4(43.5%)
Alaska Nativeselections.	49.2(6.6%)		30.8(4.1%)
Alaska Stateselections.	—		55.5(7.5%)
ANCSA d-1	30.0(4.0%)		41,4(5.6%)
ANCSA d-2	65.0(8.8%)		
Subtotal ANCSA.	144.2(19,4%)		127.7(17.2%)
Total.	244.0 (32.8%)	48.1(6.5%)	451.1(60.770)

*The Alaska situation was changed in late 1978 by major new executive withdrawals that, according to rough estimates provided to OTA by the BLM's Alaska Native Claims Office, resulted in a net increase (over prior ANCSA withdrawals noted in this table) of approximately 13 million acres (1.7%) in the amount of public domain formally closed to hardrock activity. See section O of this appendix.
[a]9.0 overlaps stricter ANCSA withdrawals and is not included in totals.

naval petroleum and oil shale reserves. [23] Moreover, the Secretary of Defense has generally determined that land withdrawn for strictly military purposes should be closed to mineral exploration and development for safety and security reasons.

Excluding the naval petroleum and oil shale reserves, there were 16.3 million acres of public domain and 6.6 million acres of acquired land withdrawn for strictly military purposes as of June 30, 1974.[24] All of this land is listed in the tables in section C as having been closed to mineral activity in 1975.

[23]30 U.S.C. §§ 181, 352 (1970). Sec. 12(a) of the Federal Coal Leasing Amendments Act of 1976, Public Law 94-377, 90 Stat. 1083 (1976), eliminated the restriction against mineral leasing on acquired land set apart for military or naval purposes. However, leasing of coal on such land is apparently restricted by sec. 12(b) of the Act to governmental utilities located in the State containing the land.

[24]*Public Land Statistics*, table 9.

Land withdrawn for water resource development projects of the Army Corps of Engineers is discussed in subsection I(3). The naval petroleum and oil shale reserves are discussed in subsection K(l)(a).

E. Indian (Nonreservation)

This category includes only Federal land withdrawn for special Native American uses (reindeer stations, school sites, fishing areas, livestock reserves, and so forth). It does not include tribal or individual Native land. Nor does it include Federal land in Alaska currently being transferred to Alaska Natives, which is discussed in subsection 0(1).

BLM listed 5 million acres withdrawn for Native uses as of June 30, 1974.[25] However, the withdrawals for 4.1 million of these acres in Alaska were revoked by subsection 19(a) of the Alaska Native Claims Settlement Act.[26] The remaining 0,9 million acres were in the lower 48 States (O.1 million acres of public domain and 0.8 million acres of acquired land)[27] and are listed in the tables in section C as having been closed to mineral activity in 1975,

F. National Parks, Monuments, Recreation Areas, and Historic Sites

1. National Parks, Monuments, and Historic Sites

National parks have always been established by express congressional designation, while national monuments and historic sites have been established either by statute or by executive action pursuant to authority granted in the Antiquities Act of 1906.[28] All parks, monuments, and historic sites are under the jurisdiction of the National Park Service.

National parks and monuments are statutorily excluded from the operation of the Mineral Leasing Acts.[29] It has been held that national monuments designated by the President pursuant to the Antiquities Act are also closed to location under the Mining Law.[30] All but five of the congressionally designated national parks and monuments were closed by statute to locations under the Mining Law in 1975. All national historic sites have been closed to mineral activity.

The five national parks and monuments open to locations under the Mining Law in 1975 were Coronado National Memorial, Death Valley National Monument, Glacier Bay National Monument, Mount McKinley National Park, and Organ Pipe Cactus Na-

[25] Ibid.
[26] 43 U.S.C. § 1618(a) (Supp. V 1975). See subsec. O(1) of this appendix.
[27] *Public Land Statistics*, table 9.
[28] 16 U.S.C. § 431 (1970).
[29] 30 U.S.C. §§ 181, 352 (1970).
[30] *Cameron* v. *United States*, 252 U.S. 450, 459 (1920).

tional Monument.[31] In Coronado National Memorial and the Glacier Bay and Organ Pipe Cactus National Monuments, title could be acquired to the mineral deposits only, exclusive of the land containing them. All five of these units were closed by Congress in 1976 to future locations under the Mining Law, and existing mineral rights on patented or unpatented mining claims within any area of the National Park System were made subject to regulations prescribed by the Secretary of the Interior “which he deems necessary or desirable for the preservation and management of those areas. ” Prior to the 1976 legislation, mining activities were discouraged by administrative actions by the National Park Service but nonetheless continued at a high level in certain units, for example Death Valley National Monument.

The five units contained a total of 7. I million acres of Federal public domain land in 1975. The two units in Alaska—Glacier Bay and Mount McKinley—accounted for 4.7 million of these acres. The 7.1 million acres are listed in the tables in section C as having been highly restricted in terms of hardrock mineral activity in 1975. They, like all other acreage in national parks and monuments, were closed to mineral leasing in 1975.

As of June 30, 1974, there were 19.8 million acres of public domain and 5 million acres of acquired land, or a total of 24.8 million acres, under the sole jurisdiction of the National Park Service. ” New areas added through December 31, 1975, were in the initial stages of land acquisition and contained only 431 acres of Federal land. ” The 19.8 million acres of public domain included 19.6 million acres in national parks, monuments, and historic sites and 0.2 million acres in national recreation areas. The 0.2 million acres in national recreation areas are discussed in subsection 2.

The 19,6 million acres of public domain and 5 million acres of acquired land contained in national parks, monuments, and historic sites in 1975 are listed in the tables in section C as having been closed to mineral leasing and also closed, except for the 7.1 million acres discussed above, to location under the Mining Law in 1975.

2. National Recreation Areas

National recreation areas (NRAs) have been established by both statute and executive action, generally on land previously or concurrently withdrawn for reclamation or other water resource development purposes. The water resource development purpose is given a higher priority than recreational use, which in turn usually has a higher priority than mineral development, except in those areas where the Mining Law remains applicable and mining is therefore a preemptive use. NRAs have been established as units of the National Park System and also within areas of the National Forest System.

In 1975, four of the National Park System NRAs were under the sole jurisdiction of the National Park Service. Of these four units, only one, the Gateway NRA (3,716 acres

[31] 16 U.S.C. § 450 v-2 (1970), 16 U.S.C. § 447 (1970), 49 Stat. 1817 (1936), 16 U.S.C. § 350 (1970), and 16 U.S.C. § 450z (1970), respectively.

[32] Public Law 94-429, 90 Stat. 1342, 16 U.S.C.A. §§ 1901-1912 (Supp. 1977).

[33] U.S. National Park Service, *Index of the National Park System and Affiliated Areas as of Jan. 1, 1975* (1975).

[34] *Public Land Statistics*, table 9.

[35] U.S. National Park Service, "Summary of Acreages, Dec. 31, 1975" (1976) (Big Cypress and Big Thicket National Preserves and Cuyahoga Valley National Recreation Area).

of acquired land), was closed by statute to mineral development in 1975.[36] The Delaware Water Gap NRA (23,050 acres of acquired land) was subject to the operation of the mineral leasing laws,[37] and the Lake Chelan and Ross Lake NRAs (166,629 Federal acres, almost all public domain) were subject to leasing of both hardrock and Leasing Act minerals, if the Secretary of the Interior found that mineral development would not have significant adverse effect on the administration of the recreation area. Only the Lake Chelan and Ross Lake NRAs contain significant acreage; their 0.2 million acres of public domain are listed in the tables in section C as having been highly restricted with respect to any sort of mineral activity in 1975, since the National Park Service does not generally favor mineral activity in any of its units.

Nine of the National Park Systems NRAs, totaling 2.9 million Federal acres, were on public domain land withdrawn for reclamation purposes in 1975 and are included in the acreage figures given for reclamation land in subsection 1(1). All of these NRAs were subject to the dominant reclamation use. The Glen Canyon NRA (1.2 million acres), the Whiskeytown Lake unit of the Whiskey town-Shasta-Trinity NRA (42,422 acres), and, by interpretation, the Lake Mead NRA (1.5 million acres) were open by statute to leasing of both hardrock and Leasing Act minerals.[39] The other six NRAs were open to mining location and mineral leasing to the extent allowed by the underlying reclamation withdrawal.[40] Although mineral activity is not common in these nine NRAs, it does occur: three uranium leases were issued in 1975 in the Lake Mead NRA, in tributary side canyons of the Grand Canyon being studied for inclusion in the Grand Canyon National Park and the Wilderness System.[41]

The two remaining National Park System NRAs were on land withdrawn for other agencies,[42] and are included in the acreage figures given for those agencies elsewhere in this appendix,

There were seven NRAs administered by the Forest Service in 1975. The Hells Canyon, Oregon Dunes, and Sawtooth NRAs, totaling around 1.4 million acres of public domain, were closed by statute to any form of mineral activity,[43] The Flaming Gorge NRA and the Shasta-Trinity portion of the Whiskey town-Shasta-Trinity NRA, together totaling around 0.4 million acres of public domain, were open by statute to leasing of all minerals, including hardrock minerals, subject to the consent of the Secretary of Agriculture.[44] According to the Forest Service, mineral activity is permitted in these two NRAs subject to the appropriate lease conditions. In 1975 there were prospecting permits for trona (sodium carbonate) and pending permit applications for phosphate and oil and gas in Flaming Gorge. The remaining two National Forest System NRAs in

[36] 16 U.S.C. § 460bb (Supp. V 1975). Acreage figures for the National Park System NRAs were obtained from U.S. National Park Service, *Index of the National Park System and Affiliated Areas as of Jan. 1, 1975* (1975).

[37] 16 U.S.C. §§ 460 o-3 and o-4 (1970).

[38] 16 U.S.C. § 90c-1(b) (1970).

[39] 16 U.S.C. §§ 460dd-2, 460q-5, and 460n-3 (1970 and Supp. V 1975), respectively. The Department of the Interior has interpreted the passing reference to "mineral leasing" in the statute establishing the Lake Mead NRA as authorizing leasing of hardrock as well as Leasing Act minerals, despite the absence of any reference to hardrock leasing as is found in the statutes establishing the Glen Canyon, Lake Chelan, Ross Lake, and Whiskeytown-Shasta-Trinity NRAs. The regulations authorizing hardrock leasing refer only to the Lake Mead and Whiskeytown-Shasta-Trinity NRAs. 43 CFR § 3500.1-3 (1975).

[40] Arbuckle, Bighorn Canyon (16 U.S.C. § 460t-2 (1970)), Coulee Dam, Curecanti, Lake Meredith, and Shadow Mountain.

[41] Sierra Club Legal Defense Fund, Inc., press release, Dec. 9, 1975.

[42] Golden Gate (Defense Department, 16 U.S.C. § 460cc-2 (Supp. V 1975)) and Amistad (United States Section, International Boundary and Water Commission, United States and Mexico).

[43] 16 U.S.C. §§ 460gg-8, 460z-8, and 460aa-9 (1970 and Supp. V 1975), respectively. Acreages for NRAs other than Hells Canyon are from U.S. Forest Service, "National Forest System, Areas as of June 30, 1974," File 1380 (5400) (1975). Acreage for Hells Canyon estimated by Forest Service personnel early in 1976.

[44] 16 U.S.C. §§ 460v-4 and 460q-5 (1970), respectively.

1975 were small units in the Eastern United States which perhaps were open to some mineral activity (the statutes are not clear).[45]

The tables in section C list 1.4 million acres of Forest Service NRAs as having been closed to all mineral activity and 0.4 million acres as having been open subject to moderate or slight restriction in 1975. All of the acreage was public domain.

Other recreational areas have been developed in conjunction with water resource development projects of the Army Corps of Engineers. These areas are included in the acreage figures given in subsection I(3).

3. Historic and Archeological Sites and Objects

In addition to the national historic sites included in the National Park System discussed in subsection 1, there are many historic or archeological sites, buildings, or objects on or adjacent to Federal land that are protected by various Federal laws.

The Antiquities Act of 1906 makes it a crime to "appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity," situated on Federal land without the permission of the Secretary of the department that has jurisdiction over such land, and the Act further provides that permission may only be granted for examinations, excavations, and gatherings undertaken for the benefit of recognized scientific or educational institutions.[46] This Act, if strictly enforced, would apparently prohibit mineral development in any area of Federal land containing historic sites or objects of antiquity, at least prior to removal and preservation of the objects in public museums ("removal" of sites is another matter).[47]

Other historic preservation statutes and executive orders, which apply to any Federal or federally licensed or assisted project, activity, or program on or off Federal land, require historic and archeological surveys prior to commencement of such projects, activities, or programs, consideration of effects on significant historic and archeological properties, and, when feasible, salvage of historic and archeological objects and data.[48]

The acreage impacted by these statutes, especially the Antiquities Act of 1906, could be quite large, but no acreage estimate has been attempted.

G. Protection of Fish and Wildlife

1. The National Wildlife Refuge System

Several statutes authorize establishment of particular refuges. In 1934, Congress gave the President general authority to establish refuges within national forests, with

[45] Spruce Knob-Seneca Rocks and Mount Rogers NRAs, 16 U.S.C. §§ 460p-4 and 460r-4 (1970), respectively.
[46] 16 U.S.C. §§ 432 and 433 (1970).
[47] Ibid.
[48] Historic Sites Act of 1935, 16 U.S.C. §§ 461-467 (1970); Historical and Archeological Data Preservation Act of 1960, 16 U.S.C. §§ 469-469c (1970), as amended by Public Law 93-291 (1974): National Historic Preservation Act of 1966. 16 U.S.C. §§ 470-470n (1970): National Environmental Policy Act of 1969, 42 U.S.C. §§ 433 l(b)(4), 4332 and 4335 (1970): Public Law 94-429, § 9, 90 Stat. 1343, 16 U.S.C.A. § 1908 (Supp. 1977); Exec. Order 11593. 36 F.R. 8921 (1971), 16 U.S.C. § 470 note (Supp. V 1975).

uses other than for fish and wildlife purposes being permitted ''so far as such uses may be consistent with the (fish and wildlife) purposes ., , .''[49] Most refuges, however, have been established by executive action dating as far back as the 19th century, almost always relying on the President's implied authority. In 1966, Congress enacted the National Wildlife Refuge System Administration Act of 1966 to give formal recognition to the system and consolidate the authorities relating to the various refuges, reserves, and game ranges.[50] The Act states that "the United States mining and mineral leasing laws shall continue to apply to any lands within the System to the same extent they apply prior to October 15, 1966, unless subsequently withdrawn under other authority of law."

As of June 30, 1974, there were 26.9 million acres of public domain and 3.9 million acres of acquired land, or a total of 30.8 million acres, under the primary jurisdiction of the Fish and Wildlife Service included in the National Wildlife Refuge System,[51] Close to 2 million acres of additional land in the system were primarily under the control of some other Federal agency[52] and are included in the acreage figures given for those agencies elsewhere in this appendix,

Few refuges were left open to the Mining Law upon their establishment. Only two units of the system, the Clarence Rhode Wildlife Range (2.9 million acres) and the Cape Newenham Refuge (0.3 million acres), both in Alaska, were open in 1975 to locations under the Mining Law, and even these two units were only partially open: 1.7 million acres in Clarence Rhode and 0.2 million acres in Cape Newenham had been withdrawn for Native selections under the Alaska Native Claims Settlement Act of 1971. Five other wildlife and game ranges, although not finally withdrawn in 1975, were segregated from mining by proposed withdrawals: the Charles Russell, Kofa, Cabeza Prieta, Charles Sheldon, and Desert ranges.[53]

In sum, only 1.3 million acres (all public domain in Alaska) were open to locations under the Mining Law in 1975. These 1.3 million acres of public domain are listed in the tables in section C as having been highly restricted with respect to hardrock mineral activity. The remaining National Wildlife Refuge System acreage was closed to such activity in 1975. Thus, 25.6 million acres of public domain and 3.9 million acres of acquired land in the system in 1975 are listed in the tables in section C as having been closed to hardrock mineral activity.

The regulations of the Fish and Wildlife Services' prohibit prospecting or removing minerals from any unit of the National Wildlife Refuge System, except as authorized by BLM's leasing regulations, The BLM regulations prohibit oil and gas leasing on wildlife refuge lands, except as necessary to prevent drainage of the Federal deposits because of production on adjacent lands. Oil and gas leasing is also allowed under the BLM regulations on game ranges, Alaska wildlife areas, and wildlife coordination lands made available to the States, but only to the extent permitted by agreements

[49] 16 U.S.C. § 694 (1970).
[50] 16 U.S.C. § 668dd (1970).
[51] *Public Land Statistics*, table 9.
[52] U.S. Fish and Wildlife Service, *Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of June 30, 1975* (1975). The 2 million acre figure does not include the 2.4 million acres in game ranges jointly administered in 1975 by the Fish and Wildlife Service and the Bureau of Land Management, which are rather included in the 26.9 million acre figure.
[53] Bennethum and Lee, note 1, at 44, supplemented by information provided by the U.S. Fish and Wildlife Service. See Solicitor's Opinion M-36702, 74 I.D. 97, 102 (1967).
[54] 50 CFR § 26.29 (1975).

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entered into by BLM and the Fish and Wildlife Service.[55] Leasing of minerals other than oil and gas is permitted subject to such special stipulations as may be suggested by the Fish and Wildlife Service.[56] BLM will seek the Service's advice prior to issuing any lease and, although not required, will generally follow this advice. The Fish and Wildlife Service's manual states that it is the Service's policy usually to recommend against leasing. " Very few mineral leases exist on units of the National Wildlife Refuge System, the oft-cited exception being the oil and gas leases in the northern half (approximately 0.9 million acres) of the Kenai Moose Range in Alaska.

The 26.9 million acres of public domain, minus 1.9 million acres withdrawn for Alaskan Native selections, and the 3.9 million acres of acquired land in the National Wildlife Refuge System are listed in the tables in section C as having been highly restricted with respect to development of the fuel and fertilizer (Leasing Act) minerals in 1975. The 1.9 million Native selection acres are listed as having been closed.

2. Miscellaneous Wildlife Areas

Numerous withdrawals have been made of wildlife areas that are not included within the National Wildlife Refuge System. These withdrawals are for wildlife management or research areas, desert tortoise and pup fish reserves, and so on. At the end of 1974, this category encompassed close to 0.5 million acres formally withdrawn from mining locations and removed in practice from mineral leasing.[58] These 0.5 million acres are listed in the tables in section C as having been closed to hardrock mineral activity and highly restricted for development of other minerals in 1975.

3. The Endangered Species Act

Section 7 of the Endangered Species Act of 1973 directs all Federal agencies to "take such action necessary to insure that actions authorized, funded or carried out by them do not jeopardize the continued existence of (species of fish or wildlife in danger of extinction) . . . or result in the destruction or modification of habitat of such species which is determined . . . to be critical (to their survival)."[59] This section of the Act has already played a significant role in the delay for several years of decisions on whether to issue "preference-right" leases to mine phosphate in the Osceola and Los Padres National Forests. It undoubtedly will impact a much wider class of mineral activities in the future as areas of "critical habitat" are identified. The acreage impact has not been estimated.

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[55] 43 CFR § 3101.3 (1975).
[56] 43 CFR § 3501.3 (1975).
[57] Bennethum and Lee, note 1, at 44.
[58] Ibid., at 43; cf. FWS *Annual Report of Lands*, note 52
[59] 16 U.S.C. § 1536 (Supp. V 1975).

H. Other Wild and Natural Areas

1. The National Wilderness Preservation System

a. **Introduction.** The Wilderness Act of 1964[60] created the National Wilderness Preservation System and designated as the initial components of the system 54 national forest areas previously classified as "wilderness," "wild," or "canoe" areas, constituting a total of 9.1 million acres, Subsections 4(b) and 4(c) of the Act require that, except as otherwise specifically provided in the Act, all areas designated as wilderness shall be administered so as to preserve their wilderness character. Roads, installations, and mechanized equipment are prohibited. However, subsection 4(d) of the Act specifically provides that, until midnight December 31, 1983,

> the United States mining laws and all laws pertaining to mineral leasing shall, to the same extent as applicable prior to the effective date of this Act, extend to those national forest lands designated by this Act as "wilderness areas": subject, however, to such reasonable regulations governing ingress and egress as may be prescribed by the Secretary of Agriculture consistent with the use of the land for mineral location and development and exploration, drilling, and production, and use of land for transmission lines, water lines, telephone lines, or facilities necessary in exploring, drilling, producing, mining, and processing operations, including where essential the use of mechanized ground or air equipment and restoration of the surface of the land disturbed in performing prospecting, location, and, in oil and gas leasing, discovery work, exploration, drilling, and production, as soon as they have served their purpose.

Subsection 5(b) provides further that the Secretary of Agriculture shall, "by reasonable regulations consistent with the preservation of the area as wilderness, " permit ingress and egress to valid mining claims wholly surrounded by wilderness "by means which have been or are being customarily enjoyed with respect to other such areas similarly situated." Subsection 5(c) requires that owners of completely surrounded private land (including mineral patentees) be given either "such rights as may be necessary to assure adequate access" or Federal land of approximately equal value in exchange for the private land.

No new mining locations may be made or mineral prospecting permits or leases issued after December 31, 1983, in any national forest wilderness.[61] In addition, "subject to valid existing rights," all mineral patents issued after September 3, 1964, must reserve surface title to the United States. Mineral development can proceed beyond 1983 on any valid mining claim located prior to January 1, 1984. Furthermore, mineral exploration, including prospecting, may continue beyond 1983 in national forest wilderness areas "if such activity is carried on in a manner compatible with the preservation of the wilderness environment." In fact, the Secretary of the Interior is directed to develop and conduct a program whereby "such areas shall be surveyed on a planned,

[60] 16 U.S.C. §§ 1131-1136 (1970).

[61] National forest areas added to the wilderness system after 1964 generally are governed by the mining provisions of the 1964 Act. That Act preserved the operation of the mining and mineral leasing laws only in those wilderness areas "designated by this Act," that is, only in the 9.1 million acres designated in 1964. Solicitor's Opinion M-36702, 74 I.D. 97, 98 (1967). However, subsequent acts designating additional areas generally contain some statement to the effect that the newly designated area "shall be subject to the provisions of the Wilderness Act governing areas designated by that Act as wilderness areas." e.g., 16 U.S.C. § 90e-2(b) (1970).

recurring basis consistent with the concept of wilderness preservation by the Geological Survey and the Bureau of Mines to determine the mineral values, if any, that may be present. ”

In addition to immediately designating certain national forest areas as wilderness, the 1964 Act also directed that within 10 years a review be made of (i) all national forest areas previously classified as “primitive” (including, at the President’s discretion, any contiguous national forest areas of predominantly wilderness value); (ii) all roadless areas of at least 5,000 contiguous acres within the National Park System or the National Wildlife Refuge System; and (iii) all roadless islands within the National Wildlife Refuge System. Recommendations were to be submitted by the President to Congress regarding the suitability of each such area for inclusion within the Wilderness System.

The mining provisions of the Wilderness Act do not apply to wilderness areas designated within units of the National Park System and the National Wildlife Refuge System. These wilderness areas, unless otherwise specified in the statute providing for wilderness designation, are immediately closed to the acquisition of any new mineral development rights upon inclusion in the system. However, the incremental effect on mineral activity should be relatively small, since almost all of the areas proposed for inclusion are already closed to mineral development or are in the process of being closed by mechanisms outside the wilderness review process.

Of potentially greater significance is the failure to include units of the National Park System and, particularly, the National Wildlife Refuge System within the ambit of subsection 4(d)(2) of the Wilderness Act, which permits mineral prospecting and surveys if “carried on in a manner compatible with the preservation of the wilderness environment” and requires that surveys be conducted “on a planned, recurring basis consistent with the concept of wilderness preservation by the Geological Survey and the Bureau of Mines to determine the mineral values, if any, that may be present. ” Although mineral surveys focused solely on wilderness areas might lead to undue emphasis on mineral activity in such areas in comparison with less environmentally critical (but unsurveyed) areas, Congress might want to make some provision for gathering of mineral resource information in areas such as parks and refuges that are (or will be) closed to private mineral activity and often encompass millions of acres apiece.

Wilderness areas are designated only by Congress,

b. **National Forest Wilderness.**[82] As noted above, Congress in 1964 designated 54 national forest wilderness areas totaling 9.1 million acres of public domain, Congress also mandated the study of and recommendations on 34 national forest primitive areas totaling 5.5 million acres of public domain, with possible expansion to include contiguous areas.

The primitive area evaluation, including contiguous areas, was completed in 1974, and almost all of the study areas were recommended for inclusion in the Wilder-

[82] Except as otherwise noted, all data on national forest wilderness were obtained from *Oversight on Access to Minerals on Public Lands*, hearings on H.R. 8435 before the Subcomm. on Mines and Mining of the House Comm. on Int. and Ins. Affairs, Ser. No. 94-41, 94th Cong., 1st sess. 72-88 (1976) (hereinafter *Access Hearings*) and from additional information supplied by the Division of Recreation, U.S. Forest Service, in 1976.

ness System. These recommendations, together with proposals for other areas such as those included in Public Law 93-622, the “Eastern Wilderness Act, ” had resulted by February 1976 in the addition of 2.7 million acres of public domain and 0.2 million acres of acquired land in the national forests to the Wilderness System. Recommendations for designation of another 3.8 million acres of public domain in completed study areas were pending, None of the designated or recommended acreage was in Alaska.

In addition, pursuant to its basic statutory authority and responsibilities, the Forest Service initiated an inventory of all other national forest “roadless and undeveloped” areas of 5,000 or more contiguous acres. From an initial list of 1,449 areas totaling 55,9 million acres, 274 areas totaling 12.3 million acres were selected in 1973 for study as potential wilderness areas. As of February 1976, 40 of these selected areas had been disposed of: 30 were contiguous to primitive areas and were included in the primitive area evaluation; 6 more were included in the proposal for an Alpine Lakes Wilderness Area in Washington; 1 was designated as wilderness by the Hells Canyon National Recreation Area Act; 2 were designated as wilderness by the Eastern Wilderness Act; and I was eliminated as a study area by the Eastern Wilderness Act. The remaining 234 areas totaled approximately 11 million acres of public domain land, including 2.6 million acres in Alaska.

In conjunction with a suit brought by the Sierra Club in 1972 seeking selection of additional roadless areas for study, the Forest Service adopted a policy of managing the 1,175 unselected roadless areas (constituting some 43.6 million acres) to preserve their wilderness characteristics pending completion of land use plans encompassing the various areas, The environmental impact statement accompanying each land use plan must consider the wilderness alternative for any included unselected roadless areas. Prior to completion of a land use plan covering such unselected areas, surface occupancy that is not a matter of statutory right, or extensive surface disturbance associated with the exercise of a statutory right (for example, construction of access roads to mining claims or commencement of surface mining operations),’ will not be permitted without completion of an environmental impact statement. As land use plans are completed, the unselected roadless areas will be either added to the wilderness study category or removed from protected status, As of February 1976, eight previously unselected areas totaling 112,800 acres had been added to the wilderness study category through the land use planning process, leaving around 43.5 million acres, including 18.1 million acres in Alaska, in the unselected roadless category.

Finally, Congress itself had added 17 areas totaling over 0.1 million acres of acquired land and 9 other areas totaling close to 0.9 million acres of public domain to the mandated wilderness study list as of February 1976.

In sum, at the beginning of 1976 there were 11.8 million acres of public domain (including around 0.4 million acres in Hells Canyon and Sawtooth NRAs) and 0.2 million acres of acquired land designated as national forest wilderness (none in Alaska), 3.8 million acres of public domain in wilderness study areas recommended for designation (none in Alaska), 11.9 million acres of public domain (including around 0.6 million acres in Hells Canyon and Sawtooth NRAs) and 0.1 million acres of acquired land in

Access Hearings, note 62, at 78

other wilderness study areas (including 2.6 million acres of public domain in Alaska), and 43.5 million acres of public domain in unselected roadless areas (including 18.1 million acres in Alaska),

Locations under the Mining Law are permitted until 1984 on all national forest public domain land in the Wilderness System, and mining activities can continue (or be initiated) beyond 1984 on claims validly located prior to 1984. The Wilderness Act subjects mining activities to reasonable regulations consistent with uses of the land necessary for mineral exploration and development, including where essential the use of mechanized ground and air equipment.[64] The Forest Service's mining regulations require that approval of a plan of operation be obtained before conducting any prospecting or mining activities that will cause significant disturbance of surface resources, and before constructing any roads.[65] These regulations are applicable to all national forest land but are applied most stringently to wilderness areas and, slightly less stringently, to proposed wilderness areas, study areas, and unselected roadless areas. These regulations supersede earlier, stricter regulations applicable only to wilderness and primitive areas.[66]

The mining industry asserts that the Forest Service mining regulations are so stringently enforced in wilderness and wilderness study areas as to discourage any prospecting or development.[67] Forest Service records show that as of July 25, 1973, a total of 2,400 new mining claims had been staked since 1964 in the 9.1 million acres originally designated as wilderness, and 200 new claims had been staked in other national forest wilderness areas since their designation.[68] Many claims have also been staked in primitive and other study areas where there appear to be significant mineral resources.” Although there are examples of strictly controlled access, including limiting exploration access to helicopters,[70] there are also examples of the actual commencement of mining operations with road access and mill sites inside primitive areas.[71] In general, however, as of July 1973, little actual development had occurred in wilderness areas because of stringent operating conditions and strong and vocal public opposition;[72] only 17 permits had been issued for actual mining.[73] In 1975, according to the Forest Service, significant mineral exploration activity was taking place in 7 wilderness areas, no primitive areas, and 54 wilderness study areas.[74]

Although the above figures indicate a substantial amount of mineral activity in wilderness-related areas in the national forests through 1975, the national forest public domain wilderness and wilderness study areas, other than those in the Hells Canyon and Sawtooth NRAs, are listed in the tables in section C as having been highly restricted for hardrock mineral activity in 1975. The Hells Canyon and Sawtooth areas are included in the acreage reported for national forest National Recreation areas in subsection F(2), since both NRAs were closed by statute to mineral activity.

The national forest public domain unselected roadless areas were available for hardrock mineral activity in 1975 subject only to the completion of a land use plan or

[64] See the language quoted in the text following note 60.

[65] 36 CFR pt. 252 (1975).

[66] 36 CFR §§ 293.13-.15, 293.17 (1974).

[67] *To Amend the Wilderness Act of 1964*, hearing on S.1010 before the Subcomm. on Minerals, Materials, and Fuels and the Subcomm. on Public Lands of the Senate Comm. on Int. & Ins. Affairs, 93d Cong., 1st sess. 112 (1973).

[68] Ibid., at 60.

[69] Ibid., at 78, 83, 84.

[70] Ibid., at 76, 112-113.

[71] Ibid., at 75-76, 78-79, 82-83; cf. ibid. at 81-82.

[72] Ibid., at 17, 21, 23, 61.

[73] Ibid., at 26.

[74] *Access Hearings*, note 62, at 84.

preparation of an environmental impact statement prior to extensive surface disturbance.[75] These by now are fairly standard requirements for any area of Federal onshore land, so the national forest public domain unselected roadless areas, except for 1 million acres in Alaska subject to Native selections and hence included in the acreage reported in section O, are listed in the tables in section C as having been open to hardrock mineral activity with moderate or slight restriction in 1975.

Hardrock minerals on national forest acquired land are leased, as are the fuel and fertilizer minerals on both public domain and acquired land. Mineral leasing on national forest acquired land is subject to the consent of the Secretary of Agriculture, Although the Secretary does not have the same veto power with respect to mineral leasing on public domain land, his recommendations are almost always followed by the Secretary of the Interior. The Forest Service policy in 1975 was either to refuse to allow any mineral leasing within wilderness or wilderness study areas, or to issue leases with “no surface occupancy” stipulations. ” Mineral leasing on unselected roadless areas was subject to the requirements listed in the previous paragraph for mining locations in such areas. Thus, the national forest wilderness and wilderness study areas, again exclusive of those in the Hells Canyon and Sawtooth NRAs, are listed in the tables in section C as having been highly restricted for development of all minerals on acquired land and for development of the fuel and fertilizer minerals on public domain in 1975. The national forest unselected roadless areas, again exclusive of the 1 million acres in Alaska subject to Native selections, are listed as having been open with moderate or slight restriction to development of all minerals on acquired land and for development of the fuel and fertilizer minerals on public domain.

c, National Park System Wilderness. As of the beginning of 1976, only 0.2 million acres of the National Park System’s statutorily mandated study areas had been designated as wilderness, but an additional 15.4 million acres had been recommended for such designation. Potential wilderness additions totaling 0.4 million acres had been identified but not recommended as yet.[77] Preliminary proposals had been prepared for another 3.5 million acres, but, of this group, recommendations were to be deferred on 2.2 million acres (Glacier Bay National Monument) pending a mineral survey and on 0.7 million acres (Lake Mead NRA) pending a reclamation study. Studies had not been completed on 4.1 million acres in Big Cypress, Big Thicket, Mount McKinley, and Voyageurs National Parks; Canaveral, Cape Lookout, and Cumberland Island National Seashores; and Glen Canyon National Recreational Area.[78] Based on past experience, only a very few acres will be recommended out of the 0.1 million acres in the national seashores, whereas much of the 4 million acres (3.2 million Federal acres) in the national parks and the national recreation areas probably will be recommended eventually.

Almost all of the National Park System areas being studied or recommended for wilderness designation in 1975 were either already closed to mineral development or in the process of being closed by mechanisms outside the wilderness review process.

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[75] Ibid., at 72, 73-74, 78.

[76] Ibid., at 72.

[77] U.S. National Park Service, Wilderness Study Program, "National Park System Wilderness Recommendations," Feb. 20, 1975, as revised January 1976. Acreages include both Federal and non-Federal land.

[78] U.S. National Park Service, Wilderness Study Program, "Acreages Proposed as Wilderness," May 1975.

The exceptions were the Lake Chelan and Ross Lake National Recreation Areas (approximately 50,000 acres recommended), the Lake Mead National Recreational Area (712,100 acres identified as suitable in a preliminary proposal), and the Glen Canyon National Recreation Area (alternatives ranging from 63,000 to 853,000 acres were presented at public hearings).[79] However, these areas were already highly restricted with respect to mineral activity in 1975 (see subsection F(2)).

All of the National Park System wilderness-related areas are included in figures reported elsewhere in this appendix, as discussed in section F.

d. **National Wildlife Refuge System Wilderness.** As of the beginning of 1976, only 0.6 million acres of the National Wildlife Refuge System's statutorily mandated study areas had been designated wilderness. An additional 7.1 million acres had been recommended for wilderness designation, but the recommendations for 1.8 million of these acres (Desert Wildlife Range and Charles Sheldon Game Range) were subject to completion of mineral surveys for which congressional appropriation of funds had been requested. Wilderness recommendations had been delayed on 3.9 million acres in the Nunivak and Izembek units, and wilderness study had been delayed on 13.6 million acres in the Arctic, Clarence Rhode, Hazen Bay, and Kodiak units, due to the Native land selection process in Alaska. The 0,2 million acre Upper Mississippi River Refuge, originally determined to be unsuitable for wilderness designation, was to be restudied.[80]

All units in the National Wildlife Refuge System were already closed or highly restricted with respect to mineral activity in 1975 without reference to their status as wilderness or wilderness study areas (see subsection G(l)). Therefore, all of the system's wilderness-related areas are included in the figures reported in subsection G(l).

e. Wilderness Study Program: Overall Status. Table B.4 shows the overall status of the wilderness study program at the end of 1975, based on the data in this subsection.

Table B.4.—Status of Wilderness Study Program in 1975
(Millions of acres)

	National Forest System	National Wildlife Refuge System	Naitonal Park System
Total system[a]	187.2	30.8	27.7b
Designated wilderness	12.0	0.6	0.2
Recommended	3,8	5,3	15.4
Tentative proposal	—	5.7	3.9
Study areas	12.0	13.8	3.3
Other roadless	43.5		—

a*Public Land Statistics*, table 9.
bIncludes 2.9 million acres of land under primary reclamation withdrawals: see subsection F(2)

[79]U.S. National Park Service, Wilderness Study Program, February 1976.

[80]U.S. Fish and Wildlife Service, "National Wildlife Refuge System: Current Status of Wilderness Program," January 1976.

2. Bureau of Land Management Roadless Areas

Prior to October 1976 there was no wilderness program for the great bulk of public domain under the primary jurisdiction of BLM. However, as with the Forest Service prior to passage of the Wilderness Act of 1964, BLM on its own had established procedures for designating primitive and natural areas.[81]

Areas could be designated under these procedures only if they had been (i) classified for retention under the Classification and Multiple Use Act, which expired in December 1970; (ii) formally withdrawn or reserved by public land order; or (iii) given special status by an act of Congress. Designation of an area purportedly had no effect on its use or management, except as authorized by one of the above three categories of authority. In actual practice, however, primitive and natural areas were often designated without reliance on the three listed categories of authority and were strictly managed for the preservation of their essential characteristics.

The BLM regulations define primitive areas as "extensive natural, wild, and undeveloped areas and settings essentially removed from the effects of civilization" which have "not been disturbed by commercial utilization and . , , are without mechanized transportation. " Of 11 primitive areas designated by the end of 1975, totaling 234,003 acres,[82] only 2 were formally withdrawn from mining: 40,400 acres were withdrawn from the Mining Law but not the mineral leasing acts by Public Land Order 5386; and 2,671 acres were withdrawn from all forms of mineral activity by Public Land Order 5062, Two additional areas of 5,080 and 27,515 acres, respectively, were segregated from mineral development through classification under the Classification and Multiple Use Act prior to its expiration. A fifth area of 3,94 I acres was within the King Range National Conservation Area, where mining is allowed subject to reasonable protective regulations. The remaining six areas, totaling 154,306 acres, had been designated and were being preserved without any apparent basis in law or regulation,

The regulations governing public use of BLM primitive areas restricted travel to "nonmechanized forms of locomotion, " Construction, roads, mechanized equipment, nontransient occupancy, and the landing of aircraft were prohibited "except in connection with activities necessary in the use of the lands for authorized nonrecreation purposes."[83] Although mineral exploration and development, at least under the Mining Law, should have been an authorized nonrecreation purpose in 7 of the primitive areas, BLM officials interviewed in 1976 stated that access for mineral activity would not be allowed in any of the 11 areas.

An additional 27 areas, totaling approximately 1.5 million acres, had been processed through BLM's Management Framework Planning (MFP) process in 1975 and were being managed for their primitive values, although they had not yet been designated as primitive areas. According to BLM, mining was allowed in these areas. However, the areas serve as a pool for future designations: 4 of the 11 designated primitive areas discussed above were in the undesignated, ''managed for primitive values" category in April 1974.

[81] 43 CFR pt. 2070 (1975).
[82] U.S. Bureau of Land Management, "List of Primitive Areas, Aug. 27, 1975."
[83] 43 CFR § 6221.2 (1975).
[84] Information supplied by BLM's Division of Recreation, January 1976.

BLM field personnel, based on data compiled from the Unit Resource Analyses that precede the systematic MFP planning process, also estimated that approximately 3.9 million more acres might eventually qualify for primitive area treatment.[84] These 3.9 million acres were not subject to any special protections in 1975.

The BLM regulations” define “outstanding natural areas” as areas of “outstanding scenic splendor, natural wonder, or scientific importance that merit special attention and care in management to ensure their preservation in their natural condition, ” and which “usually are relatively undisturbed [and] representative of rare botanical, geological, or zoological characteristics of principal interest for scientific and research purposes. ” “Natural resources experiment and research areas” are “relatively small areas of land which are used for research or experimental purposes. ” There were 19 research natural areas totaling 44,676 acres and 24 outstanding natural areas totaling 276,937 acres as of February 3, 1976.[86] As with the primitive areas, the creation of specific natural areas has been accomplished through such varied means as exercise of the President’s implied withdrawal power, classification under the Classification and Multiple Use Act, and simple designation without reference to any specific authority. No specific acreage breakdown was available for 1975.

The regulations governing the use of natural areas in 1975 were even stricter than those governing primitive areas, Not only were persons forbidden to “use, occupy, construct, or maintain improvements unless permitted by law, ” but, even where permitted, such use, occupancy, construction, or maintenance could not be “in a manner inconsistent with the purpose for which the area is established.[87] BLM officials interviewed in 1976 stated that research natural areas were protected to the same extent as primitive areas (no access for mining), but that only the core physical features of outstanding natural areas were so protected.

The 76,000 acres withdrawn or segregated as primitive areas and the entire 45,000 acres of research natural areas are listed in the tables in section C as having been closed to hardrock mineral activity in 1975. The same acreage, except for the 40,000 acres withdrawn by Public Land Order 5386, is listed as having been closed to development of nonhardrock minerals also. The remaining 158,000 acres in primitive areas (plus, with respect to nonhardrock mineral activity, the 40,000 acres withdrawn by Public Land Order 5386), the 1.5 million acres “managed for primitive values, ” and the 277,000 acres in outstanding natural areas are listed in the tables as having been highly restricted for development of all minerals. The 3.9 million acres of areas with primitive potential are listed as having been open with moderate to slight restrictions on mineral activity.

The primitive, “managed for primitive values, ” potential primitive, and natural areas discussed above totaled 6 million acres in 1975, none of which were in Alaska. These 6 million acres were part of an estimated 89.5 million acres in BLM roadless areas (5,000 acres or more) and roadless islands in 1975. Approximately 64 million of these acres were subject to withdrawals under ANCSA, and they are therefore dis-

[85] 43 CFR pt. 2070 (1975).

[86] Data supplied by BLM's Division of Recreation, February 1976. At the time, the division was waiting for verification of the designation and acreage of 13 listed outstanding natural areas in Nevada, totaling 74,176 acres. These 13 areas are included in the 24 referred to in the text.

[87] 43 CFR § 6225.1 (1975).

cussed in section O of this appendix. Another 0.6 million acres were segregated from mineral entry by classification under the Classification and Multiple Use Act and are discussed in subsection M(3). The remaining 18.9 million acres, all in the lower 48 States, were not subject to any special restriction related to their roadless condition, and they are therefore listed (together with the 3.9 million acres of primitive potential areas) in the tables in section C as having been open with moderate to slight restrictions on mineral activity in 1975.

The availability of BLM roadless areas for mineral activity was greatly affected by passage of the Federal Land Policy and Management Act of 1976 ("BLM Organic Act") in October 1976. Section 603 of the BLM Organic Act requires that all BLM roadless areas of 5,000 acres or more and roadless islands, identified as having wilderness characteristics, be reviewed within 15 years and recommended as to their suitability or nonsuitability for congressional designation as wilderness. The Secretary of the Interior is required to manage such areas, pending a congressional decision on their designation as wilderness,

> so as not to impair the suitability of such areas for preservation as wilderness, subject, however, to the continuation of existing mining . . . uses and mineral leasing in the manner and degree in which the same was being conducted on [October 21, 1976]: Provided, That, in managing the public lands the Secretary shall by regulation or otherwise take any action required to prevent unnecessary or undue degradation of the lands and their resources or to afford environmental protection.[88]

Roadless areas and islands not previously withdrawn from hardrock mineral activity under the Mining Law are left open to such activity during the period of review unless subsequently withdrawn for reasons other than preservation of their wilderness character. Areas designated for preservation as wilderness are to be subject to the same restrictions and conditions as national forest wilderness.[89]

3. The Wild and Scenic Rivers System

The Wild and Scenic Rivers Act,[90] enacted in 1968, created a system of wild, scenic, and recreational rivers. Land within one-quarter mile of the bank of any wild river segment is withdrawn from location under the Mining Law and from mineral leasing. Land within one-quarter mile of the bank of any river designated by Congress for study for inclusion in the system is withdrawn from location under the Mining Law, but not from mineral leasing, until determined to be unsuitable for inclusion in the Wild and Scenic River System or until designated and classified by Congress. Although formally open to mineral leasing, such land will rarely, if ever, be leased. Scenic and recreational river segments are formally open to mining locations and mineral leasing, but again mineral leasing will be rare in scenic segments, at least, and mining locations will be subject to strict regulation.

[88] 43 U.S.C.A. § 1782 (Supp. 1977) (emphasis added). Proposed management policies have been published at 44 F.R. 2623, 2694 (1979).

[89] See subsec. H(1).

[90] 16 U.S.C. §§ 1271-1287 (1970).

Congress initially designated 8 river segments, totaling approximately 804 miles in length,[91] as components of the system. About 598 of the 804 miles are on Federal land, and Federal land accounts for almost all of the 275 miles classified as wild. Seven river segments, totaling 378 miles overall and 157 Federal miles, had been added to the system by the end of 1975. The 157 additional Federal miles consist of 99 miles of public domain (of which 64 miles are classified wild) in the Hells Canyon National Recreation Area and 58 miles of acquired land (of which 41 miles are classified wild).

Congress also initially designated 27 river segments for study, of which 3 segments (totaling 460 miles) had been found by the end of 1975 to be not qualified for inclusion in the system, leaving 24 segments (totaling 3,075 miles overall and about 1,320 Federal miles) under study. In January 1975 another 29 river segments, totaling 2,177 miles overall and approximately 1,341 primarily Federal miles (of which 184 miles were on acquired land and 119 were in units of the National Park System), were designated for study.

In sum, excluding mileage in the Hells Canyon NRA or in units of the National Park System that are covered in section F, in 1975 there were 316 miles of Federal river classified wild, 340 miles classified scenic or recreational, and 2,542 miles under study. Almost all of this mileage was on public domain rather than acquired land. At 320 acres per mile for the halfmile-wide corridor along these river segments, these mileages convert to 0.1 million acres classified wild, 0.1 million classified scenic or recreational, and 0.8 million under study.

The acreage classified wild is listed in the tables in section C as having been closed to mineral activity in 1975, The acreage classified scenic or recreational is listed as having been highly restricted. The acreage under study is listed as having been closed to hardrock mineral activity and highly restricted for development of nonhardrock minerals. None of the acreage was in Alaska.

L Surface Resource Development

1. Irrigation Projects

The Act of October 2, 1888, as amended,[92] effected an automatic withdrawal from entry under the mining and other public land laws of all land theretofore or thereafter actually designated or selected for reservoirs, ditches, or canals for irrigation purposes, until otherwise provided by law. This law remained in effect despite the later passage of the Reclamation Act of 1902.[93]

Section 3 of the Reclamation Act of 1902[94] directs the Secretary of the Interior to withdraw land required for irrigation works contemplated under the Act from public entry ("first form withdrawals"): it also authorizes him to withdraw all land believed

[91] Mileages based on rough estimates provided by the Division of Resource Area Studies, Bureau of Outdoor Recreation, Department of the Interior, February 1976.

[92] 43 U.S.C. § 662 (1970).

[93] See *PLLRC Withdrawals Study*, note 9, at 229-231

[94] 43 U.S.C. § 416 (1970).

to be susceptible to irrigation from such works (“second form withdrawals”). Mining was originally barred on first form but not on second form withdrawals.[95] In 1932, Congress authorized the Secretary, at his discretion, to open land withdrawn for construction purposes under the reclamation laws to location under the Mining Law.[96] Interior’s regulations now treat all land withdrawn for reclamation purposes as closed to location under the Mining Law unless formally opened by the Secretary, and require the Bureau of Reclamation’s consent to any opening.[97]

Land withdrawn for reclamation purposes has been open to mineral leasing since the passage of the Leasing Act in 1920, although leases are subject to special stipulations protecting the dominant reclamation use.[98] As discussed in subsection F(2), national recreation areas have been superimposed on portions of many reclamation withdrawals, and for such land further lease stipulations are required to protect the recreation use (if leasing is allowed).

As of June 30, 1974, there were about 5.7 million acres of public domain and 1.9 million acres of acquired land withdrawn for reclamation purposes, all in the lower 48 States.[99] On 2.7 million acres of the public domain included in certain NRAs (see subsection F(2)), hardrock minerals were subject to disposition through leasing rather than through location under the Mining Law, and leases could not be granted if mineral development would have a significant adverse effect on the administration of the land for recreation purposes. These 2.7 million acres are listed in the tables in section C as having been highly restricted for mineral activity in 1975. The remaining 3 million acres of public domain and the 1.9 million acres of acquired land are listed as having been closed to hardrock mineral activity and highly restricted for development of nonhard rock minerals.

2. Stockraising and Agricultural

Several public land statutes allow acquisition of private title to public land for agricultural or stockraising purposes, with retention by the Federal Government of all or some minerals in the subsurface estate, together with the right of anyone to enter upon such land under the mining or mineral leasing laws to explore for and develop the federally reserved mineral deposits.[100] The prospector or miner generally must pay the surface owner for any damages to crops, agricultural improvements, and the value of the land for grazing or agricultural purposes, or post a bond to cover such damages.[101] This narrow measure of damages, together with the lack of control by the surface owner over entry on his property and the lack even of any notice prior to entry, has often led to considerable resistance by surface owners to mineral exploration and development activity.[102] However, this resistance usually is overcome by payments (not

[95] Instructions, 35 L.D. 216 (1906); *Loney* v. *Scott*, 112 P. 172 (Ore. 1910).

[96] 43 U.S.C. § 154 (1970).

[97] 43 CFR subpt. 3816 (1975); see *PLLRC Withdrawals Study*, note 9, at 236.

[98] 43 CFR § 3501.3-2(c) (1975).

[99] *Public Land Statistics*, table 9.

[100] See, for example, the Stockraising Homestead Act of 1916, 43 U.S.C. § 299 (1970).

[101] Mall, "Federal Mineral Reservations," 10 *Land and Water L. Rev.* 1 (1975).

[102] Ibid.; *Federally Owned Locatable Minerals*, hearing before the Subcomm. on Public Lands of the Senate Comm. on Int. & Ins. Affairs, 91st Cong., 1st sess. (1969). For coal only, more control has been given to the surface owner by sec. 714 of the Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, 91 Stat. 445, 524 (1977).

legally required) to the surface owner in excess of the statutorily mandated damage payments.

As of the end of 1975, the United States had reserved all mineral rights in 39.4 million acres and rights to some or all of the Leasing Act minerals in an additional 23.9 million acres of land homesteaded for agricultural or stockraising purposes.[103] All 63,3 million acres were public domain and all but a tiny portion were in the lower 48 States. All 63.3 million acres are listed in the tables in section C as having been open with moderate to slight restrictions for development of the federally reserved minerals in 1975.

Section 10 of the Stockraising Homestead Act of 1916[104] authorizes withdrawals under the Pickett Act of "Lands containing waterholes or other bodies of water needed or used by the public for watering purposes" and also of certain access corridors (stock driveways) of specified maximum size "necessary to insure access by the public to watering places reserved hereunder and needed for use in the movement of stock to summer and winter ranges or to shipping points. " The waterholes or public water reserves can be withdrawn from development of all but the metalliferous minerals. The stock driveways, however, remain open to development of all minerals, subject to such regulations and restrictions as may be prescribed by the Secretary of the Interior[105] and subject to. retention of surface title by the United States.[106] Although stock driveways "are now often of little practical significance"[107] to the stockraising industry, 2.5 million acres remained withdrawn in the lower 48 States for stock driveway purposes at the end of 1974.[108] However, since access to the underlying minerals is relatively unaffected by the withdrawals, the 2.5 million acres are listed in the tables in section C as having been open with moderate to slight restrictions for mineral activity.

3. Water Supply and Control

The authority to withdraw waterholes or other public watering places, discussed in the previous paragraph, was at first exercised by the President on a selective basis. However, in 1926, a blanket order was issued ("Public Water Reserve No. 107") withdrawing all land within one-quarter of a mile of any spring or waterhole.[109] Such land remained open to metalliferous location. Furthermore, various statutes have authorized the withdrawal of specific watershed land in order to protect municipal and other water supplies. Some of these statutes closed the withdrawn land to mining.[110] Including additional watershed withdrawals by the Executive, about 1.5 million acres were withdrawn for water uses at the end of 1974[111] and are listed in the tables in section C as having been highly restricted with respect to mineral activity in 1975.

As of June 30, 1974, there were 0.7 million acres of public domain and 7.1 million acres of acquired land, almost all in the lower 48 States, dedicated to water resource development projects of the Army Corps of Engineers.[112] This acreage was closed to mineral activity in 1975 and is so listed in the tables in section C.

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[103] *Public Land Statistics*, table 17.
[104] 43 U.S.C. § 300 (1970).
[105] See 43 CFR subpt. 3815 (1975).
[106] 43 U.S.C. §§ 299, 300 (1970).
[107] *PLLRC Withdrawals Study*, note 9, at 196.
[108] Bennethum and Lee, note 1, at 43.
[109] *PLLRC Withdrawals Study*, note 9, at 182-189
[110] Ibid., at 192-194.
[111] Bennethum and Lee, note 1, at 43.
[112] *Public Land Statistics*, table 9.

J. Energy Development

1. Powersites

Under section 24 of the Federal Power Act,[113] the filing of an application by anyone for a permit or license for a powersite automatically withdraws the land from all forms of disposition, including mineral development, In addition, classification of land as valuable for powersite purposes by the U.S. Geological Survey (USGS)[114] effects a withdrawal of such land under section 24.15 Some powersite withdrawals are made without reliance on the Federal Power Act, either pursuant to the President's Pickett Act authority, in which case the withdrawn land is open to location of metalliferous minerals, or, on occasion, pursuant to his implied authority. [116]

In 1955, Congress opened all powersite withdrawals and reservations not covered by a power project license or permit to the operation of the mining and mineral leasing laws. Operations on placer claims, however, may be prohibited or regulated by order of the Secretary of the Interior. Furthermore, all mineral development activities are subject to being overridden at any time for power development without payment of any compensation. [117] Under such a condition, mineral exploration and development activities will be undertaken at a powersite only if the mineral potential is high and there is little chance of power development at the site for the projected life of the mine. Nevertheless, 233 location certificates and 211 affidavits of labor were filed during fiscal year 1975 for mining claims within lands withdrawn for powersite purposes.[118]

At the end of 1974, there were 15.2 million acres withdrawn as powersites.[119] Most of the withdrawn acreage was due to powersite withdrawals, classifications, and designations by USGS.[120] One USGS powersite classification, the Ramparts powersite created in 1965 on the Yukon River in Alaska, accounted for 9 million acres,[121] which were overlain by subsequent withdrawals in 1971 under ANCSA: 6.9 million acres by d-2 withdrawals, 1.3 million acres by d-l withdrawals, and 0.8 million acres by withdrawals for Native selections. The 9 million acres are included as part of the 15.2 million acres of powersite withdrawals listed in the tables in section C as having been highly restricted with respect to mineral activity in 1975. They are also included in the relevant ANCSA listings discussed in section O. The overlap is accounted for in the subtotals of the section C tables.

2. Pipeline Corridors

In 1971, the Secretary of the Interior withdrew 4.5 million acres for a utility and transportation corridor across Alaska to the Prudhoe Bay oilfields.[122] A subsequent

[113] 16 U.S.C. § 818 (1970).

[114] Pursuant to its classification authority under 43 U.S.C. § 31 (1970).

[115] See *PLLRC Withdrawals Study*, note 9, at 361.

[116] Ibid., at 356-358.

[117] 30 U.S.C. §§ 621-622 (1970); 43 CFR pt. 3730 (1975).

[118] *Public Land Statistics*, table 84.

[119] See Bennethum and Lee, note 1, at 35.

[120] See *PLLRC Withdrawals Study*, note 9, at 352, 363, table G.1.

[121] Statement of Jack O. Horton, Assistant Secretary, Land and Water Resources, U.S. Department of the Interior, hearing on Public Land Withdrawals before the Subcomm. on Public Lands, House Comm. on Int. and Ins. Affairs, 94th Cong., 1st sess., Oct. 21, 1975, table 2.

[122] Ibid.

withdrawal was made for a smaller gas pipeline corridor to Canada, bringing the total acreage withdrawn for pipeline corridors in Alaska to 5.3 million acres, of which 2.9 million acres were completely withdrawn from mineral activity. The remaining 2.4 million acres were open only to location of metalliferous minerals under the Mining Law.[123] All 5.3 million acres are listed in the tables in section C as having been closed to development of nonhardrock minerals in 1975. The 2.4 million acres open to location of metalliferous minerals are listed as having been open with moderate to slight restrictions for hardrock mineral activity, since almost all of the essential hardrock minerals (see appendix A) are metalliferous.

3. Atomic Energy

Prior to 1970, land had been withdrawn for the Atomic Energy Commission (AEC) for testing and research facilities and for control over source materials. The orders almost always withdrew the land from location under the Mining Law and often explicitly withdrew it from the leasing laws as well.[124] AEC had special authority to issue leases for uranium source material. By 1974, the AEC'S jurisdiction and authority over this land had been transferred to the Energy Research and Development Administration (ERDA), which was itself merged into the new Department of Energy in 1977. As of June 30, 1974, there were 1.4 million acres of public domain and 0.7 million acres of acquired land withdrawn for ERDA,[125] all in the lower 48 States and all listed in the tables in section C as having been closed to mineral activity in 1975.

4. Tennessee Valley Authority

The Tennessee Valley Authority was not allowing mineral leasing on its 0.9 million acres[126] of acquired land in 1975.[127] The 0.9 million acres are listed in the tables in section C as having been formally closed to hardrock mineral activity and highly restricted with respect to nonhardrock mineral activity in 1975.

K. Mineral Conservation

1. Petroleum and Oil Shale Reserves

a. **Naval Reserves.** Seven naval petroleum and oil shale reserves were established between 1912 and and 1923 to assure fuel for defense purposes. Following the Teapot Dome scandal in the 1920's, they were administered almost exclusively for conservation rather than production, until passage of the Naval Petroleum Reserves Production Act of 1976 which authorized expanded exploration on Naval Petroleum Reserve No. 4 in Alaska (NPR4, redesignated as the National Petroleum Reserve in Alaska on June 1, 1977) and maximum efficient production for at least 3 years from Naval Petroleum Reserve Nos. 1, 2, and 3 in the lower 48 States.[128]

[123] See Bennethum and Lee, note 1, at 45.
[124] *PLLRC Withdrawals Study*, note 9, at 299-303.
[125] *Public Land Statistics*, table 9.
[126] Ibid.
[127] Bennethum and Lee, note 1, at 47.
[128] Public Law 94-258, 90 Stat. 303, 304-305, 308 (1976).

NPR4 contains approximately 23.7 million acres of public domain. The other three petroleum reserves and the three oil shale reserves contain a total of just over 0.2 million acres.[129] All of the reserves are expressly closed to mineral leasing under the Mineral Leasing Act of 1920,[130] and therefore all 23.9 million acres are listed in the tables in section C as having been closed to development of the Leasing Act minerals in 1975.

The status of the reserves with respect to development of the hardrock minerals was more complex. Although it seems generally to have been assumed that the reserves were closed to locations under the Mining Law, all of the reserves other than NPR4 were established pursuant to the President's authority under the Pickett Act, which permits entry for development of metalliferous minerals under the Mining Law. ” The 0.2 million acres in these reserves are therefore listed in the tables in section C as having been open with moderate or slight restrictions for hardrock mineral activity in 1975.

NPR4 itself was established by Executive Order 3797-A pursuant to ‘*the power vested in [the President] by the laws of the United States. ” The order provided that “the reservation hereby established shall be for oil and gas only and shall not interfere with the use of the lands or waters within the area for any legal purpose not inconsistent therewith. ” This language by itself does not preclude locations under the Mining Law, but at most subjects any mining claim or mineral patent to a reservation of deposits of oil and gas. All of northern Alaska, including NPR4, was withdrawn from mining and mineral leasing in 1943:[132] however, this withdrawal was revoked in 1960, leaving NPR4 in its original withdrawal status.]” Certain portions of NPR4 in the vicinity of Alaskan Native villages were withdrawn in 1972 from all forms of appropriation, including locations under the Mining Law, for Native land selection purposes, and some or all of the remainder of NPR4 may have been completely withdrawn by other withdrawals under ANCSA. In short, the net status of NPR4 in 1975 was not clear. However, NPR4 was unequivocally closed to entry under the Mining Law early in 1976, ' so its 23.7 million acres are listed in the tables in section C as having been closed to hardrock mineral activity in 1975.

The Department of the Interior has established a narrow buffer zone around the perimeter of the petroleum reserves where practicable to protect against drainage by wells on adjacent land. Leasing of oil and gas is precluded in this buffer zone, which amounted to 0.1 million acres in the lower 48 States in 1974. Since the restriction only applies to oil and gas, the 0.1 million acres are listed in the tables in section C as having been open with slight or moderate restriction for mineral activity in 1975.

b. **Other Oil Shale Withdrawals.** In 1930, a blanket withdrawal of Federal oil shale land from mineral leasing was effected pursuant to the President's authority under the Pickett Act. Subsequent orders identified particular land in Colorado, Utah, and Wyoming included in the withdrawal and opened that land first to oil and gas leasing and then to sodium leasing.[136] In 1968, however, the land (totaling 3.7 million acres)

[129] Office of Naval Petroleum and Oil Shale Reserves, Department of the Navy, *History of Naval Petroleum and Oil Shale Reserves* (1973).

[130] 30 U.S.C. § 181 (1970).

[131] 43 U.S.C. § 142 (1970).

[132] Public Land Order 82, 8 F.R. 1599 (Feb. 4, 1943).

[133] Public Land Order 2215, 25 F.R. 12599 (Dec. 8, 1960).

[134] Naval Petroleum Reserves Production Act of 1976, § 102, 90 Stat. 303 (1976).

[135] Bennethum and Lee, note 1, at 35.

[136] *PLLRC Withdrawals Study*, note 9, at 166-168.

was withdrawn from metalliferous location under the Mining Law and from sodium leasing except where there was a finding in a particular case that mining of the sodium would not have a significant adverse effect on oil-shale values.[137] The land was thus open only for oil and gas leasing in 1975, and so the 3.7 million acres are listed in the tables in section C as having been closed to hardrock mineral activity and highly restricted (open only for oil and gas) for development of all other minerals in 1975.

2. Geothermal Resources

On February 7, 1967, the Department of the Interior issued a proposed blanket withdrawal of 86 million acres of public land from the mining and mineral leasing laws to protect geothermal steam resources. Because of intense congressional opposition to this proposed withdrawal, it was superseded on March 24, 1967, by a revised application for withdrawal of 1.1 million designated acres from the mining but not the mineral leasing laws. Leases were to be issued only if the Secretary found that the proposed use of the land would not adversely affect the geothermal resource or hinder its development or utilization, Although the withdrawal application never developed into an actual withdrawal, the mere fact of application segregated the land from location under the Mining Law and from leasing except as approved by the Secretary.[138] The withdrawal application was modified in 1973 to allow geothermal leasing under the Geothermal Steam Act of 1970 and was finally cancelled in June 1976.[139] However, in 1975 the land was still closed to hardrock mineral activity and highly restricted with respect to development of all other minerals. The 1.1 million acres are so listed in the tables in section C.

L. Surface Occupancy

1. Federal Use

Small tracts of Federal land are administered for specific agency uses by a variety of Federal agencies. Specific uses include airports, lighthouses, air navigation facilities, post offices, health facilities, prisons, test centers, office buildings, and so forth.[140] As of June 30, 1974, close to 0.5 million acres of public domain and another 0.5 million acres of acquired land were dedicated to such discrete uses under the primary jurisdiction of agencies such as the Agricultural Research Service, the Postal Service, and various agencies of the Department of Transportation.[141] These **1** million acres do not include more extensive surface uses for irrigation projects, water resource development projects, and atomic energy research, which are discussed in sections I and J. Nor do they include withdrawals by the major land management agencies of sites for

[137] Ibid., at 170; Hearing on Public Land Withdrawals, note 121, table 2.
[138] *PLLRC Withdrawals Study*, note 9, at 181-184.
[139] 41 F.R. 22964 (June 8, 1976).
[140] *PLLRC Withdrawals Study*, note 9, at 342-350.
[141] *Public Land Statistics*, table 9.

administrative buildings and public service and recreation facilities, which amounted to around 1.9 million acres in 1975.[142]

Land used for agency purposes is usually formally withdrawn from mineral activity. Even without a formal withdrawal, the land is considered closed to mineral activity if it contains improvements created by or under the authority of the Federal land management agency.[143] Thus, the 2.9 million acres discussed in the previous paragraph are listed in the tables in section C as having been closed to mineral activity in 1975.

2. Non-Federal Use

Various statutes provided for the reservation of townsites on and easements across the public domain. The total amount of land reserved for such spatial uses in 1975 was approximately 2.5 million acres,[144] which is all listed in the tables in section C as having been closed to mineral activity, although an unknown portion of the acreage overlaps acreage discussed elsewhere in this appendix or is formally open to mineral leasing.

Small (5 acres or less) tracts of Federal land classified as chiefly valuable for residence, recreation, business, or community site purposes could be leased or sold, until recently, under the Small Tract Act of 1938.[145] The minerals in land sold or leased are reserved to the United States. Under regulations in force in 1975,[146] the reserved minerals were formally available for mineral leasing but were closed to location under the Mining Law. However, there were only 351 acres under lease in 1975 and only 49 acres had been sold during fiscal 1975.[147] A more significant impact on mineral activity resulted from the classification of almost 0.5 million acres as available for disposition under the Act in 1975.[148] Applications for lease or purchase segregate such land from the operation of the mining and mineral leasing laws. The regulations also purport to segregate land classified but for which no application is pending,149 despite the lack of any apparent statutory authority for such segregation. Due to the regulation, the 0.5 million classified acres are listed in the tables in section C as having been highly restricted with respect to mineral activity in 1975.

Almost 40,000 acres of Federal land were under lease in 1975 under the Recreational and Public Purposes Act of 1926.[150] However, the mineral deposits in this land were reserved to the United States, together with the right to mine and remove such deposits under applicable laws and regulations.[151] This acreage is not listed in the tables in section C.

[142] Bennethum and Lee, note 1, at 35, figure 1. Withdrawals by the Forest Service for such purposes amounted to over 750,000 acres through 1967. See *Access Hearings*, note 62, at 70-71.

[143] *United States* v. *Cohan*, 70 I.D. 178 (1963); see *United States* v. *Schaub*, 103 F. Supp. 873 (D. Alaska 1952), *aff'd*, 207 F.2d 325 (9th Cir. 1953).

[144] Bennethum and Lee, note 1, at 43; see *PLLRC Withdrawals Study*, note 9, table G.4. Land in incorporated cities, towns, or villages is not subject to the mineral leasing acts. 30 U.S.C. §§ 181, 352 (1970).

[145] 43 U.S.C. § 682b (1970).

[146] 43 CFR § 2731.6-3 (1975).

[147] *Public Land Statistics*, table 31.

[148] Ibid., table 89.

[149] 43 CFR § 2731.2(b) (1975).

[150] *Public Land Statistics*, table 33.

[151] 30 U.S.C. § 869-1 (1970).

M. General

1. Statewide Withdrawals

Congress has withdrawn all the public domain in Alabama, Kansas, Michigan, Minnesota, Missouri, Oklahoma, and Wisconsin, totaling 1.8 million acres in 1975,[152] from the operation of the Mining Law.[153] Approximately 1.4 million of these acres were in national forests and around 57,000 acres were BLM land; the remainder was under the jurisdiction of other agencies[154] and has been discussed in the earlier sections of this appendix. Of the 1.4 million national forest acres, 1.1 million were in Minnesota and were available for leasing of both hardrock and Leasing Act minerals subject to the consent of the Secretary of Agriculture.[155] However, 0.5 million of these Minnesota public domain national forest acres were within the Boundary Waters Canoe Area, a designated wilderness area,[156] and already have been discussed in subsection H(l). Thus, the net result in 1975 of the congressional statutes affecting these seven States was the closure of 0.1 million acres of BLM land and 0.3 million acres of national forest to hardrock mineral activity and the availability of 0.6 million acres of public domain national forest through lease rather than through location under the Mining Law. The 0.1 million BLM acres and 0.3 million national forest acres are listed in the tables in section C as having been closed to hardrock mineral activity in 1975, but open with moderate or slight restriction for development of all other minerals. The 0.6 million national forest acres are listed as having been open with moderate or slight restriction for development of all minerals.

2. Forest Service

As of June 30, 1974, 160.2 million acres of public domain and 27 million acres of acquired land were under the primary jurisdiction of the Forest Service.[157] Of this acreage, 69 million acres of public domain and 0.3 million acres of acquired land in wilderness and roadless areas are discussed and tabulated in subsection H(1); 1 million acres of public domain covered by Alaskan Native selections are discussed and tabulated in subsection O(l); 11.4 million acres withdrawn for various other reasons[158] are included in the figures discussed and tabulated in preceding sections of this appendix; and 0.9 million acres in the seven States closed by Congress to operation of the Mining Law are discussed and tabulated in subsection 1 of this section. This leaves approximately 77.9 million public domain acres and 26.7 million acquired acres of national forest land yet to be included in the tables in section C. The United States did not own some or any of the mineral rights in approximately 10.2 million acres of the acquired national forest land in 1975,[159] but mineral activity on such land could be ar-

[152] *Public Land Statistics*, table 7.

[153] 30 U.S.C. §§ 48 (Michigan, Minnesota, Wisconsin), 49 (Kansas, Missouri) and 171 (Alabama) (1970); 43 U.S.C. § 1098 (1970) (Oklahoma). The mining laws were subsequently applied to certain ceded Indian land in Oklahoma by the Acts of March 2, 1895, 28 Stat. 899, and June 6, 1900, 31 Stat. 680. Four other States containing negligible amounts of public domain (Illinois, Indiana, Iowa, Ohio) are subject to the operation of the Mining Law, although they are omitted from the list of Mining Law States in the Department of the Interior's regulations. See 43 CFR § 3811.2-1 (1975).

[154] *Public Land Statistics*, table 9.

[155] 16 U.S.C. § 508b (1970).

[156] Wilderness Hearing, note 67, at 29-30.

[157] *Public Land Statistics*, table 9.

[158] *Access Hearings*, note 62, at 70-71.

[159] U.S. Forest Service, *Minerals Area Management on National Forest System Lands* 25 (1974).

ranged through the non-Federal owners of the reserved or outstanding mineral rights. Thus, the entire 104.6 million acres are listed in the tables in section C as having been available wit h moderate or slight restrict ions for development of all[160] minerals in 1975.

3. Bureau of Land Management

The Classification and Multiple Use Act of 1964, which expired in December 1970, authorized the Secretary of the Interior to classify and manage lands under the exclusive jurisdiction of BLM for multiple use, including specification of dominant uses and preclusion of uses inconsistent with the dominant use specified for any particular area.[161] Classification or proposed classification segregated the land involved from mining locations and mineral leasing unless otherwise specified. There were 3.9 million acres segregated from mining locations but not mineral leasing by classifications under this Act.[162] Of these, 3,246,624 acres were in Alaska and were covered in 1975 by the subsequent withdrawals under ANCSA, ”){ which are discussed in section O. An additional 32,595 acres were included in designated BLM primitive areas, which are discussed in subsection H(2). The remaining 0.6 million acres were still considered to be segregated from mining in 1975. They are listed in the tables in section C as having been closed to hardrock mineral activity and highly restricted with respect to development of all other minerals in 1975.

The total amount of Federal land under the exclusive jurisdiction of the BLM as of June 30, 1974, excluding Naval Petroleum Reserve No. 4 in Alaska, was 447.3 million acres,[164] of which all but 134.6 million acres of public domain and 2.3 million acres of acquired land[165] have already been discussed or will be discussed in the next sections. These 136.9 million acres are listed in the tables in section C as having been open to mineral activity with slight to moderate restrictions in 1975.

N. State Selections and Private Entries Except for Alaska

The acts granting statehood to former territories have granted to each newly admitted State the right to select a certain amount of public domain for various specific and general purposes. The selected land passes from Federal to State ownership. Upon initial selection, the land is segregated from any other form of disposition under the public land laws, including mining or mineral leasing. Actual title passes when a land patent is issued. Small amounts of Federal land continue to pass into private owmership under the homestead and other public land laws, and entries or applications under those laws also segregate the land from mineral activity. However, pending

[160] Hardrock as well as Leasing Act minerals can be leased on all or almost all national forest acquired land. See Reorganization Plan No. 3 of 1946, § 402, 60 Stat. 1099 (1946).

[161] 78 Stat. 986 (1964).

[162] Bennethum and Lee, note 1, at 42.

[163] Ibid.

[164] *Public Land Statistics*, tables 9 and 10.

[165] The 134.6 million and 2.3 million figures were calculated by subtracting all other acreage figures in the tables in sec. C, except for the homestead acreage (which constituted all but 2.5 million of the acreage reported under Stockraising and Agricultural), from the total Federal public domain and acquired acreage listed in *Public Land Statistics*, table 7. The resulting total figure of 136.9 million acres, plus the 24.3 million acres in BLM roadless areas not designated as primitive or natural discussed in subsec. H(2), is amazingly close (considering the nature of the calculations in this appendix) to the 158.8 million acres listed as vacant (unreserved) BLM land in ibid., table 10.

State selections and entries outside Alaska totaled less than 50,000 acres in 1975,[166] so no entry was made in the tables in section C.

O. Alaska Land Disposal and Classification

The Alaskan land situation is extraordinarily complex. The Federal Government originally owned all of Alaska, having purchased it from Russia in 1867. By the beginning of 1976, when the statistics in this appendix were compiled, approximately 90.6 million acres of public domain and 18,000 acres of acquired land, covered in the preceding sections of this appendix, had been designated for military use (2.4 million acres), Native reservations (O.1 million acres), national parks and monuments (7 million acres), wildlife refuges (22.2 million acres), national forests (20.7 million acres), the Ramparts water powersite (9 million acres), pipeline corridors (5.3 million acres), National Petroleum Reserve No. 4 (23.7 million acres), and surface occupancy for Federal facilities (0.2 million acres).[167] One million acres had passed into private ownership. The remaining 273 million acres, as well as some portions of the existing Federal reserves, were the subject of an extensive land selection process, with around 104.5 million acres scheduled to go to the State under the Alaska Statehood Act and approximately 44.8 million acres scheduled to go to the Natives under the Alaska Native Claims Settlement Act (ANCSA).[168] When selections are completed, the Federal Government will own about 215 million acres, or about 59 percent of the total onshore land in Alaska.

1. Native Selections

At the end of 1975, approximately 80 million acres were withdrawn from availability for mineral activities under the Federal mineral laws as a result of Native selections. Around 44.8 million of these acres will eventually pass into Native ownership. Although this acreage will no longer be available under the Federal mineral laws, it will be available for development or disposal as the Natives see fit. The Native regional corporations will control access to minerals on the 40 million acres conveyed under sections 12, 14, and 16 of ANCSA, and several of them will likely favor development, since they have emphasized mineral potential in making their land selections. In fact, some of them have obtained extensive mineral surveys of land available to them for selection, usually in return for certain development rights in the land eventually selected. Other Native groups will control access to minerals in the 4.8 million acres conveyed under sections 18 and 19, and, since these acres will often encompass culturally significant areas, these groups may be somewhat less favorable to mineral activity.[169]

ANCSA'S mineral revenue distribution scheme may act as a disincentive to development of some mineral deposits. Under the Act, mineral revenues from each region

[166] *Public Land Statistics*, table 10.
[167] See ibid., table 9, and the preceding sections of this appendix.
[168] 43 U.S.C. §§ 1601-1624 (1976).
[169] Office of Technology Assessment, U.S. Congress, *Analysis of Laws Governing Access Across Federal Lands: Options for Access in Alaska* 119-121 (1979).

are shared among all 13 regional corporations, with only 30 percent being retained by the regional corporation whose land is being developed.

Of the 40 million acres of subsurface (mineral) rights to be controlled by the regional corporations, around 3.5 million acres will underlie Federal surface and therefore may be subject to certain restrictions on mineral activity by the Federal surface management agency. The split or severed surface and subsurface ownership results from Native selections of land within the National Wildlife Refuge System and within Naval Petroleum Reserve No. 4. The United States retains the subsurface rights in such land,[170] but the appropriate Native regional corporation is authorized to select in lieu subsurface estate in an equal acreage from other Federal land available for selection in the region, if possible.

Rough data available in early 1976 indicated that Native groups had selected at least 1.9 million acres of surface inside the National Wildlife Refuge System and 1.6 million acres inside Naval Petroleum Reserve No. 4 (NPR4). As a result, the regional corporations have selected at least 3.5 million acres of in lieu subsurface estate underlying federally retained surface outside the refuges and NPR4. ’7’

The severed estate situation could restrict mineral activity with respect to both (a) the Native subsurface estate outside the refuges and NPR4 (if the subsurface underlies Federal surface subject to protective management practices) and (b) the Federal subsurface inside the refuges and NPR4 (if the subsurface underlies Native surface deemed important for subsistence or cultural purposes), However, the Federal subsurface in both the refuges and NPR4 was already closed in 1975 to activities initiated under the Federal mineral laws.

Mineral activity could also be inhibited on some of the almost 16 million acres granted directly (surface and subsurface) to the regional corporations under section 12, since such selections, except from “deficiency” land, are required to be made in a checkerboard (by township) manner. However, the effect on mineral tract assemblage should not be nearly as adverse, in most instances, as the effect of the similar checkerboarding (by section) of Federal and railroad lands in the lower 48 States, since a township contains 36 sections (each section is a square mile) and is therefore large enough to avoid most problems of fragmented ownership.

In summary, the ANCSA Native selection process resulted in around 80 million acres being closed at the end of 1975 to mineral activity initiated under the Federal mineral laws (excepting preexisting rights). However, much of this acreage was available in various degrees for mineral exploration through contracts with the soon-to-be (Native) owners of around 44.8 million of the acres.

Approximately 4.8 million of the 80 million acres were almost certain selections of former Native reserves and individual allotments under sections 18 and 19 of ANCSA.

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[170] Land selected within a national wildlife refuge also remains subject to the laws and regulations governing use and development of such refuge. In effect, the Federal Government retains almost complete control of the surface and subsurface. However, one possible reading (not accepted by the Government) of the relevant sections of ANCSA would allow the Natives to obtain subsurface rights in all land selected by regional corporations and some land selected by village corporations (under subsection 12(b)) in wildlife refuges or Naval Petroleum Reserve No. 4.

[171] Acreage figures and other information presented in this section of the appendix were obtained from the Department of the Interior, unless otherwise noted.

Since the Native villages and individuals will receive title to the subsurface as well as the surface and are expected to be more protective of specific cultural and subsistence values than the regional corporations, the entire 4,8 million acres are listed in the tables in section C as having been moderately restricted with respect to mineral activity in 1975.

The regional corporations will control the subsurface estate in the remaining 40 million acres of eventual Native land, Only about 26 million of these acres were fairly certain at the end of 1975: approximately 17 million acres of village corporation selections and 9 million acres of required (checkerboard) regional corporation selections, These 26 million acres are listed in the tables in section C as having been available for mineral activity subject to slight or moderate restrictions in 1975.

The remaining 14 million acres of subsurface estate to be controlled by the regional corporations will come out of the 49.2 million acres of remaining selections estimated to exist at the end of 1975. Although some private mineral exploration was underway in 1975 on these 49.2 million acres as a result of Native contracts that provided the explorer with funds or future development rights, this acreage is listed in the tables in section C as having been closed to mineral activity in 1975.

The 80 million acres of Native selections included approximately 1 million acres in existing national forest[172] and 2.6 million acres in areas selected by the State of Alaska. The overlap is handled in the tables in section C by reducing the "National forest roadless" and "Alaska State selections" acreages. Although the Natives also selected at least 1.9 million acres in the National Wildlife Refuge System and 1.6 million acres inside Naval Petroleum Reserve No. 4, no reductions were made in the "Fish and wildlife" and "Petroleum and oil shale reserves" acreages reported in the tables in section C, since the Federal Government retains the subsurface estate in those areas and the Natives selected in lieu subsurface estate elsewhere.

2. The National Conservation Systems (d-2 Withdrawals)

Subsection 17(d)(2) of ANCSA directed the Secretary of the Interior to withdraw up to 80 million acres of unreserved public land in Alaska that he deemed suitable for inclusion in the National Park, Forest, Wildlife Refuge, and Wild and Scenic Rivers Systems, The Act required the land to be withdrawn from all forms of appropriation under the public land laws, including the mining and mineral leasing laws, from State selection under the Alaska Statehood Act, and from selection by Native regional corporations, except to the extent the withdrawal overlapped the statutory subsection 11(a) withdrawals for Native selection purposes, in which case Native regional and village corporation selections were allowed, The Secretary withdrew a full 80 million acres.

On December 17, 1973, Secretary Morton recommended that 83.5 million acres be added to the four conservation systems in Alaska. Approximately 65 million of the 83.5 million acres were lands previously withdrawn pursuant to subsection 17(d)(2). The subsection 17(d)(2) withdrawal remained in effect as to such lands until December 18,

[172] *Access Hearings*, note 62, at 77.

1978. The subsection 17(d)(2) withdrawal terminated on December 18, 1973 for the 15 million acres not recommended. The other 18.5 million acres recommended for inclusion were lands that had been previously withdrawn pursuant to subsection 17(d)(1), to be discussed in subsection 3 below. Thus, the net effect of the "d-2" withdrawal at the end of 1975 was 65 million acres closed to mineral activity.

In late 1978, subsequent to the compilation and analysis of the statistics presented in this appendix, major new executive withdrawals and reservations, totaling some 120 million acres, were made in Alaska. Approximately 110 million acres covered by congressional or administration conservation system proposals were withdrawn by the Secretary of the Interior from settlement, sale, entry, location, or selection under the public land laws, including the Mining Laws. Eleven million acres of existing national forest were similarly withdrawn upon application by the Secretary of Agriculture. Subsequently, 56 million of these 120 million acres were reserved as national monuments by President Carter. All of this land was already closed to mineral leasing as a result of the "d-l" withdrawals discussed in subsection 3 below. Thus, the new withdrawals and reservations did not result in any increase in the amount of Federal land withdrawn from availability for development of the fossil fuel and fertilizer minerals. Most of the 120 million acres had also been previously closed to all entries under the Mining Law as a result of the earlier "d-2" or "d-l" withdrawals. According to a rough estimate provided to OTA by BLM's Alaska Native Claims Office, the new withdrawals and reservations resulted in a net increase (over prior withdrawals) of approximately 13 million acres in the amount of Federal land formally closed to hardrock mineral activity.

3. "Public Interest" (d-1) Land

Subsection 17(d)(l) of ANCSA directed the Secretary of the Interior to "review the public lands of Alaska and determine whether any portion of these lands should be withdrawn under authority provided for in existing law to insure that the public interest in these lands is properly protected." The subsection authorizes him "to classify or reclassify any lands so withdrawn and to open such lands to appropriation under the public land laws in accord with his classifications."

During 1972, the Secretary withdrew almost all unreserved public land in Alaska.[173] Most of these so-called "d-l" withdrawals simply backed up other withdrawals, such as the statutory withdrawal for Native selection purposes. Thus, any areas not selected by the Natives or recommended for inclusion in the four conservation systems remain withdrawn under subsection 17[d)(l) despite the termination of the more specific withdrawals. There is no time limit on the d-l withdrawals.

The d-l withdrawals generally permit location of only metalliferous minerals under the Mining Law and do not permit mineral leasing. Some of the "backup" d-l withdrawals, for example those backing up the statutory section 11 withdrawals for Native selection, do not permit any mineral activity. Thus, when the statutory section

[173] Public Land Orders 5169-5188, 37 F.R. 5572-5591 (1972), as amended by, e.g., Public Land Orders 5250-5257 (September 1972) and Public Land Order 5418, 39 F.R. 11547 (1974)

11 withdrawals terminated in 1975, the approximately 30 million acres of unselected land reverted to a backup d-l status that did not permit any mineral activity. These 30 million acres are listed in the tables in section C as having been closed to mineral activity in 1975.

The total d-l acreage in 1975 was calculated by subtracting withdrawals for all other purposes from the total Federal onshore Alaska acreage. The resulting d-l acreage was 71.4 million acres. Subtraction of the 30 million d-l acres backing up prior Native selection withdrawals, discussed immediately above, leaves 41.4 million acres considered to be closed to mineral leasing and subject to moderate or slight restrictions on location under the Mining Law (since they remained available for location of metalliferous minerals, and all but one of the essential locatable minerals discussed in appendix A is metalliferous).

4. State Selections

The Alaska Statehood Act, as amended,[174] provided 102,550,000 acres in general grant selections and 800,000 acres of community expansion and recreation selections as grants of land to the new State. An additional 1.1 million acres of mental health facility and school lands were granted prior to statehood and were confirmed by the Statehood Act. The State also owns an estimated 35 million to 45 million acres of submerged land beneath the surrounding territorial sea.[175]

Prior to ANCSA'S enactment the State had either selected, received tentative approval for patent to, or received patent to about 26 million acres of land under the Statehood Act.[176] One month after the enactment of ANCSA, during the 90-day withdrawal of all unreserved land accomplished by subsection 17(d)(l) of ANCSA, the State made an attempted selection of its remaining entitlement—approximately 77 million acres. The Secretary of the Interior subsequently withdrew much of this acreage under subsection 17(d)(2) for the mandated four conservation systems study. A compromise eventually resulted in the State retaining 42 million acres of its attempted selection and relinquishing 35 million acres, while Interior transferred 14 million acres out of the subsection 17(d)(2) category and replaced them with other acreage. At the end of 1975, the State had selected a total of 70.1 million acres, of which 15.3 million had been patented to the State and another 13.1 million had been tentatively approved for patent,

A limited amount of the 26 million acres selected by the State prior to ANCSA'S enactment was made available for Native selection under paragraphs 1l(a)(2) and 12(a)(l) of ANCSA. It is estimated that 2.6 million of these acres will pass into Native ownership. Therefore, the actual effective total of State selections was 67.5 million acres at the end of 1975. The State's selection of its remaining 37 million acres must await opening of additional desirable land to such selection.

The State has sought to select land with the highest mineral and other resource potential. The State managed to select 68 million acres, or almost two-thirds of its en-

[174] 72 Stat. 339 (1958), as amended, 77 Stat. 223 (1963).
[175] *Public Land Statistics*, table 4.
[176] H.R. Rep. No. 92-581, 92nd Cong., 1st sess. 39 (1971).

titlement, with a minimum of constraint upon its choice. It owns the Prudhoe Bay oil fields in addition to the submerged land, and it is believed to have selected some of the areas with the greatest hardrock mineral potential. It appears that the State will allow, and even encourage, responsible and orderly development of its mineral resources,

Under section 6(g) of the Alaska Statehood Act, the State may execute conditional leases and make conditional sales of tentatively approved land. The State has allowed some conditional leases to be issued Furthermore, although land selected but not tentatively approved is legally closed to mineral development under Federal law, the State is allowing mining claims to be located on such land and then relocated under State law when State title has been obtained.[177] A special land use permit is required for the use of heavy equipment, including heavy mining equipment, on State land.

The 15.3 million acres already patented to the State at the end of 1975 were no longer Federal land and ordinarily should not be included in the accounting of Federal land in this appendix. However, since the published BLM land statistics, which were the basis for the total Federal acreage data used in this appendix, showed only 13 million acres of non-Federal land in Alaska in 1975,[178] of which 1 million acres were privately owned, only 12 million of the 15.3 million State-owned acres were treated as non-Federal; the remaining 3.3 million patented acres were treated as if they were still Federal land subject to tentatively approved State selections. Thus, there were (for our purposes) 55.5 million acres of Federal land subject to State selections that had not yet been patented. Of these selected but unpatented lands, 16.4 million acres had been tentatively approved and 39.1 million acres were unapproved.

All 55.5 million acres of State selected land are listed in tables B.2 and B.3 as having been open with moderate or slight restrictions for location of hardrock minerals under *State* law in 1975. The 16.4 million acres of tentatively approved State selections are listed in table B.1 as having been open to mineral leasing for the fossil fuel and fertilizer minerals under State law, while the 39.1 million acres of selected but unapproved land are listed as having been closed.

11 Alaska Adm. Code § 86.115 (1974).

[178]*Public Land Statistics*, table 7.

Appendix C

Survey of Mineral Industry on Techniques, Parties, Costs, Acreages, and Times For Exploration, Development, and Production of Various Mineral Occurrence Types in the Onshore United States

A. Introduction

During the conduct of the study, it became apparent that consideration of many critical areas of the Federal onshore mineral laws, such as diligence requirements, acreage limits, length of tenure, ability of industry to pay royalties, roles of prospectors and small exploration groups, assessment work, and other areas, could be greatly improved by collection and presentation of basic data on the techniques, parties, costs, acreages, and times involved in exploitation of various types of mineral deposits,

Such basic data were not available in the detail, completeness, and form required for useful analysis. Therefore, with the assistance of the Advisory Committee for this study, the Office of Technology Assessment (OTA) prepared a questionnaire and forms to obtain such data from industry. The questionnaire is reprinted in edited form in section B below. Summary tables for each of the four general categories of mineral occurrence types are presented in section C, followed by the completed forms for each individual mineral occurrence type (the forms are arranged in the same order as the mineral occurrence types in the summary tables).

Each form was filled out by an active mineral explorationist knowledgeable on the particular mineral occurrence type and employed by (or consultant to) one of the larger companies exploring for such occurrences, under the overall direction of the heads of the exploration groups of such companies. The companies involved were AMAX Inc., Anaconda, ASARCO Inc., Homestake Mining Company, Mobil Oil Company, Occidental Minerals Corporation, and Texasgulf Inc. Ray E. Gilbert, a mineral exploration consultant, also contributed data.

The Office of Technology Assessment greatly appreciates the cooperation of these individuals and companies and is particularly appreciative of the efforts of Leo Miller and George Erdosh of Texasgulf Inc., who coordinated the data gathering effort.

The forms were filled out under a very short time constraint and were meant to indicate orders-of-magnitude rather than precise statistics.

B. The Questionnaire
OTA Survey of Mineral Industry on Techniques, Parties, Costs, Acreages, and Times for Exploitation of Various Mineral Occurrence Types on Onshore U.S. Land

The office of Technology Assessment of the U.S. Congress is a research arm of the Congress that is charged with providing accurate and objective information to the Congress in areas designated by chairpersons of congressional committees or by OTA'S bipartisan Congressional Board.

OTA is currently engaged in a study of the Federal onshore mineral and mining laws for use by the Congress, particularly the Senate Committee on Energy and Natural Resources and the House Committee on Interior and Insular Affairs. It is expected that the study will be relied upon heavily by those committees and by officials in the executive branch in formulating and considering various proposed revisions to the Federal onshore mining and mineral leasing laws.

Consideration of many critical areas of the laws, such as diligence requirements, acreage limits, length of tenure, ability of industry to pay royalties, role of prospectors and small exploration groups, assessment work, and other areas, could be greatly improved by collection and presentation of basic data on the techniques, parties, costs, acreages, and times involved in exploitation of various types of mineral deposits. This survey is intended to gather such data.

1. The Forms

Table C. 1 lists the mineral occurrence types for which OTA would like to obtain data. [Table C. I has been moved to section C.] Although data on each type is not necessary, it is hoped that all of the more significant types, such as Marine Sedimentary (Oil and Gas) and Vein and Replacement Deposits [Gold, Silver, Copper. Etc.) will be covered. Complete coverage, of course, would provide the best data source for analysis and use.

The types are divided into four categories which appear to present different sorts of problems in exploitation: surficial, stratabound-extensive. stratabound-discrete, and discordant. A good sample of types from each category is essential to the success of the data gathering effort. General descriptions of each category are:

Surficial—generally unconsolidated and unburied mineral deposits resulting from weathering or deposition during late geologic time;
Stratabound-extensive—large laterally continuous mineral deposits confined to a single stratigraphic unit;
Stratabound-discrete-randomly distributed and/or discontinuous mineral deposits, essentially confined to specific stratigraphic units; and
Discordant-mineral deposits that transect strata and/or are related to intrusive rocks, volcanic activity, etc.

Form 1 is to be used to provide summary statistics for each of the mineral occurrence types listed in table C.1. Form 1 asks for data on the range (minimum. average, maximum) of cost, acreage, and time required by different individuals and companies for different deposits of the same type. Care should be taken to make sure the ranges include the smallest as well as the largest type of operation. If there is a great variation in cost, acreage, or time between larger and smaller participants, the variation and the reason for it should be noted (e.g., in the Additional Comments column). Only data for onshore mineral exploitation in the United States or similar areas (e.g., Canada) should be used. If no U.S. data is available, foreign data can be used to estimate what the costs, acreages, and times would be in the United States. (Indicate on form, in Additional Comments column, that foreign data was used as basis for estimate.)

The data used for form 1 should include data on failures as well as successes in exploration, development, and production. This should be fairly easy to do since the form is broken down into four exploration stages in addition to development and production, and it is also broken down for each stage into the techniques used. Thus, data can be listed by technique in each stage, whether the technique was successful or not in a particular case, so that a larger sample of data is used which more accurately reflects the overall aggregate costs of a mineral exploitation program or project. (Note that separate listing of the data for successes and failures is not requested; it is merely desired that all available data be used to estimate the range of costs, acreages, and times for a particular technique or stage of exploitation.)

Preferably, the ranges should be for mineral exploitation on Federal land in the Western United States exclusive of Alaska. The Additional Comments column should be used to indicate any substantial variations from this range for areas such as Alaska or the Midwest (if appropriate, simply give percentage increase or decrease). If data is only available for an area other than the Western United States, either estimate the data for occurrences in the Western United States from similar deposits elsewhere or give the data for the other deposits—in either case, explain in the Additional Comments column.

2. Detailed Instructions

OTA form 1 is merely an expansion of the mineral exploitation activities, methods, costs, and times tables prepared by Paul Bailly of Occidental Minerals Corporation for various conferences and workshops. An example of one of Bailly's tables, listing 10 different ventures, is attached to this questionnaire [the table has been moved to section C], and it should indicate the distinctions between the two stages of Target identification and the two stages of Target Investigation on form 1. Form 1 also includes the development and production stages, which have their traditional meaning. The Bailly example also illustrates the sorts of techniques (activities or methods) that should be listed and the use of O, F, or L to indicate whether the technique is an Office, Field, or Laboratory method or activity. It is not necessary to list land acquisition as a separate activity on Form I; however, if land acquisition costs are included, they should be listed separately from all other costs in the appropriate stage.

Explanations and instructions for each column heading on Form 1 are presented immediately below. Form 1 usually calls for minimum, average, and maximum figures.

Main Activities and Methods: see Bailly example.

0.F. or L: Office, Field, or Laboratory—see Bailly example.

1.S. M, or L: Individual prospector or explorationist, Small firm or group of individuals, Medium-sized firm, or Large firm. For Form 1, give percentage which each group (I, S, M, or L) makes up of those performing each activity (or participating at each stage) of the exploitation of the mineral occurrence type. Do not count, e.g., an individual as an I participant if he or she is funded by an S, M, or L participant. Arbitrary definitions of I, S, M, and L are: I—no more than 2 people working together spending less than $10,000 per year on mineral exploitation; S— no more than 50 people working together spending less than $250,000 per year; M—expenditures of less than $2,500,000 per year; L—expenditures of $2,500,000 or more per year. **[Note:** Some respondents, instead of listing quantitative percentages of participation, used an "X" to indicate participation by one or more of the four categories of participants.]

Direct Cost; Cost exclusive of land acquisition cost, taxes, etc., which however can be listed separately from all direct costs. Costs should be reported in 1977 dollars (i.e., past costs should be adjusted to current equivalent 1977 figures). Overhead should be reported, but separately from direct costs as either a dollar figure or a percentage of direct costs.

Area Being Investigated, Area Covered: Area in square miles covered by activity or to which technique is applied, which is usually distinct from:

Area Under Cluim, Option, Lease, Etc: Area in acres for which exploitation rights were acquired or optioned prior to activity or use of technique.

Duration of Each Stage: Divided into three categories, each reported in months:

Without Any Delays: Time in months required for activity or method in the absence of any delays due to economics, regulatory restrictions, etc. Includes time lost due to normal climatic change in seasons, although any very significant climatic or seasonal loss in time common in a particular geographic region (e.g. Alaska) should be noted in the Additional Comments column, Also includes any normal delay due to company's inability to fund all possible projects simultaneously,

Delays Due to Economics, Technology (Nonregulatory): Delays in addition to normal delays occasioned by, e.g., drop in metal prices, too low an ore grade, lack of technological development (rather than normal wait for delivery or manufacture of on-the-shelf technology),

Delays Due Solely to Regulation; Delays in addition to normal and nonregulatory delays which do not overlap such delays and are caused by governmental orders, restrictions, or refusals to act (e.g., on permit application).

Additional Comments: Any additional comments. Should be used to describe significant variations in costs, times, or acreages resulting from geographic location (e. g., Alaska) or size of participant (e.g., individual prospector versus large firm),

C. Tables and Forms

The following pages contain: (1) the Bailly table and the table of illustrative mineral occurence types that were attached to the questionnaire, (2) summary tables, one for each of the four general categories of mineral occurrence types, and (3) the completed forms, one for each individual mineral occurrence type. The completed forms, including comments, have not been edited by OTA beyond regrouping of numbers where appropriate.

Main Activities and Methods During the Four Stages of Exploration for Ten Successful Ventures Previous to a Decision that a Profitable Surface Mine Can Be Opened

Exploration Stages	VENTURE #1 Search for a New Porphyry Copper Ore Deposit in Southwest U.S.A.	VENTURE #2 Search for Blind Stratiform Lead-Zinc Deposit in Carbonate Formations	VENTURE #3 Search for Massive Sulfide Deposit with Base-Precious Metal Values in Canadian Precambrian Shield	VENTURE #4 Search for a New Iron Deposit in Precambrian Shield	VENTURE #5 Search for a New Placer Gold-Tin Deposit in Alaska
REGIONAL APPRAISAL (Stage #1)	O-Geologic Compilation* O-Photogeologic study (rock units and structure) O-Structural analysis* F-Field inspection of area selected from air and/or on ground*	O-Geologic Compilation* O-Paleogeologic and Paleogeographic reconstitutions	O-Geologic Compilation* O-Photogeologic study (rock units, contacts and structures)	Geologic compilation*	O-Geologic Compilation* O-Photogeologic study (geomorphology)
RECONNAISSANCE (Stage #2)	F-Reconnaissance geologic mapping of outcrops* F-Stream Sediment geochemical surveys F-Aeromagnetic survey F-Gravity survey in gravel-covered areas F-Reconnaissance Induced Polarization survey of covered areas	Reconnaissance drilling for stratigraphic and facies data* Photogeologic study Stream Sediment geochemical surveys Mercury Sniffer Surveys	Airborne Electromagnetic Survey* (with or without aeromagnetic) Stream Sediment geochemical survey Field inspection of anomalous areas	F-Aeromagnetic Survey F-Photogeology (formation structure) F-Reconnaissance (formational mapping)*	Reconnaissance panning* Reconnaissance drilling and sampling (physical separation of heavy minerals)
[illegible] SURFACE INVESTIGATION OF TARGET AREA (Stage #3)	F-Detailed geologic structural-alteration mapping of outcrops L-Petrographic-mineralogy-trace element study of rock samples F-Detailed Induced Polarization Survey of anomalous covered areas		F-Mapping of outcrops if any* F-Detailed helicopter-borne or ground electromagnetic (and magnetic) survey* or detailed Induced Polarization Survey F-Detailed stream sediment and/or soil geochemical survey	F-Detailed mapping F-Detailed ground magnetic surveys*	F-Detailed magnetic survey
DETAILED THREE DIMENSIONAL PHYSICAL SAMPLING OF TARGET AREA (Stage #4)	F-Drilling* - Logging* L-Mineralogical, Chemical analyses and physical tests on samples (cores and cuttings)* F-Down-hole geophysical surveys L-Amenability tests on ore-grade mineralization O-Reserves computations* O-Preliminary Valuation* F-Investigation of water problems and water availability for plants* F-Investigation of suitability of ground for plant, tailings, dump and town sites F-Shaft sinking or tunneling to obtain bulk samples L-Ore dressing bulk tests	as for Venture #1	Same as for Venture #1	Same as for Venture #1	Same as for Venture #1 excluding down-hole geophysics and tunneling

Exploration Stages	VENTURE #6 Search for a New Phosphate Deposit in Southeastern Coastal U.S.A.	VENTURE #7 Search for a New Uranium Deposit in Clastic Formation of Western U.S.A.	VENTURE #8 Search for a New Coal Deposit in Western U.S.A.	VENTURE #9 Search for a New Cement-Grade Limestone Deposit in U.S.A.	VENTURE #10 Search for a New Gravel Deposit Near Urban Center in U.S.A.
REGIONAL APPRAISAL (Stage #1)	Geologic compilation* Study of water well cuttings Photogeologic study (Formation mapping) Geologic field check along road cuts if any	O-Geologic compilation* O-Photogeologic study (formation mapping paleogeography structure)*	O-Geologic compilation marketing area*	O-Geologic compilation for marketing area* O-Photogeology	None
RECONNAISSANCE (Stage #2)	Airborne Radiometric Survey Reconnaissance drilling for stratigraphy* Chemical analyses of drill samples and ore dressing tests on high grade samples*	F-Airborne Radiometric Survey* F-Reconnaissance mapping of formations facies* F-Drilling for stratigraphy and facies information	F-Field check of sections containing coal seams* F-Reconnaissance drilling for stratigraphy and coal thickness F-Chemical and calorific check of outcrops or drill samples (not badly burned)	Examination of outcrops and sampling* Reconnaissance drilling for stratigraphy and chemical analyses of all limestone samples*	O-Compilation of geologic information for suburban area* F-Reconnaissance auger drilling and testing of gravel
[illegible] SURFACE INVESTIGATION OF TARGET AREA (Stage #3)	F-Detailed radiometric ground survey F-Detailed mapping of outcrops if any*	F-Detailed radiometric ground survey F-Detailed mapping of outcrops			
DETAILED THREE DIMENSIONAL PHYSICAL SAMPLING OF TARGET AREA (Stage #4)	Same as for Venture #1	Same as for Venture #1	as for Venture #1	Same as for Venture #1 excluding down-hole geophysics	Same as for Venture #1 excluding down-hole geophysics and tunneling

At the end of each stage all results are integrated and area of interest redefined
Legend: O = Office study. F = Field investigation. L = Laboratory tests
* = activity of method which is indispensable

Source: Bailly, "Exploration Methods and Requirements," Table 2.1, in American Institute of Mining Engineers, *Surface Mining*, Ch. 2 (1968)

Table C.1 Illustrative Mineral Occurrence Types

SURFICIAL		NONSURFICIAL					
		STRATABOUND-EXTENSIVE		STRATABOUND-DISCRETE		DISCORDANT	
Geologic Environment	Typical Ores	Geologic Enironment	Typical Ores	Geologic Environment	Typical Ores	Geologic Environment	Typical Ores
Aluminous Clays and Latenites	"Bauxite, Kaolinite	Bedded Precambrian	"Iron, Copper, Gold	Marine Sedimentary	'011 and Gas, Bromine, Bante	Breccia Pipes	"Uranium, Molybdenum, Copper, Gold, Diamond
Latentes	"Nickel (Cobalt)	Marine Sedimentary	" Phosphate, Iron, 011 Shale, Manganese	Continental Sedimentary (Sandstones and Fossil Placers)	" Uranium (Vanadium), Gold, Titanium	Porphyries	"Copper-Molybdenum, Gold, Tin
Stream Placers	Gold, Silver, Platinum Tin, Rare Earths, Iron, Gem Stones	Marine Evaporite	" Potassium " Sodium "Sulfur, " Gypsum, Lithium, Mangesium	Lacustrine Evaporites	" Gypsum, " Trona, " Boron	Pegmatites	Lithium, Fluorine, Beryllium, Rare Earths, Mica, Feldspar, Columbium, Tantalum
Coastal Placers	Titanium, Zirconium, Chromium, Rare Earths, Gem Stones	Continental Sedimentary	"Coal, 011 Shale, " Boron, Sodium	Fossil Laterites	Bauxite	Veinn and Replacement Deposits	"Gold, "Silver, Copper, Alunite, Mercury, Lead, Zinc, Bante, Fluorine, Tungsten, Molybdenum, Uraium. Iron, Graphite, Gem Stones, Native Sulfur, Gilsonite
Residual Deposits	Bante, Iron, Manganese, Titanium, Phosphate, Columbium, Vermiculite	Continental Volcanic	Bentonite	Young Tuffs and Related Sedimentary	Beryllium, Mercury, Fluorite, Native Sulfur	Massive Sulfide Pipes	Copper-Lead-Zinc-Silver (Gold, Pyrite)
Brines in Evaporites	"sodium, " Potassium, "Magnesium, " Boron, Lithium. Tungsten	Stratiform Igneous Complexes	" Iron Chromium Platinum Group Metals Vanadium	Shale Hosted Massive Sulfides	'Copper-Lead-Zinc-Silver	Rhyolitic Volcanic	"Tin, Tungsten, Bismuth
Supergene Enrichment	Copper, Silver, Lead, Zinc, Gold, Manganese			Carbonate Stratiform	"Zinc-Lead-Bante-Fluorine (Copper, Cobalt)	Mafic and Ultra mafic Intrusive	Nickel-Copper, Olivine
				Volcanogenic Massive Sulfides	"Copper-Lead-Zinc-Silver (Gold, Pyrite, Bante)	Podiform Ultramafic	Chromium, Copper, Iron, Nickel, Asbestos
				Metamorphic	Garnet, Kyanite, Graphite	Anorthosite Complexes	Titanium, Iron, Vanadium
						Veins in Ultramatic	Asbestos, Talc
						Veins in Meta-morphosed Dolomites	Talc
						Salt Domes	"Sulfur
						Carbonate and Alkalic Complexes	Phosphate, Rare Earths, Iron, Titanium Columbium Copper

*Described in Ad Hoc Geological Committee on Remote Sensing from Space, *Geological Remote Sensing from Space* (1977)

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Table C.2 Summary Mineral Exploitation Statistics for Surficial Mineral Occurrence Types

	Main Activities and Methods, In Chronological Sequence	U, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1 Aluminous clays and laterites-kaolinite and bauxite		5	5	15	75	85	200	590	25%	1K	10K	100K	=	—	—	6	10	18	2	4	12	0	6	—	
	2 Laterites-nickel		—	—	—	X	10	19.5	26	15%	2K	6K	30K		—	—	1.5	2.5	3.5	—	—	—	—	—	—	
	3 Stream Placers-gold, silver, tin		X	X	X	—	—	3	15	Incl.	—	—	—	—	—	—	1	—	3	—	—	—	—	—	—	
	4 Coastal Placers-titanium		0	33	33	34	15	20	25	5%	1K	8K	10K	—	—	—	—	10	—	—	8	—	0	0	0	
	5 Residual deposits-phosphate		0	10	30	60	10	16	30	4	10K	100K	1000K		—	—	4	6	8	—	—	—	—	—	—	
	6 Brines in evaporites		—	—	—	—	2	6	12	3	10K	100K	1000K	=	—	—	1	3	6	—	—	—	—	—	—	
	7 Supergene enrichment-copper, silver, etc		9	9	32	50	4	12	20	4	1	100	1K	—	—	—	4	8	15	4	4	4	1	1	1	
	8 Supergene enrichment-silver		—	—	—	X	—	35	—	15	—	1K	—	—	—	—	—	12	—	—	—	—	—	—	—	
	Total																									
Stage 2: Detailed Reconnaissance	1 Aluminous clays and laterites-kaolinite and bauxite		5	10	25	60	60	250	1020	27%	10	40	100	—	—	—	6	15	40	0	2	12	0	6	—	
	2 Laterites-nickel		—	—	—	X	10	30	35	15%	100	300	500	—	—	—	1	2	2.5	—	—	—	—	—	—	
	3 Stream Placers-gold, silver, tin		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	4 Coastal Placers-titanium		10	30	30	30	—	10	—	5%	—	1K	—		—	—	—	10	—	—	8	—	—	0	—	
	5 Residual deposits-phosphate		0	10	30	60	50	80	145	15	100	1K	10K		4K	10K	7	10	20	—	—	—	0	1	5	
	6 Brines in evaporites		—	—	—	—	8	21	48	8	4	20	1K	—	—	—	2	7	18	—	—	—	—	—	—	
	7 Supergene enrichment-copper, silver, etc		2	8	25	65	32	108	200	26	1	5	50	—	2K	10K	7	15	33	5	5	5	0	1	2	
	8 Supergene enrichment-silver		—	—	—	X	—	60	—	25	—	3	—		1K	—	—	12	—	—	—	—	—	—	—	
	Total																									
Stage 3: Detailed Surface Investigation of Target Area	1 Aluminous clays and laterites-kaolinite and bauxite		5	5	5	85	80	160	360	15%	6	12	40	3.8K	7.7K	25.6K	6	12	36	0	2	6	4	18	—	
	2 Laterites-nickel		—	—	—	X	16	28	39	15%	5	7	15	2K	3K	6K	2.3	4.5	6.8	—	—	—	—	—	—	
	3 Stream Placers-gold, silver, tin		X	X	X	—	14	—	42		1	—	10													
	4 Coastal Placers-titanium		20	20	30	30	2	12	30	5%	1	10	25	640	6.4K	16K	8	24	40	5	—	8	2	3	4	
	5 Residual deposits-phosphate		0	10	30	60	35	90	140	18	3	5	12	600	1K	8K	2	5	12	—	—	—	0	1	3	
	6 Brines in evaporites		—	—	—	—	5	25	50	6	4	12	100	1.2K	7.6K	60K	2	5	14	—	—	—	0	6	60	
	7 Supergene enrichment-copper, silver, etc		0	8	30	62	60	125	300	45	1	3	10	100	1K	10K	5	15	22	1	5	12	1	3	6	
	8 Supergene enrichment-silver		—	—	—	X	—	110	—	30	—	3			1K			12								

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Table C.2 (Cont'd)

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	1. Aluminous clays and laterites-kaolinite and bauxite		1	4	20	75	1.7K	5.7K	12.3K	20%	3	6	20	1920	3.8K	12.8K	24	36	60	3	12	30	5	14	20	
	2. Laterites-nickel		—	—	—	X	4542	8081	14262	15%	1	2	2.5	2K	3K	6K	24	36	48	18	24	36	24	36	48	
	3. Stream Placers-gold, silver, tin		—	X	X	—	120	—	1000		1	—	10													
	4. Coastal Placers-titanium		0	0	50	50	49	345	1662	5%	1	5	10	640	6.4K	16K	12	24	50	1	2	5	4	6	24	
	5. Residual deposits-phosphate		0	0	35	65	100	200	460	36	3	5	12	600	1K	8K	6	12	36	3	6	10	1	6	20	
	6. Brines in evaporites		—	—	—	—	55	340	1.2K	36	4	12	100	1200	7.6K	60K	9	24	42	—	—	—	0	6	60	
	7. Supergene enrichment-copper, silver, etc.		0	0	12	88	750	3500	6300	1200	1	3	10	1K	5K	10K	27	54	186	8	42	192	5	30	72	
	8. Supergene enrichment-silver		—	—	—	X	—	1000	—	250	—	2	—	—	2K	—	—	18	—	—	6	—	—	2	—	
	Total																									
Stage 5: Development	1. Aluminous clays and laterites-kaolinite and bauxite		1	2	5	92	75K	280K	361K	10%	1	2	6	1.9K	3.8K	12.8K	36	48	60	6	12	24	12	36	—	
	2. Laterites-nickel		—	—	—	X	23K	30K	35K	20%	0.5	1	1.5	2K	3K	6K	38	48	63	—	—	—	12	18	24	
	3. Stream Placers-gold, silver, tin		—	X	X	—	—	10K	50K																	
	4. Coastal Placers-titanium		0	0	50	50	—	—	—	—	5	10	15	3.2K	6.5K	10K	—	—	—	—	—	—	—	—	—	
	5. Residual deposits-phosphate		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6. Brines in evaporites		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	7. Supergene enrichment-copper, silver, etc.		0	0	5	95	5135	81K	502K	1290	1	2	10	1K	5K	10K	48	75	156	42	66	144	48	78	108	
	8. Supergene enrichment-silver		—	—	—	X	—	3600	—	900	—	2	—	—	2K	—	—	36	—	—	—	—	—	—	—	
	Total																									
Stage 6: Production	1. Aluminous clays and laterites-kaolinite and bauxite		1	2	5	92	—	—	—	—	—	—	—	1.9K	3.8K	12.8K	—	—	—	—	—	—	—	—	—	
	2. Laterites-nickel		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	3. Stream Placers-gold, silver, tin		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	4. Coastal Placers-titanium		0	0	50	50					5	10	15	3.2K	6.4K	10K										
	5. Residual deposits-phosphate		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6. Brines in evaporites		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	7. Supergene enrichment-copper, silver, etc.		0	0	5	95	—	—	—	—	1	2	10	1K	5K	10K	—	—	—	—	—	—	—	—	—	
	8. Supergene enrichment-silver		—	—	—	X	—	—	—	—	—	2	—	—	2K	—	—	—	—	—	—	—	—	—	—	
	Total																									

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Table C.3 Summary Mineral Exploitation Statistics for Stratabound Extensive Mineral Occurrence Types

	Main Activities and Methods, In Chronological Sequence	O. F. or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Regional Appraisal	1 gold-uranium-base metal		3	20	35	42	1	9	45	1	5	1K	300K	—	—	—	0 2	2	10	0 8	3 5	6	0	C	0	
	2 Marine sedimentary-phosphate		0	10	40	50	2	6	12	3	10K	100K	1000K	—	—	—	-1	3	6	=	—	—	=	—	=	
	3 Marine evaporite-potash		15	25	30	30	5	10	20	15%	1K	1000K	1000K	—	—	—		—	—		—	—		—		
	4 Continental sedimentary-coal		12	20	33	35	3	10	14	15%	100	140	200	—	—		3	8	10	—	—	—	—	—	—	
	5 Stratiform igneous complex		—	—	—	X	53	153	362	195	500	40K	100K	—	—	—	6	18	42	—	—	—	—	—	—	
Stage 2: Detailed Reconnaissance	1 Bedded Precambrian gold-uranium-base metal		1	20	35	44	1	30	180	3	5	40	500	—	—	—	0 2	2	24	0	0 5		0	0	0	
	2 Marine sedimentary-phosphate		0	10	40	50	8	21	48	8	500	2K	10K	—	—	—	2	6	14	—	—	—	—	—	—	
	3 Marine evaporite-potash		15	25	30	30	3	6	8	15%	200	4K	8K	—	—	—	—	—	—	—	—	—	—	—	—	
	4 Continental sedimentary-coal		20	23	28	29	3	9	12	15%	50	0	140	—	—	—	2	6	8	—	—	—	—	—	—	
	5 Stratiform igneous complex		—	—	—	X	319	607	1075	372	—	—	—	10K	20K	50K	12	27	90	—	—	—	—	—	—	
Detailed Surface Investigation of Target Area	1 gold-uranium-base metal		0	20	35	45	15	110	430	12	0 3	2	7	200	1K	4K	1	7	20		1	1	0	4	12	
	2 Marine sedimentary-phosphate		0	5	10	85	3	9	24	3	4	62	200	2 5K	7 6K	13K	2	5	14		—	—	0	4	100	
	3 Marine evaporite-potash		15	20	35	35	0	0	0	0	200	5 0	800	1K	8K	15K	6	12	18	8	16	20	36	60	?	
	4 Continental sedimentary-coal		0	10	45	45	20	160	275	15%	25	5	70	640	1K	5K	6	12	18	—	—	—	3	4	6	
	5 Stratiform igneous complex		—	—	—	X	1172	2355	5744	1005	10	20	50	10K	15K	25K	16	24	48	1	6	12	1	3	6	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	1 Bedded Precambrian gold-uranium-base metal		0	10	40	50	285	1800	7400	180	0 3	2	7	200	1K	4K	16	50	78	7	19	35	12	24	72	
	2 Marine sedimentary-phosphate		0	0	40	60	260	1191	4295	55	4	12	200	2 5K	7 6K	13K	12	30	60	—	—	—	0	24	100	
	3 Marine evaporite-potash		2	10	38	50	420	840	1010	15%	200	500	800	1K	8K	15K	12	18	24	18	24	30	24	36	42	
	4 Continental sedimentary-coal		0	10	45	45	25	40	60	15%	—	—	—	5K	10K	25K	6	12	24							
	5 Stratiform igneous complex		—	—	—	X	2810	4735	7654	1435	4	10	20	2560	6 4K	13K	24	36	48	3	9	18	3	3	18+	

Sheet 2 of 2

Table C.3 (Cont'd)

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to eg			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	1 Bedded Precambrian-gold-uranium-base metal				—	—	—	—	—	—	—		—	—	—	—		—	—	—	—	—	—	—	—	
	2 Marine sedimentary-phosphate		100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	3 Marine evaporite-potash																									
	(a) conventional mine			4	46	46	72K	85K	106K	15%	10	30	5C	1K	8K	15K	18	30	42	15	24	30	21	27	33	
	(b) solution mine			C	30	70	95K	121K	185K	15%	10	30	5C	5K	8K	15K	18	20	24	20	22	26	26	28	36	
	4 Continental sedimentary-coal			1C	45	45	22K	59K	86K	15%	—	—	—	5K	10K	25K	12	24	36	11	20	30	6	10	24	
	5 Stratiform igneous complex		°	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Stage 6: Production																										

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Table C.4 Summary Mineral Exploitation Statistics for Stratabound Discrete Mineral Occurrence Types

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1 Marine sedimentary oil and gas		—	—	—		110	350	600	20	1K	5K	40K	—	—	—	1	6	12	—	—	—	—	—	—	
	2 Continental sedimentary uranium		—	—	X	—	75	125	250	25	4K	6K	10K	—	—	—	6	15	24	1	2	3	—	—	—	
	3 Lacustrine evaporite		0	10	30	60	2	6	12	3	10K	100K	1000K	—	—	—	1	3	6	—	—	—	—	—	—	
	4 Fossil laterite		2	3	15	80	100	286	680	20%	1K	20K	100K	—	—	—	12	21	62	4	14	30	2	10	12	
	5 Shale Hosted massive sulfide-copper		0	10	30	60	2 5	8	15	10%	2K	15K	25K	—	—	—	1 5	3 5	7	—	—	—	—	—	—	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	—	—	X	15	29	51	15%	4K	12K	30K	—	—	—	1 75	3 5	7	—	—	—	—	—	—	
	7 Carb Strat-Ba, F		8	17	28	47	9	18	28	15%	7 5K	10K	15K	—	—	—	7	10	14	—	—	—	—	—	—	
	8 Carb Strat-Pb-Zn-Cu		6	14	30	50	9	18	28	15%	7 5K	10K	15K	—	—	—	7	10	14	—	—	—	—	—	—	
	9 Volc Mass Sulfide		0	30	30	40	40	95	150	14	10K	100K	1000K	—	—	—	6	14	28	—	—	—	—	—	—	
	10 Metamorphic		0	50	40	10	7	20	35	3	1K	10K	50K	—	—	—	2	5	8	—	—	—	—	—	—	
Stage 2: Detailed Reconnaissance	1 Marine sedimentary oil and gas		—	—	—	—	1300	6 5K	22K	—	1K	5K	40K	—	—	—	12	36	60	1	2	6	0	2	6	
	2 Continental sedimentary uranium		—	—	X	—	150	400	700	80	2K	4K	6K	-	—	—	9	15	30	1	3	5	1	3	5	
	3 Lacustrine evaporite		—	10	30	60	8	21	48	8	4	20	1K	—	—	—	2	6	14	—	—	—	—	—	—	
	4 Fossil laterite		5	10	25	60	50	230	980	27%	10	40	100	—	—	—	6	15	40	0	12	12	0	6	0	
	5 Shale Hosted massive sulfide-copper		0	10	30	60	12 5	81	137	10%	2K	15K	25K	—	—	—	2	10	15	—	—	—	—	—	—	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	—	X	X	60	122	244	15%	2K	3K	8K	—	—	—	2 5	5 5	12	—	—	—	—	—	—	
	7 Carb Strat-Ba, F		8	17	31	44	11	18	19	15%	100	200	400	—	—	—	1	3	3	—	—	—	—	—	—	
	8 Carb Strat-Pb-Zn-Cu		7	14	25	55	112	369	781	15%	100	200	400	200	300	500	3	6	13	0	6	12	4	18	32	
	9 Volc Mass Sulfide		0	30	30	40	25	65	130	13	100	200	400	—	—	—	4	8	15	—	—	—	—	—	—	
	10 Metamorphic		0	50	40	10	10	20	40	4	500	2K	5K	—	—	—	2	4	5	—	—	—	0	1	3	
Stage 3: Detailed Surface Investigation of Target Area	1 Marine sedimentary-oil and gas		—	—	—	—	600	1100	1800	—	—	—	—	50K	200K	1 5M	12	24	60	1	2	6	—	—	—	
	2 Continental sedimentary uranium		—	—	X	—	175	475	850	95	8	30	150	5K	20K	100K	6	12	24	1	3	5	1	2	3	
	3 Lacustrine evaporite		0	5	30	65	5	25	50	6	4	12	100	1 2K	7 6K	60K	2	5	14	—	—	—	0	6	60	
	4 Fossil laterite		5	5	15	75	80	160	360	15%	6	12	40	3 8K	7 7K	26K	6	12	36	0	2	6	4	12	0	
	5 Shale Hosted massive sulfide-copper		0	10	30	60	9	20	72	10%	—	—	—	100	1K	10K	1	2	4	—	—	—	—	—	—	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	—	X	X	40	59	101	15%	10	15	40	6K	8K	12K	3 5	6	9	—	—	—	—	—	—	
	7 Carb Strat-Ba, F		9	25	33	33	20	75	140	15%	5	9	17	2K	2K	4K	4	10	12	1	2	2	2	6	12	
	8 Carb Strat-Pb-Zn-Cu		4	14	40	42	17	46	75	15%	5	10	20	2K	7K	12K	12	12	12	—	—	—	—	—	—	
	9 Volc Mass Sulfide		0	30	30	40	25	50	95	10	10	25	60	1 5K	4K	10K	5	12	25	—	—	—	0	8	16	
	10 Metamorphic		0	50	40	10	21	37	58	7	3	5	15	500	1K	5K	3	5	10	—	—	—	0	1	5	

Sheet 2 of 2

Table C.4 (Cont'd)

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min		Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	1 Marine sedimentary-oil and gas		—	—	—	—	1K	5K	20K	50	10	50	200	1.6K	24K	128K	1	3	6	—	—	—	—	—	—	
	2 Continental sedimentary-uranium		—	—	X	—	700	2K	4.4K	330	2	4	8	5K	20K	100K	30	45	72	3	6	12	10	20	50	
	3 Lacustrine evaporite		0	0	30	70	55	340	1.2K	36	4	12	100	1.2K	7.6K	60K	9	36	60	—	—	—	0	6	60	
	4 Fossil laterite		1	4	20	75	1.7K	5.7K	12.3K	20%	3	9	40	1.9K	3.8K	12.8K	24	36	60	3	12	30	5	14	20	
	5 Shale Hosted massive sulfide-copper		0	5	20	75	24	231	668	10%	—	—	—	100	1K	10K	6	17	40	—	—	—	2	9	18	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	—	X	X	10.7K	14K	24.8K	15%	1	2	2.5	4K	7K	9K	36	60	100	24	36	60	24	36	48	
	7 Carb. Strat.-Ba, F		4	20	37	39	530	980	1550	15%	3	5	10	500	1K	4K	6	12	24	2	4	6	6	12	24	
	8 Carb. Strat.-Pb-Zn-Cu		0	13	42	45	3K	13.9K	30K	15%	3	7	15	1.9K	4.5K	9.6K	21	29	160	9	36	60	12	12	24	
	9 Volc. Mass. Sulfide		0	10	35	55	137	275	523	38	2	5	10	1K	4K	10K	8	15	36	—	—	—	0	6	24	
	10 Metamorphic		0	50	40	10	45	105	203	15	1	2	4	300	500	5K	6	12	30	—	—	—	0	4	12	
Stage 5: Development	1 Marine sedimentary-oil and gas		—	—	—	—	555	5.3K	31K	67	4	15	50	1.3K	4.5K	16K	4	14	39	5	6	9	0		2	
	2 Continental sedimentary-uranium		—	—	X	—	—	60K	—	—	2	4	8	5K	20K	100K	—	—	—	—	—	—	—	—	—	
	3 Lacustrine evaporite		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	4 Fossil laterite		1	2	5	92	75K	280K	361K	10%	1	2	6	1.9K	3.8K	12.8K	9	14	20	3	5	10	6	17	—	
	5 Shale Hosted massive sulfide-copper		0	0	20	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	—	—	X	95K	120K	145K	20%	0.25	0.5	0.75	4K	7K	9K	18	24	30	—	—	—	12	18	24	
	7 Carb. Strat.-Ba, F		2	22	38	38	362	4658	8510	15%	1	2	6	500	1K	4K	18	36	90	4	7	12	6	18	48	
	8 Carb. Strat.-Pb-Zn-Cu		0	14	43	43	2002	5010	7020	15%	3	7	15	1.9K	4.5K	9.6K	12	24	36	24	30	40	12	20	36	
	9 Volc. Mass. Sulfide		0	0	30	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	10 Metamorphic		0	30	50	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Stage 6: Production	1 Marine sedimentary-oil and gas		—		—	—	—	—	—	—	2	7	25	1.3K	4.5K	16K	—	—		—	—	—	—		—	
	2 Continental sedimentary-uranium		1	—	X	—	—	:	1	≡	2	4	8	5K	20K	100K	—	—	—	—	—	—	—	=	—	
	3 Lacustrine evaporite		1		—	—	—	1	1		—	—	—	—	—	—	—	—	—	—	—	—	—		—	
	4 Fossil laterite		.	IN	5	92	—	1	1		—	—	—	1.9K	3.8K	12.8K	—	—	—	—	—	—	—		—	
	5 Shale Hosted massive sulfide-Copper			°	20	80	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6 Shale Hosted massive sulfide-Pb-Zn-Ag		—	1	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	
	7 Carb. Strat.-Ba, F		o	:	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	
	8 Carb. Strat.-Pb-Zn-Cu		—	1	45	45	—	1	1	1	:	7	15	1.9K	4.5K	9.6K	120	300	200	—	—	—	—	1	—	
	9 Volc. Mass. Sulfide		—	1	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	
	10 Metamorphic		—	1	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	

of 2

Table C.5 Summary Mineral Exploitation Statis Discordant Mineral Occurrence Types

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1 Breccia pipes		—	X	X	X	14	—	76	—	—	000K	—	—	—	—	—	—	—	—	—	—	—	—	—	
	2 Porphyry copper		—	—	—	X	16	101	191	143	2K	7K	20K	—	—	—	7	16	34	—	—	—	—	—	—	
	3 Biogenic sulfur		0	10	30	60	2	6	12	3	10K	100K	1000K	—	—	—	1	3	6	—	—	—	—	—	—	
	4 Vein-replacement		25	25	25	25	6	14	55	5%	1	10	20	—	—	—	6	12	60	—	—	—	—	—	—	
	5 Mass. sulf. pipes-Base & Precious metals		5	10	30	55	3 7	38	635	25%	100	2K	100K	—	—	—	0 5	1 5	18	0 01	1	6	0	0 2	4	
	6 Mafic-ultramafic		0	20	40	40	2	6	12	3	10K	100K	1000K	—	—	—	1	3	6	—	—	—	—	—	—	
	7 Anorthosite complexes		0	20	30	50	1	2	3	1	10K	100K	1000K	—	—	—	1	2	3	—	—	—	—	—	—	
	8 Vein-ultramafic		0	5	10	85	4	20	155	25%	100	10K	25K	—	—	—	1	5	22	0	4	8	0	1	2	
	9 Vein-dolomite		40	40	20	0	3	10	19	10%	100	500	1K	—	—	—	1 5	4	8	—	—	—	—	—	—	
	10 Carbonatite-alkalic		0	20	40	40	4	7	15	1	10K	20K	50K	—	—	—	3	5	9	—	—	—	—	—	—	
Stage 2: Detailed Reconnaissance	1 Breccia pipes		—	X	X	X	5	—	30	—	100	—	1K	—	—	—	—	—	—	—	—				—	
	2 Porphyry copper		—	—	—	X	135	368	822	318	30	50	80	0	4K	12K	9	21	30	0	—	·2	0	·	6+	
	3 Biogenic sulfur		0	10	30	60	8	21	48	8	1	12	50	—	—	—	2	6	14	—	—			—	—	
	4 Vein-replacement		25	25	25	25	2	11	27	5%	1	10	20	—	—	—	1	8	16	—	—	—	—		—	
	5 Mass. sulf. pipes-Base & Precious metals		4	16	30	50	22 2	113	1540	25%	1	500	10K	20	1K	5K	0 5	9	48	0	9	..	0	6	40	
	6 Mafic-ultramafic		0	20	40	40	20	129	578	19	1	500	5K	—	—	—	2	12	36	—	—	1	—		—	
	7 Anorthosite complexes		0	20	30	50	16	42	128	11	100	2K	5K	—	—	—	1	3	9	—	—	1		—	—	
	8 Vein-ultramafic		0	4	9	87	5	22	400	25%	5	200	2K	—	—	—	0 5	3	18	0	2	..	0	2	8	
	9 Vein-dolomite		45	40	15	0	11	24	45	—	—	—	—	—	—	—	4	9	17	—	—	1	—	—	—	
	10 Carbonatite-alkalic		0	10	45	45	50	70	160	7	20	50	200	—	—	—	3	6	12	—	—		—	—		
Stage 3: Detailed Surface Investigation of Target Area	1 Breccia pipes		X	X	X	X	7	·	30	—	1	—	20	640	—	12 8K	2	9	18	—	—	—	—	—	—	
	2 Porphyry copper		—	—	—	X	592	935	1284	425	2	3	5	5K	10K	20K	18	24	32	1	5	12	1	3	6	
	3 Biogenic sulfur		0	0	40	60	7	17	72	5	1	4	12	600	2 6K	10K	2	6	16	—	—	—	0	7	54	
	4 Vein-replacement		26	28	23	23	3	25	60	5%	0 1	3	5	50	1K	5K	7	20	60	6	10	24	5	24	12+	
	5 Mass. sulf. pipes-Base & Precious metals		1	10	25	64	5	41	350	25%	0 1	5	40	40	2K	40K	0.3	7	26	1	5	20	0	0 2	14+	
	6 Mafic-ultramafic		0	20	40	40	8	20	50	6	1	4	50	100	2 5K	30K	1	6	20	—	—	—	0	4	72	
	7 Anorthosite complexes		0	10	30	60	20	30	70	6	2	4	20	1K	2.5K	10K	1	3	6	—	—	—	0	1	10	
	8 Vein-ultramafic		0	5	10	85	6 5	65	370	25%	1	15	100	100	1K	10K	2	10	90	1 5	7	60	1	6	46+	
	9 Vein-dolomite		20	50	30	0	2	7	16	—	—	—	—	40	100	500	1	1.5	3	—	—	—	—	—	—	
	10 Carbonatite-alkalic		0	10	45	45	47	73	160	14	5	40	88	3 2K	15K	30K	6	15	35	—	—	—	0	3	28	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	1 Breccia pipes		—	—	—	—	175	—	1700	—	—	—	—	640	—	12 8K	3	6	12	—	—	—	—		—	
	2 Porphyry copper		—	—	—	X	2810	4735	7654	1435	1	2	3	2K	2 5K	3K	23	36	48	3	9	18	3	3	18+	
	3 Biogenic sulfur		0	0	40	60	31	131	696	—	1	4	12	600	2 6K	10K	3	12	48	—	—	—	0	6	48	
	4 Vein-replacement		0	10	45	45	200	6 1K	15 5K	15%	0 1	1	3	50	200	2K	30	42	56	8	10	16	6	3	46	
	5 Mass. sulf. pipes-Base & Precious metals		1	10	30	59	76	549	6624	25%	0 1	0 5	2	40	500	2K	6	20	72	6	12	90	1	8	8+	
	6 Mafic-ultramafic		0	10	40	50	170	763	3K	50	1	4	50	100	2 5K	30K	9	24	48	—	—	—	0	2	48	
	7 Anorthosite complexes		0	0	25	75	213	463	883	30	2	4	20	1K	2 5K	10K	9	24	40	—	—	—	0	'	50	
	8 Vein-ultramafic		0	0	10	90	155	928	4630	25%	0 1	0 4	2	100	1K	10K	4	20	52	4	10	48	4	8	36+	
	9 Vein-dolomite		5	45	50	0	23	68	148	—	—	—	—	40	100	500	4	10	21	—	—	—	—	`	—	
	10 Carbonatite-alkalic		0	5	40	55	193	463	878	31	3	6	15	1K	3K	10K	12	24	50	—	—	—	0	6	25	

Table C.5 (Cont'd)

Sheet 2 of 2

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	1. Breccia pipes		—	—	—	—	3.5K	—	8.2K	—	0.5	—	3	640	—	6.4K	24	—	36	—	—	—	—	—	—	
	2. Porphyry copper		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	3. Biogenic sulfur		0	0	30	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	4. Vein-replacement		0	10	45	45	15K	30K	50K	15%	0.1	0.3	2	50	200	2K	12	24	36	6	12	18	16	24	60	
	5. Mass. sulf. pipes-Base & Precious metals		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6. Mafic-ultramafic		0	0	30	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	7. Anorthosite complexes		0	0	10	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	8. Vein-ultramafic		0	0	10	90	6.1K	21.9K	406K	25%	—	—	—	—	—	—	18	36	84	5	28	60+	8	20	20+	
	9. Vein-dolomite		0	40	60	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	10. Carbonatite-alkalic		0	0	50	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Stage 6: Production	1. Breccia pipes		—	—	—	—																				
	2. Porphyry copper		—	—	—	—																				
	3. Biogenic sulfur		—	—	—	—																				
	4. Vein-replacement		—	—	—	—																				
	5. Mass. sulf. pipes-Base & Precious metals		—	—	—	—																				
	6. Mafic-ultramafic		—	—	—	—																				
	7. Anorthosite complexes		—	—	—	—																				
	8. Vein-ultramafic		—	—	—	—																				
	9. Vein-dolomite		0	40	60	0																				
	10. Carbonatite-alkalic		—	—	—	—																				

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 3

Geologic Environment: Surficial Aluminous Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of America

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost $000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geological Compilation	O	0	5	10	85	15	50	150	20%	1K	10K	100K				2	6	12							
	Photogeological studies (rock units weathering)	O	0	5	10	85	20	50	100	20%	1K	20K	100K				6	10	12							
	Land use compilation	O	0	0	20	80	10	40	60	20%	1K	2K	50K				1	2	4	2	4	6				
	Field inspections of several selected areas	F	5	5	25	65	30	70	200	30%	100	1K	20K				2	6	18	0	4	12	0	6		
	Compilation and evaluation	O	5	5	25	65	10	40	80																	
	Total						85	200	590	25%							6	10	18	2	4	12	0	6		
Stage 2: Detailed Reconnaissance	Geological mapping	L	1	4	20	75	20	40	100	20%	10	40	100				4	12	24	0			0	6		
	Soil geochemistry	L	1	4	20	75	10	20	40	10%	10	40	100				4	12	24	0	C'dcwm.	Loam	0	6		
	Drilling and sampling	L	5	10	25	60	20	150	800	30%	5	20	50				6	12	36	0			2	6		
	Compilation and evaluation of data	O	5	10	25	60	10	40	80	30%	10	40	100				2	4	8							
	Total						60	250	1020	27%							6	15	40	0	2	12	0	6		
Stage 3: Detailed Surface Investigation of Target Area	(Land acquisition)	F	10	20	20	50	(40)	(200)	(400)	10%	6	12	40	3840	7680	25600	4	12	36	0	2		4	12		
	Preliminary Feasibility study	O	5	5	5	85	40	80	200	10%	2	4	8				2	6	12	0	2	4				
	Preliminary Environmental studies (eco. legal. Political)	F	5	5	5	85	40	80	160	20%	20	80	200				6	12	36	0	2	6	4	12		
	Total						80	160	360	15%							6	12	36	0	2	6	4	18		

Geologic Environment: Surficial Aluminous Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of America

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 3

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Detailed Drilling and assaying	F	1	4	20	75	700	1500	3000	30%	6	12	40	1920	3840	12.8K	6	12	24	2	3	12	2	6	12	
	Metallurgical Testing	F	1	4	20	75	100	200	400	10%	6	12	40				3	12	24	0	2	4				
	Reserve calculation	O	5	10	25	60	20	40	80	10%	6	12	40				1	2	4	0	2	3				
	Environmental Studies	F	1	4	20	75	100	400	1000	20%	6	12	40				12	12	12	0	2	3	2	6	12	
	Preliminary Mine Planning	O	1	4	20	75	20	40	80	10%	6	12	40				2	4	6	0	2	3				
	Compilation of Data & Feasibility Study	O	1	4	20	75	20	100	200	10%	6	12	40				2	4	6	0	1	1½				
	(Land Acquisition)	F	5	10	25	60	(300)	(2K)	(4K)	10%	6	12	40				12	12	12	0	6	12	0	6		
	Fill-in Drilling & Assaying	F	1	4	20	75	200	1000	2000	30%	3	6	20	1920	3840	12.8K	4	6	8	1	2	4	2	4	8	
	Bulk Sampling & Metallurgical Testing	F	5	10	25	60	100	700	1500	20%	3	6	20				4	8	16	0	2	4	1	6		
	Mining Tests	F	1	4	20	75	100	400	1000	20%	3	6	20				8	16	32	0	2	3	2	6		
	Preliminary Engineering for Plant, etc	O	1	4	20	75	50	300	700	10%	3	6	20				4	6	8	0	1	2				
	Final Feasibility study	O	1	4	10	85	100	300	700	10%	3	6	20				6	8	12	0	1	2				
	Environmental Studies	F	1	4	10	85	100	400	1000	20%	3	6	20				12	12	12	0	1	2				
	Legal Work	O	1	4	10	85	100	300	600	10%	3	6	20				6	8	12	0	1	2				
	Total						1710	5680	12.3K	20%							24	36	60	3	12	30	5	14	20	
Stage 5: Development	Mine Construction	F	1	2	5	92	20K	50K	100K	10%	1	2	6				24	36	60	6	12	24	12	36		
	Mill Construction	F	1	2	5	92	20K	50K	100K	10%							18	24	36	6	12	24	12	36		
	Infrastructure Construction	F	1	2	5	92	20K	50K	100K	10%							12	24	36	6	12	24	12	36		
	Permits	O	1	2	5	92	50	100	200	10%				1920	3840	12.8K	12	24	36				12	36		
	Environmental studies & work	F/O	1	2	5	92	15K	30K	60K	10%							24	36	48	6	12	24	12	36		
	Geological & Technical studies & Drilling	F/O	1	2	5	92	100	300	600	20%							12	18	24	6	12	24	12	24		
	Total						75.2K	280K	361K	10%							36	48	60	6	12	24	12	36		

Geologic Environment: Surficial Aluminous Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of America

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 3 of 3

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 6: Production		F	1	2	5	92	10K	20K	40K	10%							12	24	36				6	2		
		F/O	1	2	5	92	20K	50K	100K	15%				1920	3840	12.8K										
		F					8K	16K	32K																	
		F					7K	14K	28K																	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Surficial — Laterites
Typical Ores: Nickel

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Compilation	O				X	1	2 5	4		4K	12K	60K	—	—	—	5	7 5	1 0	—	—	—	—	—	—	
	Paleogeography studies	O		X			2	3	4					—	—	—	5	7 5	1 0	—	—	—	—	—	—	
	Field Reconnaissance of pre-mineral rocks	F				X	7	14	18	15%	2000	6000	30000	—	—	—	5	1 0	1 5	—	—	—	—	—	—	
	Total						10	19 5	26	15%							1 5	2 5	3 5							
Stage 2: Detailed Reconnaissance	Geologic mapping of pre-mineral rocks	F				X	10	30	35		100	300	500	—	—	—	1 0	2 0	2 5	—	—	—	—	—	—	
	Geochemical sampling	F				X				15%				—	—	—				—	—	—	—	—	—	
	Total						10	30	35	15%							1	2	2 5							
Stage 3: Detailed Surface Investigation of Target Area	Detailed geologic mapping of target areas	F				X	12	20	25		50	100	150	—	—	—	2	4	6	—	—	—	—	—	—	
	Detailed geochemical sampling of target area	F				X	2	3	7	15%	5	7	15	2K	3K	6K	—	—	—	—	—	—	—	—	—	
	Mineralogical studies	L		X			2	5	7		—	—	—	2K	3K	6K	25	5	75	—	—	—	—	—	—	
	Total						16	28	39	15%							2 25	4 5	6 75	—	—	—	—	—	—	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling logging					X	400	2500	3000		1 0	2 0	2 5	2K	3K	6K	—	—	—	—	—	—	—	—	—	
	Assaying						20	125	150		—	—	—	2K	3K	6K	24	36	48	—	—	—	—	—	—	
	Metallurgical studies						10	100	300		—	—	—	2K	3K	6K	—	—	—	—	—	—	—	—	—	
	Amenability studies						5	1 0	1 5		5	1 0	1 5	2K	3K	6K	2	25	5	—	—	—	—	—	—	
	Hydrology						50	100	200		5	1 0	1 5	2K	3K	6K	CONTINUAL			—	—	—	18	24	36	
	Order of magnitude studies						1	5	10	15%	5	1 0	1 5	2K	3K	6K	25	1 0	2 0	—	—	—	—	—	—	
	Environmental studies						50	150	400		5	1 0	1 5	2K	3K	6K	CONTINUAL			—	—	—	24	36	48	
	Budget estimates						10	100	200								3	8	12							
	Definitive estimates						4000	5000	10^4		5	1 0	1 5	2K	3K	6K	—	—	—	18	24	36	—	—	—	
	Total						4 54K	8 1K	14 3K	15%							24	36	48	18	24	36	24	36	48	
Stage 5: Development	Open-pit mine Mine planning & pre production stripping					X	5K	7K	10K	20%	5	1	1 5	2K	3K	6K	8	12	18				12	18	24	
	Mine plant construction					X	18K	23K	25K								30	36	45							
	Total						23K	30K	35K	20%							38	48	63				12	18	24	
Stage 6: Production																										
	Total																									

Geologic Environment: Surficial — Stream Placers
Typical Ores: Gold, Tin, Silver, Diamonds

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1. Regional appraisal mainly literature to locate largest areas of alluvium first countrywide, then state wide	O	One looks for area with history of mining	x	x			1	5	included	1 to 10		No limit other than size of deposit	**see	below		mo		3 mos							The greatest time consumer could be 3, i.e. picking up land.
	2. Locate most favored areas from study of source rocks	O		x	x			1	5	included																
	3. Visit the area to ascertain land position who holds lands and what portion of it is available for what price	F		x	x			1	5	included																
	Total							3	15																	
Stage 2: Detailed Reconnaissance	**This stage would probably be omitted unless the taking of a few widely-spaced** large samples from natural exposures in cliff faces in streams incised in the alluvium can be regarded as detailed reconnaissance										*Generally speaking, large companies are no longer interested in placers other than perhaps tin in Malaysia and in Russia for two reasons 1) Insufficient dollars in the ground, and 2) Unlikelihood of being environmentally allowed to disrupt ground. **I really think one can forget about any future major placer operations in view of the politician's attitude toward preservation of the **status quo of the environment** resulting from pressure from vociferous, well organized, intelligent, but ignorant minority groups. So, unless the above comments are noted and action taken by Politicians, then the time taken in completing this form is wasted and is costing us dollars.															
Stage 3: Detailed Surface Investigation of Target Area	**As described under stage 2: detailed reconnaissance**	F	x	x	x		'4		42		1 to 10															At the end of this stage we would know whether to proceed or get out.
	Total						'4		42																	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling with churn-type drill on a grid pattern. Initially the grid lines could be as much as ½ to 1 mile apart with individual holes 500 to 1000 ft. apart. This drill pattern would be closed	F		x	x		120		1000		1 to 10															At the end of this state, assuming success, we would be considering the cost of a dredge & a dredging operation.
	Total						120		1000																	
Stage 5: Development	No gold dredge has been built since the 50s other than by the Russians who incidentally had sent over one of California's Yoba Dredges on which their present dredges are no doubt patterned.			x	X		***A dredge today would cost any where from $10 million to $50 million. To recommission an old one would cost close to $10 million.**				*NOTE:* As previously stated, it would appear that even if a dredging operation finally cleared the environmentalists, the time and costs involved in doing this would be considerable and very few companies will be game to try.															
Stage 6: Production											A medium-sized gold dredge would shift approximately 8,000 to 12,000 yards in a 24-hour period, which is about 300,000 yards for a 30-day month. With a grade of 1/100 oz Au/cubic yard, which is higher than average by possibly a factor of 2, the average monthly ounces of gold recovered would be 3,000, which at a gold price of $140/ounce = $420,000 gross per month, or $5,040,000 per annum. We might net 15% of this. ***NOTE:* In Alaska, or elsewhere where permafrost exists, the dredging year is 180 days.**															

Geologic Environment: Surficial — Coastal Placers
Typical Ores: Titanium (Ilmenite)

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, In Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Literature Research	O		33	33	34	5	10	15	5%	1K	8K	10K	None	None	None		6			6		0	0	0	Work could be done by very small operators.
	Field Inspection	F		33	33	34	5	5	5	5%		4K		0	0	0		2			2			0		
	Wide-spread surface sampling of dark sands along roads, etc	F		33	33	34	5	5	5	5%		4K		0	0	0		2			2			0		
	Total						5	20	25	5%								10			8		0	0	0	
Stage 2: Detailed Reconnaissance	Surface sampling in areas of free access at say 400' intervals	F		33	33	33						1K		0	0	0		4			4					
	Land work determination of ownership, etc.	O	25	25	25	25		10		5%		1K		0	0	0		6			6			0		
	Total							10		5%								10			8			0		
Stage 3: Detailed Surface Investigation of Target Area	(Land Acquisition)	O	25	25	25	25	(5)	(15)	(30)	5%	1	10	25	640	6.4K	25K	4	20	24		?			0		Federal Prospecting Permits now take more than 2 years to be issued Exact length of delay will not be known until permit is issued
	Surface sampling	F	25	25	25	25	2	10	25	5%	1	20	50	640		25K								?		
	Auger sampling 400' intervals	F			50	50	08	8	2	5%	1	10	25			16K	2	4	6	4		8	2	3	4	
	Assay of sample	I			50	50	08	8	2							16K	2	2	2	1			0	0	0	
	Plotting, drafting	O			50	50	01	1	1							16K	1	1	1	1			0	0	0	
	Total						2	12	30	5%							8	24	40	5	?	8	2	3	4	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Churn drilling at 400'	F			50	50	6	68	400	5%	1	5	10	640	6.4K	16K	2	20	50	1	2	5	4	6	24	
	Bulk Sampling	F			50	50	8	1	12	5%	1	5	10	640	6.4K	10K	1	2	3	1	1		0	5	10	
	Environmental base line studies	O			50	50	5	25	100	5%						10K	12	18	36	1	1		0	0	0	
	Environmental impact study	O			50	50	10	50	650	5%						10K	4	8	24	1	1		0	0	0	
	Operating permits	O			50	50	10	0○	500	5%						10K							6	12	60	
	Total						49	345	662	5%							2	24	[illegible]	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]	
Stage 5: Development	Construction	F			50	50	5	7	25	5%				3.2K	6.4K	10K	10	2	24	5	5	5	0	3	6	
Stage 6: Production																										

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Surficial — Residual Deposits
Typical Ores: Phosphate

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic appraisal, regional area selection	O		10	30	60	5	8	15	2	10K	100K	1000K	—	—	—	2	3	4							
	Air-photo, topographic and geologic map studies of selection	O					5	8	15	2	10K	100K	1000K				2	3	4							
	Total						0	6	3°	4							4	6	8							
Stage 2: Detailed Reconnaissance	Geochemical and or soil surveys	F		10	30	60	15	25	45	5	'0°	'K	'OK	2K	4K	PK	2	3	6							
	Geologic reconnaissance mapping	F					15	25	40	5	'0°	'K	'OK	2K	4K	PK	2	3	6							
	Overburden check drilling	F					20	30	60	5	1⊙	∞	1K	2K	4K	OK	3	4	8					1	5	
	Total						50	80	145	15							7	10	20					1	5	
Stage 3: Detailed Surface Investigation of Target Area	Detailed geologic mapping	F		°	30	60	10	25	35	5	3	5	12	600	1<	8K	1	2	3				—	—	—	
	Detailed geochem and or soil survey	F					10	30	40	6	3	5	12	600	K	8K	1	2	3				—	—	—	
	Trenching	F					10	25	50	5	3	5	12	600	!K	8K	1	2	3				0	1	3	
	Analyses	L					5	10	15	2	—	—	—				1	2	3				—	—	—	
	Total						35	90	140	18							[illegible]	5	12				0	1	3	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Overburden grid drilling	F			35	65	4°	70	150	10	3	5	12	600	1K	8K	3	8	18	1	6	10		6	20	
	Deep trenching or shaft sinking	F			35	65	2°	60	150	12							2	5	15	1	2	5		3	15	
	Engineering and economic feasibility studies	O					10	20	40	4							2	5	10	—	—	—	—	—	—	
	Pilot plant operation	F					30	50	120	10							2	5	15	1	3	5	1	2	5	
	Total						100	200	460	36							6	12	36	3	6	10	1	6	20	
	otal																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Surficial — Brines in Evaporites

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			[illegible]ion (Mon[illegible]) [illegible] Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of geological literature & maps, selection of geologically economically and politically favorable target regions	O					2	6	12	3	10K	100K	1000K				1	3	6							
	Total						2	6	12	3							1	3	6							
Stage 2: Detailed Reconnaissance	Study of geological literature and maps, selection of specific target areas	O					3	9	18	3	4	20	1K				1	3	6							
	Surface geologic study & sampling	F					5	12	30	5	4						1	4	12							
	Total						8	21	48	8							2	7	18							
Stage 3: Detailed Surface Investigation of Target Area	Extensive sampling	F					5	25	50	6	4	12	100	1.2K	7.6K	60K	1	3	8							
	(Land acquisition)	F					(2)	(25)	(500)	(5)	4	12	100	1.2K	7.6K	60K	1	3	8				0	6	60	
	Total						5	25	50	6							2	5	14				0	6	60	
Stage 4: Detailed Three-Dimensinal Physical Sampling of Target Area	Drilling, sampling	F					8	100	250	5	4	12	100	1.2K	7.6K	60K	1	18	24				0	6	60	
	Analyses of samples	L					5	10	50	1							1	18	24							
	Beneficiation studies	L					5	50	250	5							1	18	24							
	Feasibility study	O					10	50	100	5				2.6K	7.6K	60K	3	12	18							
	Marketing study	O					12	30	60	5							2	6	12							
	Pilot beneficiation	F					15	100	500	15							3	6	18							
	Total						55	340	1.2K	36							9	24	42				0	6	60	
Stage 5: Development																										
	Total																									
Stage 6: Production																										
	Total																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet of 2

Geologic Environment: Surficial — Supergene Enrichment
Typical Ores: Cu, Ag, Pb, Zn, Au, Mn

	Main Activities and Methods, In Chrological Sequence	O, F or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			[illegible]	S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Compilation	O	10	10	30	50	1	3	5	1	1	100	1K	0	0	0	1	3	6	1	1		0	0	0	
	Structural Studies	O	10	10	30	50	1	3	5	1	1	100	1K	0	0	0	1	2	3	1	1		0	0	0	
	Compilation of Previous Mining Activity	O	10	10	30	50	1	3	5	1	1	50	100	0	0	0	1		3	1	1		0	0	0	
	Field Survey	F	5	5	40	50	1	3	5	1	1	100	200	0	0	0	1	2	3	1	1		1	1	1	
	Total						4	2	20	4							4	8	5	4	4	4				
Stage 2: Detailed Reconnaissance	Surface Mapping of rocks Att	F	5	10	25	60	5	15	25	5	1	3	10	100	1K	10K	2	6	12	1	1	1	0	0	0	Time for Lanc acquisi not included
	Rock Soil Geochem	F	5	10	25	60	10	25	50	5	2	10	50	100	1K	10K	2	3	12	1	1	1	0	0	0	
	Petrog mineralogic studies	L	0	5	10	85	2	3	5	1	1	1	5	—	—	—	1	2	3	1	1	1	0	0	0	
	Geophysics (IP SP) Mag	F	0	5	10	85	10	50	100	5	5	5	10	100	2K	10K	1	2	3	1	1	1	0	1	2	
	Field inspection of Anomalies	F	0	10	40	50	5	15	20	10	5	7	10	100	2K	10K	1	2	3	1	1	1	0	0	0	
	Total						32	108	200	26							7	15	33	5	5	5		1	2	
Stage 3: Detailed Surface Investigation of Target Area	Detailed geologic and alteration mapping	F	0	10	40	50	5	25	50	10	1	3	10	100	1K	10K	1	7	10	0	0	0	0	0	0	
	Detailed Surface geochemistry	F	0	10	40	50	5	25	50	10	1	3	10				1	7	10	0	0	0	0	0	0	
	Preliminary Drilling	F	0	5	20	75	50	75	200	25	1	2	5				3	8	12	1	5	12	1	3	6	
	Total						60	125	300	45							5	15	22	1	5	12	1	3	6	
Stage 4: Detailed Three-Dimensional Physical Physical Sampling of Target Area	Drilling	F	0	0	20	80	100	750	2000	250	1	[illegible]	10	<	5K	°K	12	30	96	1	6	36		6	2	
	Prelim Metallurgical Testing	L	0	0	20	80	50	250	300	50	1	3	10				3	10	12	1	6	36	0	0		
	Driving underground workings for bulk sample	F	0	0	10	90	200	500	1000	200	1	1	2				3	18	36	2	12	48	1	6	[illegible]	
	Final Metallurgical Environmental and support studies		0	0	10	90	200	1500	2000	500	1	3	10				6	15	18	2	12	48		12	24	
	Feasibility Study	O	0	0	5	95	200	500	1000	200	1	3	10				12	15	24	2	6	24		6	12	
	Total						750	3.5K	6.3K	1.2K							27	54	186	8	42	192	5	30	72	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Surficial — Supergene
Typical Ores: Cu, Ag, Pb, Zn, Au, Mn

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	Permits	O	°	°	1°	3°	10	25	50	15	1	3	10	×	5K	10K	12	18	48	6	12	36	12	18	24	
	Mine-Mill Design and Engineering	L	0	0	0	90	25	150	300	25	1	3	5				12	18	36	12	18	36	12	18	24	
	Site Preparation	F	0	0	:0	90	100	1K	2K	250	1	2	5				12	15	24	12	18	36	12	18	24	
	Construction of Mine Mill	F	0	0	5	95	5000	80K	500K	1000	1	2	5				12	24	48	12	18	36	12	24	36	
	Total	I					5 1K	81 2K	502K	1290							48	75	156	42	66	144	48	78	108	
Stage 6: Production	Operating Permits	O	°	°	5	95	25	50	100	50		3	0	K	5K	0K	12	24	36	6	12	36	6	18	36	
	Labor Negotiations	O	°	°	5	95	25	50	100	75	—	—	–	—			6	10	12	6	12	36	6	12	36	
	Town Site	F	°	°	5	95	200	500	1K	200	1	2	3				12	18	24	6	12	36	6	12	36	
	Mine-Mill Shakedown	F	0	°	5	95	20°	500	1K	500	—	—	–				3	6	12	6	12	36	6	10	12	
	Total						45°	1 1K	2 2K	825							21	48	84	24	48	144	24	52	130	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Surficial — Supergene Enrichment
Typical Ores: Silver

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by: I	S	M		Direct Cost ($000) of Each Activity or Method, Excluding Overhead		Area (Sq. Mi.) Being Investigated	Area (Acres, Under Claim, Option, Lease, Etc.	Duration (Months) of Each Stage: Without Any Delays	Plus Non-Regulatory Delays	Plus Delays Due Solely to Regulation	Additional Comments
Stage 1: Regional Appraisal	Geologic Compilation	O												
	Field Examination	F												
	Total													
Stage 2: Detailed Reconnaissance	Surface Geochem	F				X	50	20	3	ıK	6			
	Prelim Geol Mapping	F				X	10	5	3	ıK	6			
	2 ²						≈	≈0			=			
Stage 3: Detailed Surface Investigation of Target Area	Geol Mapping	F				X	10	5	3	ıK	w			
	Drilling	F				X	100	25	1	ıK	w			
	3 /						·	≈0			N			
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling	F				X	1K	250	2	2K	a	6	04	
	√ —							= V⊢			0	a	<	
Stage 5: Development	Metallurgical Work	L			X		300	75	—	2K	12			
	Mine-Mill Engr	L			X		300	7 m	2		12			
	Feasibility	O			X		1K	250	2		12			
	Construction	F				X	2K	500	1		24			
	Total						3.6K	300			36			
Stage 6: Production	Permits	O				X	250	75	2	2K	18			
	Mine Mill Shakedown	F				X	250	75	—		6			
	Total													

Geologic Environment: Stratabound Extensive-Bedded Precambrian
Typical Ores: Gold or Uranium or Base Metals

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Compilation	O	3	20	35	42		4	2	0	1K	50K	390K	—	—	1	0 2	0	6 0	9 8	0	3 0	1	1	—	Zero minimum means the method was not applicabl or the projectwas aban cloned betore the method would have beenapplied
	Potogeology	O	3	20	35	42	0	2	10	0	25	100	1K	—	—	1	0	0 5	2 0	0	0	1 0	1	1	—	
	Geologic field check	F	3	20	35	42	0	N	5	0	5	40	500	—	—	1	0	0 5	0	0	0 0	1 0	1	1	—	
	Geophysics Compilation	O	3	20	35	42	0	.	5	0	25	1K	OK	—	—	1	0	0 2	0	0	1 0	1 0	1	1	—	
	Total							9	45								0 2	2	0	0 8	3 5	6	0	0	0	
Stage 2: Detailed Reconnaissance	Reconnaissance mapping	F	1	20	35	44		10	100	1	5	40	500	—	—	—	0 2	2	24	—	—	—	—	—	—	See Comment May be concurrent under Regiona Appraisal
	Geochemical sampling and analysis	F	1	20	35	44	0	5	25	0 5	5	40	500	—	—	—	0	2	24	—	—	—	—	—	—	
	Ground radiometric Reconnaissance	F	1	20	35	44	0	1	5	0 1	5	40	500	—	—	—	0	0 5	2	—	—	—	—	—	—	
	Airborne geophysical	F	'1	20	35	45	0	15	50	1 5	5	40	500	—	—	—	0	0 2	0 5	—	0 5	1	—	—	—	
	Total						1	30	180	3							0 2	2	24	0	0 5	1	0	0	0	
Stage 3: Detailed Surface Investigation of Target Area	Geologic mapping	F	0	20	35	45	10	30	90	3	0 3	2	7	200	1K	4K	1	4	12			1	—	—	—	concurrent
	Sampling and analysis	F	0	20	35	45	5	15	30	2	0 3	2	7	200	1K	4K	1	4	12		1	1	—	—	—	See comment under Regional Appraisal
	Ground geophysical	F	0	20	35	45	0	10	40	1	0 3	2	7	200	1K	4K	0	3	6	0	1	1	—	—	—	
	Trenching	F	0	20	35	45	0	5	20	1	0 3	2	7	200	1K	4K	0	1	2	0	0	0	0	4	12	
	Drilling	F	0	20	35	45	0	50	250	5	0 3	2	.	200	1K	4K	0	2	8	0	.	1	0	4	12	
	Total						15	110	430	12							1	7	20				0	4	12	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Areas	Drilling	F		10	40	50	250	1K	5K	100	0 3	2	■	200	1K	4K	12	24	48	4	8	16	6	12	36	See comment under Regional Appraisal
	Underground work for bulk samples	F	0	10	40	50	0	700	2K	70	0 3	2	7	200	1K	4K	0	18	30	0	6	10	6	12	36	
	Sampling and assaying	F	0	10	40	50	10	40	200	3	0 3	2	7	200	1K	4K	12	42	60	.	2	4	0	0	0	
	Ore dressing tests	L	0	10	40	50	15	40	100	3	0 3	2	7	200	1K	4K	2	6	12	.	2	3	0	0	0	
	Feasibility studies	O	0	10	40	50	10	40	100	4	0 3	2	7	200	1K	4K	2	3	6	.	1	2	0	0	0	
	Total						285	1 8K	7 4K	180							6	5o	8	7	9	35	12	24	72	
Stage 5: Development	Not qualified to complete this																									
	Total																									
Stage 6: Production	Not qualified to complete this																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Stratabound Extensive-Marine Sedimentary
Typical Ores: Phosphate

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of geological literature & maps, selection of geologically economically & politically favorable target regions	O		10	40	50	2	6	2	3	10K	100K	1000K					3	6							
	Total						2	6	2	3								3	6							
Stage 2: Detailed Reconnaissance	Study of geological literature and maps, selection of specific target areas	O		0	4°	50	3	9	18	3	500	2K	10K					3	6							
	Aerial photography, surface geologic study & sampling	F					5	12	30	5	500	2K	10K					4	12							
	Total						8	21	43	8								6	4							
Stage 3: Detailed Surface Investigation of Target Area	Gamma ray surveys of water wells, geologic mapping & sampling	F		5	10	85	3	9	24	3	4	12	200	2.5K	7.6K	13K	1	3	8				0	2	12	
	(Land acquisition)	F					(10)	(500)	(5000)	6						13K	1	3	8				0	2	100	
	Total						3	9	24	3							2	5	14				0	4	100	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Areas	Drilling, sampling	F			40	60	100	500	2000	6	4	12	200	2.5K	7.6K	13K	4	18	36				0	24	100	
	Analyses of samples	L					5	25	75	1							4	18	36							
	Beneficiation studies	L					10	100	300	5							2	12	36							
	Compilation and study of data	O					8	36	60	1							4	18	36							
	Feasibility study	O			35	65	25	100	300	12							6	12	24							
	Sinking test pit	F					100	500	1500	25							3	6	12							
	Marketing study	O					12	30	60	5							2	6	12							
	Total						260	1191	4295	55							12	30	60				0	24	100	
Stage 5: Development																										
	Total																									
Stage 6: Production																										
	Total																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Stratabound Extensive-Marine Evaporite
Typical Ores: Potash

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Compilation of geologic literature mapping	O	10	20	35	35																				
	Oil gas well log studies	O	15	25	30	30																				
	State and Federal Survey visits	O	15	25	30	30																				
	Basin analyses	O	15	25	30	30					500K	1000K	1000K													
	Choice of basin to be investigated	O	15	25	30	30	5	10	20	15%	1K	4K	8K	—	—	—	NA	—	—	—	NA		NA			
	Total						5	10	20	15%																
Stage 2: Detailed Reconnaissance	Detailed well log analysis	O	15	25	30	30	2	3	4		1K	4K	8K	—	—	—										
	Determination of property									15%																
	Distribution/ownership	O F	15	25	30	30	1	3	4		200	500	800	—	—	—	NA				NA		NA			
	Total						3	6	8	15%																
Stage 3: Detailed Surface Investigation of Target Area	Option to lease property	O F	15	20	35	35	(5)	(20)	(75)		200	500	800	1K	8K	15K	6	12	18	8	16	20	—	—	—	Issuance of Prospecting Permits or even competitive leases is practically non-existent. Carlsbad, N.M. Area has best near-term chance for exploring Federal ground for Potash.
	Federal Ground	O	25	25	25	25	(4)	(10)	(16)		200	500	800	1K	8K	15K	NA	NA	NA	—	—	—	36	60	?	
	File Prospecting Permit									15%																
	State Ground	O	25	25	25	25	(0.3)	(2)	(3.2)		200	500	800	500	4K	7.5K	1	2	3				1	3	3	
	Total						0	0	0								6	12	18	8	16	20	36	60	?	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Baseline Environ. Study	O F	0	5	45	45	20	40	60								12	18	24	—	—	—	—	—	—	
	Dia. drilling and radiometric logging	F	2	10	38	50	100	200	700		200	500	800	1K	8K	15K	12	18	24	18	24	30	24	36	42	
	Assay costs									15%																
	Solution Mining Potential	F	0	10	90		250	500	1000								6	12	18	12	18	24	24	30	42	
	Drilling greater than 3,500 ft. depth; less than 9,000 ft. depth: Engineer Feasibility	O F	0	5	45	45	50	100	250								6	12	18	—	—	—	—	—	—	
	Total						420	840	1010	15%							12	18	24	18	24	30	24	36	42	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Stratabound Extensive-Marine Evaporite
Typical Ores: Potash

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M		Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	File for Necessary Permits-obtain	O	5	15	40	40	2	3	4		·o	30	50	'K	8K	15K	6	·2	·8	—	—	—	18	24	30	
(a) Conventional Mine	Dev Surf. Dia Drill	F	0	10	40	50	200	400	1 4K	5-ō	'o	30	50	·K	8K	15K	6	.2	·8	—	—	—	12	18	24	
	Shaft Sink	F	0	4	46	46	2K	5K	15K		o	30	50	.K	8K	15K	6	2	·8	3	15	21	NA	NA	NA	
	Refinery Construct (1 5 mill typ K20 cap)	F	0	0	30	70	70K	80K	90K		·0	30	50	1<	8K	15K	12	18	24	15	21	27	21	27	33	
	Total						72 2K	85 4K	106 4K	15%							18	30	42	15	24	30	21	27	33	
(b) Solution Mine	Drill & Rig Prod. wells (15-20)	F	0	0	30	70	4500	6000	·o<	15%	·o	3o	5o	5K	8K	15K	18	20	24	20	22	26	26	28	32	
	Construct Evap. Ponds or Crystallizer	F	0	0	30	70	35K	50K	.oo<		·o	3o	5o	5K	8K		12	14	18	14	16	20	20	22	26	
	Refinery Const (1 5-2 0 million typ K20 cap)	F	0	0	30	70	55K	65K	75K		o	3o	5o	5<	8K		18	20	24	20	22	26	26	28	32	
	Total						5K	121K	185K	5%							18	20	24	20	22	26	26	28	36	

NOTE: Reference to a definitive study of Potash Mining in the U.S. can be had by:

1) Preliminary Regional Environmental Analysis Record Oct. 1975 - Potash Leasing in Southeast New Mexico. Approx. 800p.
2) Executive Summary and Supplement-Environmental Analysis Record Spring, 1976-Potash Leasing in Southeastern New Mexico. 187 p.
3) Adams, S.S., 1975, *Potash* in: Industrial Minerals and Rocks, 4th Ed. S.J. Lefond, Editor, pp. 963-990.

Geologic Environment: Stratabound Extensive-Continental Sedimentary
Typical Ores: Coal

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1 Regional Appraisal	Compilation geology	O	10	20	35	35	2	6	8	15%	100	140	200	—	—	—	2	6	8	—	—	—	—	—	—	
	Regional mapping	F	15	20	30	35	1	4	6		50	100	140	—	—	—	1	3	4	—	—	—	—	—	—	
	Total						3	10	14	15%							3	8	10	—	—	—	—	—	—	
Stage 2: Detailed Reconnaissance	Prospect examination	F	25	25	25	25	2	6	8	15%	50	100	140	—	—	—	2	6	8	—	—	—	—	—	—	
	Compilation	O	10	20	35	35	1	3	4		50	100	140				2	6	8							
	Total						3	9	12	15%							2	6	8							
Stage 3: Detailed Surface Investigation of Target Area	Initial leasing	F	25	25	25	25	(10)	(100)	(250)		25	50	70	640	1K	5K	3	6	9							
	Initial drilling and mappin	F	0	10	45	45	15	150	250	15%							3	4	6	—	—	—	3	4	6	
	Preliminary evaluation	O	5	'15	30	50	5	10	25																	
	Total						20	160	275	15%							6	12	18				3	4	6	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Lease purchase of total project area	F	°	10	45	45	(2K)	(6K)	(20K)	15%	—	—	—	5K	10K	25K	6	12	24							
	Baseline environmental study		°	10	45	45	25	40	60								2	3	4							
	Total						25	40	60	15%							6	12	24							
Stage 5: Development	Development drilling	F	0	10	45	45	2K	4K	6K	15%	—	—	—	5K	10K	25K	12	24	36	5	°	°	6	10	24	
	Apply for permits, federal, state, county, municipal	°	0	10	45	45	0.5	1	5	15%	—	—	—				—	—	—	—	—	—	—	—	—	
	Environmental impact statement	°	0	0	50	50		**			10	2°	5°				12	24	36	6	7	8		NA		
	Engineering feasibility study	°	0	10	45	45	50	75	10°	15%	—	—	—				6	12	18		3	6		NA		**cited as 5 to 10% of total capital cost.
	Transportation study	°		10	45	45	60	100	15°	15%	—	—	—				3	6	12		3	6				
	Marketing study	°	0	10	45	45	60	100	15°	15%	—	—	—				3	6	12	000	3	6				
	Total capital cost of mine preparation, including facilities						20K	55K	≡0K																	
	Total						22K	59K	86K	5°-							12	24	36		2°	30	6	10	24	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

Geologic Environment: Stratabound Extensive-Stratiform Igneous Complex
Typical Ores: Iron, Chromium, Platinum, Nickel

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Concept	O				X	--	—	—	42	500	40K	100K			-	0	12	24							
	Geologic Data Compilation	O				X	4	7	21	7							1	2	6							
	Prospector Submittals	O F					2	4	7	4							0.5	1	2							
	Geophysical Ex Data Comp	O					4	7	21	7								2	6							
	Air Photo Interpretation	G					4	7	21	7							.	2	6							
	Geologic Reconn	F					4	14	21	4								4	6							
	Aeromagnetic Survey	F O					30	100	250	00							1 1	6	12							
	Geochemical Reconn	F O					7	14	21	14							3 2	4	6							
	Land Acquisition										100	500	1K	10K	20K	50K										
											In U S this size area difficult to acquire by claiming															
	Total						53	153	362	195							[illegible]	[illegible]	[illegible]							
Stage 2: Detailed Reconnaissance	Geologic Mapping						11	28	42	28							3	8	12							
	Geophysical Surveys Airmag						20	50	100	50							3	6	12							
	EM IP						50	100	200	100							6	12	24							
	Ground Magnetics						20	36	72	36							6	12	24							
	Geochem Survey						7	11	21	11							2	3	6							
	Drilling for Geochem Stratigraphic Data						200	350	500	115							3	6	12							
	Data Compilation Go-No Go Decision						11	32	140	32							3	9	40							
	Land Acquisition													10K	15K	25K										
	Total						319	607	1075	372							12	27	90							

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Stratabound Extensive-Stratiform Igneous Complex
Typical Ores: Iron, Chromium, Platinum, Nickel

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to eg			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 3: Detailed Surface Investigation of Target Area (concurrent)	Geologic Mapping	F					11	28	42	28	10	20	50	10K	15K	25K	3	8	12	0	2	6				
	Geochemical Survey	F					7	11	21	11							2	3	6							
	EM IP Surveys	F					25	70	100	70							3	8	12							
	Prelim Envir Impact	F O					4	7	11	7							1	2	3							
	Petrographic-Mineralogic Studies	L					4	4	7	4							1	1	2							
	Geologic Compilation-Reserve Computation	O					21	35	63	35							2	3	6							
	Diamond Drilling	F					1K	2K	5K	650							12	18	24	1	4	6	1	3	6	
	Geophysical D H Logging	F O					100	200	500	200							2	3	4							
	Total						1172	2355	5744	1005							16	24	48	1	6	12	1	3	6	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Areas (concurrent)	Drilling - Logging	F					1K	1500	2K	500	4	10	20		64°0	13K	12	18	24		4	6		3	6	
	Core Analysis	L					4	4	7	4							1	1	2							
	Geophysical D H Logging	F					20	20	20	20							3	3	3							
	Reserve Calculations	O					7	14	21	14							2	3	6							
	Prelim Metallurgical Tests	L					25	50	100	50							1	3	6							
	Prelim Feasibility Investment	O					4	7	11	7							1	2	3							
	Plant Site Invest	F					4	7	11	7							1	2	3							
	Envir Impact Study	F O					21	63	84	63							6	18	24				0		inf	
	Shaft Sinking	F					1500	2K	3300	200							11	11	11	2	5	2	2		12	
	Met Testing	L					200	1K	2K	500							3	6	12							
	Feasibility Study	O					25	70	100	70							2	6	12							
	Total						2810	4735	7654	1435							24	36	48	3	9	18	3	3	18+	

Geologic Environment: Stratabound Discrete-Marine Sedimentary
Typical Ores: Oil & Gas Play (Lower 48)
Estimated 5-year cycle for Phase I through IV Exploratory Phase

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet of

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M		Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal Geology and Geophysics published data collections	Stages Assessment of 1 Basin potential Mgt recommends entry	O	See Comment No 1				A Staff 100	300	500	20	1K	5K	40K	See comment No. 2			1	6	12		NONE			NONE		1 No good way to estimate percentage of each activity by others 2 Generally no land holdings at this phase
	2 Literature search	O					B Data Collection																			
	3 Accumulate published data, log files, reports, etc	O					10	50	100																	
	4 Assemble regional reports, maps cross-sections etc	O																								
	5 Regional field trips	F																								
	Total						110	350	600								1	6	12		0			0		
Stage 2: Detailed Reconnaissance Proprietory data collecting and prospect generation	1 Exploration team assigned	O					A Staff 300	500	2000	-5	1K	5K	40K				12	36	60	1	2	6	0	1-2	6	1 Incipient stage of acreage acquisition 2 Field operation restricted in some areas to summer months
																				Permit Delays Environmental Clearance						
	2 Seismic operations	F					B Data Collection																			
	3 Field geology	F																								
	4 Data purchase	O					1K	6K	20K																	
	5 Begin interpretation of data	O																								
	6 Lab studies of samples, etc	L																								
	7 Maps and prospects generated	O																								
	8 Recommend land purchase	O																								
	Total						1.3K	6.5K	22K								12	36	60	1	2	6	0	2	6	

Geologic Environment: Stratabound Discrete-Marine Sedimentary
Typical Ores: Oil & Gas Play (lower 48)
Estimated 20 years development and production

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 3: Detailed Surface Investigation of Target Area Area Prospect definition and land acquisition	Stages 1 Begin land acquisition O = 25% F = 75%	O F					A Staff 500 B Land Costs (1K)	600 (2.5K)	800 (6K)	60				50K	200K	1.5M	12	24	60	A Fee Lands 0 B Federal Lands 1	1 2	6 6				Acquisition land on prospects
	2 Detail seismic and geological as needed	O F					C Detail Data 100	500	1000																	
	3 Final interpretation and montage preparation	O																								
	4 Proposal to drill to mgt	O																								
	Total						600	1100	1800								12	24	60	1	2	6	—	—	—	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area Drilling operations-wildcat wells	1 Drill prospects run borehole surveys, production testing as required	F					1K	5K	20K	50	10	50	200	Approximate 25% of prospect acreage leased before drilling commences	75%	100%	1	3	6							Specific prospect evaluation
	Total						1K	5K	20K	50							1	3	6							
Stage 5: Development	1 Scoop & Design	O				*	10	20	50	3	4	15	50	1280	4480	16K	1	2	3	—	—	—	—	—	—	*Reporting for a Major Operator
	2 Roads & Locations	F				*	10	60	300	6		Same			Same		1	1	2	0	1	3	—	—	—	
	3 Production Facilities	F				*	25	150	500	15		Same			Same		2	3	6	0	1	3	—	—	—	
	4 Devlpmt. Drilling	F				*	500	5000	30000	40		Same			Same		3	12	36	3	4	6	0	1	2	
	5 Flow Lines	F				*	10	20	100	3		Same			Same		1	2	3	2	2	3	—	—	—	
	Total						555	5250	30950	67							4	14	39	5	6	9	0	1	2	
Stage 6: Production	1 Contract Sale	O				*	2	3	5	1	2	7	25	1280	4480	16K	1	2	3	—	—	—	0	1	1	*Reporting for a Major Operator
	2 Pipeline Connection	F				*	—	—	—	—		Same			Same		1	2	6	1	2	3	0	0	1	
	3 Unitization	O				*	5	7	10	1		Same			Same		3	4	6	2	3	4	0	1	3	
	4 Water Disposal, Injection	O				*	2	3	5	1		Same			Same		1	2	3	1	2	3	0	0	1	
	5 Improved Recovery	F				*	50	300	1000	30		Same			Same		3	6	12	3	4	6	—	—	—	
	Total																									

Geological Environment: Stratabound Discrete-Continental Sedimentary (Sandstone)
Typical Ores: Uraninite, Coffinite (Open Pit)

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1 Select Basin	O			100		25	50	100	10		Western U.S.		0	0	0	3	6	9	0	0	0	0	0	0	
	2 Literature Exam	O			100		25	25	50	5		Western U.S.		0	0	0	2	4	6	0	0	0	0	0	0	
	3 Field check for proper host rock, alteration & possible mineralization	F			100		25	50	100	10	4K	6K	10K	0	0	0	3	6	12	1	2	3	0	0	0	
	Total						75	125	250	25							6	15	24	1	2	3				
Stage 2: Detailed Reconnaissance	1 Subsurface study of an area by use of gamma & electric logs, map major paleo drainage	O			100		25	25	50	5	2K	4K	6K	0	0	0	3	6	9	0	0	0	0	0	0	
	2 Conduct regional geophysical programs	F			100		100	350	600	70	2K	4K	6K	0	0	0	6	12	24	1	2	3	1	2	3	
	3 Select best areas from above activities plus what land is available. Best geological prospect not always available	O			100		25	25	50	5	1K	2K	3K	0	0	0	2	4	6	0	1	2	0	1	2	
	Total						150	400	700	80							9	15	3	1	3	5	1	3	5	
Stage 3: Detailed Surface Investigation of Target Area	1 Examination of area for surface showings of host rock, alteration & mineralization	F			100		25	50	100	10	4K	6K	10K	0	0	0	3	6	12	1	2	3	0	0	0	
	2 Check land for previous activity & possible staking by competitors	O F			100		25	25	50	5	500	1K	2K	0	0	0	1	2	3	0	1	2	0	0	0	
	3 Local geophysical program	F			100		25	50	100	10	200	400	600	0	0	0	3	6	9	0	1	2	0	1	2	
	4 Possible radiometrics, geochemical or radon programs	F			100		100	350	600	70	2K	4K	6K	0	0	0	6	12	24	1	2	3	1	2	3	
	5 (Acquisition of land by staking or by negotiation)	F			100		(50)	(200)	(750)	(40)	8	30	150	5K	20K	100K	4	6	12	1	2	3	1	2	3	
	Total						175	475	850	95							6	12	24	1	3	5	1	2	3	

Geologic Environment: Stratabound Discrete-Continental Sedimentary (Sandstone)
Typical Ores: Uraninite, Coffinite (Open Pit)

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	1 Some broad-spaced drilling	F			100		50	250	500	50	8	30	150	5K	20K	100K	6	9	12	1	2	3	1	2	3	
	2 Grid Drilling on close-spaced pattern	F			100		500	1K	2 5K	200	2	4	8				24	36	48	2	4	6	1	2	4	
	3 Establish field camp, roads, etc	F			100		25	50	100	10							2	4	6	1	2	3	1	2	3	
	4 Calculation of reserves	O			100		25	50	100	10							2	4	6	1	2	3	0	0	0	
	5 Engineering studies	O F			100		50	100	200	20							6	12	24	2	4	6	1	2	3	
	6 Environmental studies & permits	O F			100		50	200	400	40							6	9	12	1	2	3	6	12	36	
	Total						[illegible]	2K	4 4*	33°													°	2°	[illegible]	
Stage 5: Development	1 Continuous drilling	F			100		1K	1 5K	2K	300	4	8	16	5K	20K	100K										
	2 Establish permanent camp				100		2K	4K	6K		2	4	8							6	12	24	6	12	24	
	3 Filing fed & state reports & permits				100		250	500	750																	
	4 Mine development				100			32K									Any one of these stages may be delayed by 6 mos - 2 yrs. by non-regulatory or regulatory reasons									
	5 Mine plant				100			2K																		
	6 Mill Construction				100			15K																		
	7 Transportation				100			5K																		
	Total							60K												6	12	24	6	12	24	
Stage 6: Production	1 Mining				100		12 5K				2	4	8	5K	20K	100K	Lifetime of property									
	2 Milling				100		35K																			
	3 Rehabilitation of Environment				100		5K																			
	Total						53K																			

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Stratabound Discrete-Lacustrine Evaporite

	Main Activities and Methods, In Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of geological literature & maps selection of geologically economically and politically favorable target regions	O		10	30	60	2	6	12	3	10K	100K	1000K				1	3	6							
	Total						2	6										3	6							
Stage 2: Detailed Reconnaissance	Study of geological literature and maps selection of specific target areas	O		10	30	60	3	9	18		4	20	K				.	3	6							
	Surface geologic study & sampling	F					5	12	30	7	4						.	4	12							
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling, sampling	F			30	7°	8	100	250	5	4	12	100	1.2K	7.6K	60K	1	18	24				0	6	60	
	Analyses of samples	L					5	10	50	1							1	18	24							
	Beneficiation studies	L					5	50	250	5							1	18	24							
	Feasibility study	O					10	50	100	5				2.5K	7.6K	60K	3	12	18							
	Marketing study	O					12	30	60	5							2	6	12							
	Pilot beneficiation	F					15	100	500	15							3	6	18							
	Total						55	340	1.2K	36							9	36	60				0	6	60	

Form 1

Sheet 1 of 3

Geologic Environment: Stratabound Discrete-Fossil Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of A.

Summary Mineral Exploitation Statistics for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chronological Sequence	D, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geological Compilation	O	0	5	10	85	15	50	150	20%	1K	10K	100K	—	—	—	2	6	12							
	Protogeological studies (rock units)	O	0	5	10	85	20	50	100	20%	1K	20K	100K				6	10	12							
	Paleogeological reconstitutions	O	0	0	10	90	10	20	40	20%	1K	2K	100K				6	10	12							
	Land Use compilations	O	0	0	20	80	10	40	60	20%	1K	2K	50K				1	2	4	2	4	6				
	Field inspections of several selected areas	F	5	5	25	65	30	70	200	30%	100	1K	20K				2	6	18	0	4	12	0	6	0	
	Aeromagnetics of selected areas	F	0	5	10	85	5	16	50	10%	500	2K	10K				2	3	4	2	6	12	2	4	6	
	Compilation & evaluation	O	5	5	25	65	10	40	80																	
	Total						100	286	680	20%							12	21	62	4	14	30	2	10	12	
Stage 2: Detailed Reconnaissance	Geological Mapping	F	1	4	20	75	20	40	100	20%	10	40	100				4	12	24	0	2	6	0	6	0	
	Drilling and sampling	F	5	10	25	60	20	150	800	30%	5	20	50				6	12	36	0	2	12	2	6	0	
	Compilation and evaluation of data	O	5	10	25	60	10	40	80	30%	10	40	100				2	4	8							
	Total						50	230	980	27%							6	15	40	0	2	12	0	6	0	
Stage 3: Detailed Surface Investigation of Target Area	(Land Acquisition)	F	10	20	20	50	(40)	(200)	(400)	10%	6	12	40	3.8K	7.7K	25.6K	4	12	36	0	2	0	4	12	0	
	Preliminary Feasibility Study	O	5	5	15	75	40	80	200	10%	2	4	8				2	6	12	0	2	4				
	Preliminary Environmental Studies (Eco. Legal. Political)	F	5	5	15	75	40	80	160	20%	20	80	200				6	12	36	0	2	6	4	12	0	
	Total						80	160	360	15%							6	12	36	0	2	6	4	18		

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 3

Geologic Environment: Stratabound Discrete-Fossil Aluminous Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of A.

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Detailed Drilling and Assaying	F	1	4	20	75	700	1500	3000	30%	6	12	40	1.9K	3.8K	12.8K	6	12	24	2	3	12	2	6	12	
	Metallurgical Testing	F	1	4	20	75	100	200	400	10	6	12	40				3	12	24	0	2	4				
	Reserve Calculations	O	5	10	25	60	20	40	80	10	6	12	40				1	2	4	0	2	3				
	Environmental Studies	F	1	4	20	75	100	400	1000	20	6	12	40				12	12	12	0	2	3	2	6	12	
	Preliminary Mine Planning	O	1	4	20	75	20	40	80	10	6	12	40				2	4	6	0	2	3				
	Compilation of Date & Feasibility Study	O		4	20	75	20	100	200	10	6	12	40				2	4	6	0	1	1½				
	(Land Acquisition)	F	5	10	25	60	(300)	(2K)	(4K)	10	6	12	40				12	12	12	0	6	12	0	6	0	
	Fill-in Drilling and Assaying	F	1	4	20	75	200	1K	2K	30%	3	6	20	9K	3.8K	12.8K	4	6	8	1	2	4	2	4	8	
	Bulk Sampling and Metallurgical Testing	F	5	10	25	60	100	700	1.5K	20	3	6	20				4	8	16	0	2	4	1	6		
	Mining Tests	F	1	4	20	75	100	400	1K	20	3	6	20				8	16	32	0	2	3	2	6		
	Preliminary Engineering for plant etc.	O	1	4	20	75	50	300	700	10	3	6	20				4	6	8	0	1	2				
	Final Feasibility study	O	1	4	10	85	100	300	700	10	3	6	20				6	8	12	0	1	2				
	Environmental studies	F/O	1	4	10	85	100	400	1K	20	3	6	20				12	12	12	0	1	2				
	Legal Work	O	1	4	10	85	100	300	600	10	3	6	20				6	8	12	0	1	2				
	Total						1710	5680	12.3K	20%							24	36	60	3	12	[illegible]	5	14	[illegible]	
Stage 5: Development	Mine Construction	F	1	2	5	92	20K	50K	100K	10%		2					2	3	5	½	1	2	1	3		
	Mill Construction	F	1		5	92	20K	150K	100K	10							5	2	3	½	1	2	1	3		
	Infrastructure Construction	F	1		5	92	20K	50K	100K	10							1	2	3	½	1	2	1	3		
	Permits	O	1		5	92	50	100	200	10				9K	3.8K	2.8K		2	3				1	3		
	Environmental studies & work	F O	1		5	92	15K	30K	60K	10							2	3	4	½	1	2	1	3		
	Geological and Technical studies and drilling	F O	1		5	92	100	300	600	20								1½	2	½	1	2	1	2		
	Total						75K	280K	361K								9	14	20	3		10	6	7		

Form 1

Summary Mineral Exploitation Statistics for a Specific Mineral Occurrence Type

Sheet 3 of 3

Geologic Environment: Stratabound Discrete-Fossil Aluminous Clays & Laterites
Typical Ores: Kaolinite & Bauxite for U.S. of A.

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 6: Production	Start-up	F	1	2	5	92	10K	20K	40K	10								1	2	3				½	1	
	Replacement of equipment over life of mine	F O	1	2	5	92	20K	50K	100K	15				1.9K	3.8K	12.8K										
	Annual Cost of Personnel	F					8K	16K	32K																	
	Other op costs	F					7K	14K	28K																	
	Total						45K	100K	200K																	

Geologic Environment: Stratabound Discrete-Shale Hosted Massive Sulfides
Typical Ores: Copper-Lead-Zinc-Silver

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic compilation	O		10	30	60	2	6	12	10%	2K	15K	25K				1	3	6							
	Geologic field check	F		10	30	60	0.5	2	3	10%							5	5	1							
	Total						2.5	8	15	10%							1.5	3.5	7							
Stage 2: Detailed Reconnaissance	Stream, soil and rock geochemical surveys	F		10	30	60	10	75	125	10%	2K	15K	25K				2	10	15							
	Field inspections of anomalous areas	F		10	30	60	2	5	10								5	1	2							
	Photogeologic study	O		10	30	60	5	1	2								25	5	1							
	Total						12.5	81	137	10%							2	10	15							
Stage 3: Detailed Surface Investigation of Target Area	Mapping of outcrops	F		10	30	60	5	1	2					100	1K	10K	1	5	1							
	Detailed soil, rock geo-chemical survey	F		10	30	60	1.5	4	10								1	5	1							
	Detailed ground electro-magnetic survey or induced polarization survey	F		10	30	60	4	10	50								1	5								
	Trenching	F		10	30	60	3	5	10								5	1	2							
	Total						9	20	72								1	2	4							
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling-logging	F		5	20	75	15	200	600	10%				100	1K	10K	1	6	12				2	9	18	
	Chemical analyses of cores	L		5	20	75	1	10	25								5	1	3							
	Down-hole geophysics	F		5	20	75	2	5	10								5	1	2							
	Amenability tests on ore-grade mineralization	L		5	20	75	4	12	25								2	6	12							Fine-grained nature of this ore may be serious problem
	Reserves Computations	O		5	20	75	1	2	4								5	1	2							
	Preliminary valuation	O		5	20	75	1	2	4								5	1	2							
	Site Investigations	F		5	20	75											1	5	12							
	Shaft sinking for bulk samples	F		0	20	80																				
	Bulk sample tests			0	20	80																				
	Total						24	231	668	10%							6	17	40				2	9	18	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Stratabound Discrete-Shale Hosted Massive Sulfides
Typical Ores: Copper-Lead-Zinc-Silver

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development					20	80																				
	Total																									
Stage 6: Production					20	80																				
	Total																									

Geologic Environment: Stratabound Discrete-Shale Hosted Massive
Typical Ores: Lead-Zinc-Silver

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet of 2

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic compilation	O				x	2	4	8		4K	12K	30K	—	—	—	0 25	° 5	1 °	—	—	—	—	—	—	
	Stratigraph correlation	O		X		x	3	6	10		4K	12K	30K	—	—	—	0 5	. 0	2 °	—	—	—	—	—	—	
	Structural analysis	O				x	3	5	8	15%	4K	12K	30K	—	—	—	0.5	. 0	2 °	—	—	—	—	—	—	
	Field Reconnaissance of pre-mineral rocks within area being investigated	F				x	7	14	25		200	400	1K	—	—	—	0 5	0	2 °	—	—	—	—	‘1	—	
	Total						15	29	51	5%							1 75	≡ 5	7 °							
Stage 2: Detailed Reconnaissance	Geologic mapping of pre-mineral rocks	F				x	10	20	4°		100	2°°	400	—	—	—	1 0	2 0	4 °	—	—	—	—	—	—	
	Geochemical sampling stream-ground water	F				x	5	9			2K	3K	8K	—	—	—	1 0	2 0	4 °	—	—	—	—	—	—	
	Gravity surveys	F			x		30	60	8 0	15%	250	500	1 2K	—	—	—	1 0	2 0	5 °	—	—	—	—	—	—	
	Induced polarization surveys	F			x		15	33	66		12	30	60	—	—	—	0 5	1 5	3 0	—	—	—	—	—	—	
	Total						60	122	244	15%							2 5	5 5	12 0							
Detailed Surface Investigation of Target Area	tion of potential target areas	F				X	2	8	6		9	15	40	6K	8K	12K	0 25	8	2 0	—	—	—	—	—	—	
	Detailed geochemical analyses of target areas	F/L		X			2	3	7	5%	3	5	12				2 0	3	3 5	—	—	—	—	—	—	
	Detailed gravity surveys	F			X		3	6	8		O	15	25				075	1 °	5	—	—	—	—	—	—	
	Detailed induced polarization surveys	F			X		33	42	70		6	9	15				0 5	1 °	2 °	—	—	—	—	—	—	
	Total						40	59	101	15%							3 5	6 0	9 0	—	—	—	—	—	—	

Sheet 2 of 2

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Stratabound Discrete-Shale Hosted Massive Sulfides
Typical Ores: Lead-Zinc-Silver

	Main Activities and Methods, In Chronological Sequence	D, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	[illegible]	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling-logging	F				x	600	1000	2000		1 0	2 0	2 5	4K	7K	9K	18	24	36	—	—	—	—	—	—	
	Assaying	L			x		18	35	66		1 0	2 0	2 5				—	—	—	—	—	—	—	—	—	
	Metallurgical studies	L			x		10	100	300		1 0	2 0	2 5				'	24	36			—	—	—	—	
	Amenability studies	O				x	0 5	1 0	1 5		0 5	1 0	1 5				0 2	0 25	0 5			—	—	—	—	
	Hydrology	F		x			50	100	200		4K	8K	30K				CONTINUAL			—		—	18	24	36	
	Order of magnitude studies	O				x	1 0	5 0	10	15%	0 25	0 5	0 75				0 25	1 0	2 0	—	—	—	—	—	—	
	Environmental studies	F			x		50	150	400		4K	6K	12K				CONTINUAL			—	—	—	24	36	48	
	Shaft sinking for bulk samples	F				x	2000	2500	3500		0 25	0 5	0 75				6	8	10	—	—	—	6	12	24	
	Budget estimate	O				x	10	100	200		0 25	0 5	0 75				3	8	12	—	—	—	—	—	—	Delays due to low metal prices or metallurgical problems
	Definitive est	O				‘1	8000	10^4	18000		0 25	0 5	0 75				18	24	30	24	36	60	—	—	—	
	Total						10739	13991	24781	15%							36	60	100	24	36	60	24	36	48	
Stage 5: Development	Underground Mine																									
	Mine planning & development of drifts, cross cuts raises, shafts	F				x	20K	30K	45K	20%	0 25	0 5	0 75	4K	7K	[illegible]	18	24	30	INDEFINITE			12	18	24	
	Plant Construction	F				‘1	75K	90K	100K																	
	Total						95K	120K	145K	20%							18	24	30				12	18	24	

Geologic Environment: Stratabound Discrete-Carbonate Stratiform
Typical Ores: Barite-Fluorite
NOTE (1) Wrn U S (2) Mid-continent

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet of 2

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional* Appraisal (1) & (2)	Compilation (includes structure, stratigraphy, geophysics, geochemistry) Literature imagery Map: 1" = 80 mi, 1" = 8 mi, 1" = 4 mi	O	5	15	30	50	5	7	10		7.5K	10K	15K	—	—	—	6	9	12	—						*Because of similar origin, exploration for barite fluorite is similar to exploration for carbonate hosted base metals. Because of the lower unit value & the somewhat greater areal extent of barite fluorite occurrences, the allowable expenditures and the amount of drilling (to feet) is usually less. The "halo" occurrence that is often observed on district scale—barite fluorite around above or below base metals has been used to locate detailed reconnaissance areas. Similarly, peripheral scout drilling for base metals metals has led to location of fluorspar barite deposits
	Survey oil-water well cuttings (2)	L	10	20	35	35	1	3	5					—	—	—	0	3	6	—						
	Regional drainage sediment-orientation (1)	F	5	10	20	65	2	5	8	15%				—	—	—	1	3	6	—						
	Prospect exam-familization mapping (1)	F	15	20	30	35	1	3	5					—	—	—	1	3	6	—						
	Total						9	18	28	15%							7	10	14							
Stage 2: Detailed Reconnaissance (1) & (2)	Compilation geology geochemistry, geophysics	O	5	15	30	50	2	4	6		100	200	400				1	2	3	—						(taking of property position sometimes deferred to next stage following some types of geophysical surveys . . .)
	Field mapping	F	10	20	35	35	2	4	6	15%							1	3	3	—						
	Drainage sediment surveys	F L	5	10	20	65	2	3	8								1	2	3							
	Evaluation	O	10	20	35	35	5	7	9								1	1	1							
	Total						11	18	19	15%							1	3	3							
Stage 3: Detailed Surface Investigation of Target Area	Geophysics EM-barite & fluorite (for stratigraphic & structural mapping) (1)	F	5	10	30	55	2	3	4	15%	5	9	17	—	—	—	0.5	1	2	—	—	—	—	—	—	
	Gravity barite (1) & (2)	F	5	5	45	45	5	10	20	15%	5	9	17	—	—	—	2	3	4	—	—	—	—	—	—	
	Target selection (1) (claim stake) (100cl.)	F	25	25	25	25	(20)	(20)	(40)	15%	5	9	17	2K	2K	4K	1	1.5	2	0.5	0.5	0.5	—	—	—	
	(Option to lease pur) (2 yr.) (2)	O F	10	30	30	30	(80)	(150)	(200)	15%	5	9	17				2	3	8	1	1	1	—	—	—	
	Geochem soil sampling (1) & (2)	F	10	30	30	30	2	4	6	15%	5	9	17				0.5	1	2	—	—	—	—	—	—	
	Environmental base line study (1) & (2)	O F	0	10	45	45	5	50	100	15%	5	9	17	2K	2K	4K	1	2	3	1	2	2	—	—	—	
	Dozer trenching (1)	F	25	35	30	30	6	8	10								1	1	1	—	—	—	2	6	12	

Geologic Environment: Stratabound Discrete-Carbonate Stratiform
Typical Ores: Barite-Fluorite
Note: (1) Wrn. U.S. (2) Mid-continent

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 ♁ 2

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling (1) & (2) 1,000 ft ctrs	F	0	20	40	40	150	300	500		5	9	17				3	6	12	1	2	3	6	12	24	
	Access via adit (1)	F	5	20	35	40	300	500	800		3	5	10	500	1K	4K	6	12	24	2	4	6	6	12	24	
	Trenching via dozer (1) & (2)	F	0 25	30	25	25	30	50	60	15%	3	5	0				2	2	2	0.5	0.5	0.5	6	12	24	
	Assays analyses	L	5	20	35	40	5	25	35		3	5	0				1	2	3	—	—	—	—	—	—	
	Bulk sampling	F L		20	35	40	10	35	50		3	5	0				2	3	4	—	—	—	—	—	—	
	Beneficiation (bench tests)	L		10	45	45	25	50	75		3	5	0				3	6	8	—	—	—	—	—	—	
	Initial feasibility study	O	8	10	45	45	10	20	30		3	5	10				1	2	3	—	—	—	—	—	—	
	Total						530	980	1550	15%							6	12	24	2	4	6	6	12	24	
Stage 5: Development	Permit Applics (Fed. St. Co. Mun)	O	10	30	30	30	·	3	10	15%		2	6	500	1K	4K	6	12	36	2	3	4	6	12	36	
	Environ. impact study-company support	O F	0	10	45	45	50	70	250								12	18	24	—	—	—	—	—	—	
	Engineering pit design or underground planning	O	0	10	40	40	·	10	50								1	6	12	—	—	—	—	—	—	
	Drilling (Surf)	F	0	20	40	40	10	50	100								6	12	24	—	—	—	2	3	°	
	Drilling (undrgrd)	F	0	20	40	40	0	25	100								3	6	8	—	—	—	1	2	e	
	Mine Develop	F	5	25	35	35	100	1500	3000								1	8	16	2	4	8	2	3	*	
	Plant construction	F	0	20	40	40	200	3000	5000								6	12	24	[illegible]	[illegible]	4	2	3	*	
	Total						362	4658	8510	15%							8	36	90	4	7	[illegible]	[illegible]	[illegible]	[illegible]	
Stage 6: Production																										

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

Geologic Environment: Stratabound Discrete-Carbonate Stratiform
Typical Ores: Lead-Zinc-Copper - Wrn. U.S. - Midcontinent

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Compilation includes structure, stratigraphy, geophysics, geochemistry, Literature, imagery Map 1 = 80 mi, 1 = 8 mi, 1 = 4 mi	O	5	15	30	50	5	7	10		7.5K	10K	15K	—			6	9	12	—	—	—	—	—	—	
	Survey of water well cuttings	L	10	20	35	35	1	3	5					—	—		0	3	6	—	—	—	—	—	—	*Mostly applicable only in Wrn. U.S.
	*Regional drainage sediment orientation	F	5	10	20	65	2	5	8	15%				—		—	1	3	6	—	—	—	—	—	—	
	Prospect exam familiarization mapping	F	15	20	30	35	1	3	5								1	3	6		—	—	—	—	—	
	Total						9	18	28	15%							7	10	14							
Stage 2: Detailed Reconnaissance	Compilation, geology, geochemistry, geophys	O	5	15	30	50	2	4	6		100	200	400	—	—	—	—	—	—	—			—	—	—	
	Field mapping photogeologic	F	10	20	35	35	2	4	6					—	—	—	1	3	6		—	—	—	—	—	
	Drainage sed. sampl	F	5	10	20	65	3	4	10	15%				—	—		1	2	3	—	—	—	—	—	—	
	Aeromagnetic surveys	F	0	5	40	55	50	100	250					—	—	—	1	2	2	—	—	—	—	—	—	
	Informational drilling (subsurface mapping	F	0	5	40	55	50	250	500					200	300	500	3	4	5	—	—	—	2	6	8	
	Compilation, evaluation	O	10	20	35	35	5	7	9					—	—	—	3	4	5	—	—	—	—	—	—	
	(Target selection property acquisition 20 A/claim at $100/yr 2 yr option at $100/A/year)	O	25	25	25	25	(30)	(1515)	(3000)		—	—	—	3K	9K	15K	1	6	12	0	6	12	2	12	24	
	Total						112	369	781	15%							3	6	13	0	6	12	4	18	32	
Stage 3: Detailed Surface Investigation of Target Area	Geochem. soil sampling*	F	10	30	30	30	4	8	10		5	10	20	2K	7K	12K	3	5	12	—	—		—	—	—	*Mostly Wstrn. U.S.
	Geophys. mapping (IP EM)	F	5	10	30	55	1	3	5								3	5	12	—	—	—	—	—	—	
	Photogrammetry base maps 1 = 200, 1 = 100	O	20	20	30	30	2	5	10	15%							3	4	6	—	—	—	—	—	—	
	Environmental studies baseline data	F	0	10	45	45	10	30	50								12	12	12	—	—	—	—	—	—	Max. fig. Wrn. U.S.
	Total						17	46	75	15%							12	12	12							

Geologic Environment: Stratabound Discrete-Carbonate Stratiform
Typical Ores: Lead-Zinc-Copper - Wrn. U.S. - Midcontinent

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 3

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 4: Detailed Three-Dimensional Dimensional Physical Sampling of Target Area	¹Drill 1,000' ctrs	F	0	2°	40	45	1.1K	4.2K	3.8K		3	7	15	1.9K	4.5K	9.6K	11	15	23	3	12	24	6	6	12	
	²Drill 50' ctrs	F	0	1°	45	45	1.9K	9.6K	2K	15%							20	29	160	6	24	36	6	6	2	
	Assays/analyses	L	0	2°	40	40	25	61	25								—	—	—	—	—	—	—	—	—	
	Dozer work	F	25	35	20	20	25	61	25								—	—	—	—	—	—	—	—	—	
	Total						3.05K	39	3°3K	15%							21	29	160	9	36	60	12	12	24	
Stage 5: Development	Permit applics.	O	10	30	30	30	—	—	—		3	7	15	1.9K	4.5K	9.6K	12	24	36	24	30	40	12	20	36	
	Feasibility studies	O	10	10	45	45					3	7	15	1.9K	4.5K	9.6K										
	Plant/operations design	O	0	20	40	40					3	7	15	1.9K	4.5K	9.6K										
	Surface drilling 200' ctrs	F	0	20	40	40	192	960	1920	15%	3	7	15	1.9K	4.5K	9.6K										
	Shaft sinking $1000/ft.	F	0	10	45	45	1600	3500	4000		3	7	15	1.9K	4.5K	9.6K										
	Drifting $150/ft	F	0	10	45	45	100	300	600		3	7	15	1.9K	4.5K	9.6K										
	Undergd. drilling $25/ft	F	0	10	45	45	50	150	300		3	7	15	1.9K	4.5K	9.6K										
	Environmental Impact statement	O/F	0	10	45	45	60	100	200		3	7	15	1.9K	4.5K	9.6K										
	Total						2002	5010	7020	15%							12	24	36	24	30	40	12	20	36	
Stage 6: Production	Plant/mill constr.	F	0	10	45	45					3	7	15	1.9K	4.5K	9.6K	10 yrs	25 yrs	100 yrs							
	Receipt of final Federal-State-county permits	O								15%	3	7	15	1.9K	4.5K	9.6K										
	Operations	F									3	7	15	1.9K	4.5K	9.6K										
	Total									15%							10	25	100							

In Wrn. U.S. drilling depths can be shallow—say 400-1,000 feet, but drilling costs are high—say total $30/ft. In midcontinent drilling depths now average 2000 feet, but costs range (total) $12-$15/ft.

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Stratabound Discrete-Volcanogenic Massive Sulfides
Typical Ores: Cu-Pb-Zn-Au-Ag

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Selection of volcanic belts	O		30	0	40	5	15	20		10K	100K	1000K		—		1	2	3							
	Geol. Reconn. and selection of volcanic units	F					15	30	50	[illegible]	1K	10K	100K				3	6	10							
	Airborne geophysics	F					20	50	80	5	100	500	1K				2	6	15							
	Total						40	95	150	14								14	28							
Stage 2: Detailed Reconnaissance	Geologic mapping & sampling	F		30	30	40	15	40	80	8	100	200	400	—		—	3	6	10							
	Geochemical survey	F					10	25	50	5	100	200	400		—	—	2	5	8							
	Total						25	65	130	13							4	8	16							
Stage 3: Detailed Surface Investigation of Target Area	(Land Acquisition)	F		30	30	40	(10)	(30)	(60)	(4)	—	—	—	1.5K	4K	10K	2	5	15	—	—	—	—	4	8	
	Detailed mapping, sampling	F					10	20	35	4	10	25	60				2	4	8	—	—	—	—	4	8	
	Ground geophys. survey	F					15	30	60	6	5	15	40				3	6	10	—	—	-	—	4	8	
	Total						25	50	95	10							5	12	26					8	16	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Testing geological geophysical targets by drilling	F		0	5	55	25	50	75	5	2	5	10	1.5K	4K	10K	3	5	10	—			—	3	6	
	Detailed drilling	F					50	100	200	5	2	5	10				4	8	12	—				—	—	
	Analyses	L					2	5	8	·		—	—	—			1	2	3			—	—	—	—	
	Sinking of exploration shaft or drilling for bulk samples	F			30	70	50	100	200	5		1	2	1K	·	8K	5	12	24					6	24	
	Engineering & economic feasibility	O					10	20	40	2																
	Total						137	275	523	8							8	15	36					6	24	
Stage 5: Development					30	70																				
	Total																									
Stage 6: Production																										
	Total																									

Geologic Environment: Stratabound Discrete-Metamorphics
Typical Ores: Graphite, garnet, kyanite

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Duration: Plus Non-Regulatory Delays			Duration: Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic study of favorable metamorphic regions	O		50	40	10	2	5	10	1	1K	10K	50K	—	—	—	1	2	3	—	—	—	—	—	—	
	Selection of most likely areas and field checking	F					5	15	25	2	1K	5K	10K	—	—	—	1	3	5	—	—	—	—	—	—	
	Total						7	20	35	3							2	5	8							
Stage 2: Detailed Reconnaissance	Small-scale geologic appraisal, sampling	F		50	40	10	10	20	40	4	500	2K	5K	—	—	—	2	4	5	—	—	—	0	1	3	
	Total						10	20	40	4							2	4	5	—	—	—	0	1	3	
Stage 3: Detailed Surface Investigation of Target Areas	Detailed geologic mapping, structural studies	F		50	40	10	10	20	30	4	3	5	15	500	1K	5K	2	3	5	—	—	—	0	1	5	
	Trenching & detailed sampling	F					10	15	25	3	2	4	10				2	3	5	—	—	—	0	1	5	
	Analyses	L					1	2	3	—							1	2	3							
	Total						21	37	58	7							3	5	10				0	1	5	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Detailed trenching and drilling	F		50	40	10	15	50	100	5	1	2	4	300	500	5K	4	6	10				0	2	8	
	Engineering feasibility study	O		30	50	20	8	15	25	2							2	4	8							
	Marketing Study	O					2	5	8	1							1	1	2							
	Pilot plant study	F					20	35	70	7							2	4	10				0	2	4	
	Total						45	105	203	15							6	12	30				0	4	12	
Stage 5: Development				30	50	20																				
	Total																									
Stage 6: Production																										
	Total																									

Sheet of 2

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Discordant-Breccia Pipes
Typical Ores: Copper, Lead, Zinc, Silver, Molybdenum, Uranium, Gold, Diamond

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	1 Regional appraisal mainly of literature first country-wide narrowed to state-wide narrowed to specific areas in possibly several different states and several different geologic environments	O		x	x	x	6		36		Millions of square miles															
	2 Visits in field to selected areas in each state to narrow this down to one area	F			x	x	8		40	½	Each area investigated from a few sq miles to 100 sq miles						*Doubt if the regional appraisal would be done by individual prospecting He would probably move into a known mining area with a history of mining									
	Total						14		76																	
Stage 2: Detailed Reconnaissance	1. Selected area say of the order of 100 sq. miles or maybe several hundred mapped at a scale of 1 inch to 1 mile	F		x	x	x	5		30		100		1K													At the end of this period we should have delineated the area of land to be applied for or staked
	Total						5		30																	
Stage 3: Detailed Surface Investigation of Target Area	1 (Land acquisition-staking, front money, etc.)	F	x	x	x	x	(3)	(100) (gross)	(1K) (possible)		1		20	640		12 8K	1		6							
	2 Detailed geologic mapping	F		x	x	x	3		10		1		20	640		12 8K	½		6							
	3 Geophysics	F		x	x	x	3		10		1		20	640		12 8K	½		6							
	4 Geochemistry	F		x	x	x	1		10		1		20	640		12 8K	½		6							
	Total						7		30								2		18							
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling anywhere from 5,000' to 100,000 feet at say $15 ft—						75		1500					640	10-20 acres being drilled	12 8K	3		12							Duration dependent upon number of drill rigs used plus of course results
	plus underground bulk sample for metallurgical testing						100		200																	
	Total						175		1700								3		12							

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Discordant-Breccia Pipes
Typical Ores: Copper, Lead, Zinc, Silver, Molybdenum, Uranium, Gold, Diamond

Sheet 2 of 2

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	Shaft						3K		6 K		½		3	640		6 4K	24		36	No experience of this			No experience of this			
	Headframe						100		200								Includes headframe hoist & underground development									
	Hoist						300		1K																	
	Underground drifting						100		1K																	
	Total						3500		8200								24		36							
Stage 6: Production																										
	Total																									

Minimum of 1,000 tons per day, as much as
10,000 tons per day underground
50,000 tons per day open pit
Ore value = $80 to $150 per ton—much lower in case of open pit copper which could be as little as $50 per ton
We would expect to make 15% profit minimum

Geologic Environment: Discordant-Porphyry
Typical Ores: Copper, Molybdenum

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

of 2

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Concept	O				X				42	2K	7K	20K	—	—	-	0	12	24							
	Geo Data Compilation					X	4	·	14	7							1	2	4							
	Prospector Submittal	F/O				X	2	4	7	4							5	1	2							
	Geophysical etc Data	F/O				X	4	7	14	7							1	2	4							
	Aerophoto Interpretation	O				X	0	2	4	2							0	5	1							
	Geo Reconn	F				X	2	14	21	14							1	4	6							
	Aeromagnetic Survey	F/O				X	0	60	120	60							0	2	3							
	Geochemical Reconn	F/O				X	4	7	11	7						.	1	2	3							
	Land Acquisition													0	4K	12K										
	Total						16	101	191	143								16	34							
Stage 2: Detailed Reconnaissance	Geological Mapping	F				X	11	28	42	28	30	50	80							0		12	0		inf	
	Geophysical Surveys Induced Polarizations	F				X X	50	100	125	100							6	12	15							
	Aeromagnetics	F/C					20	50	100	50							1	3	5							
	Ground Magnetics	F/C					18	36	72	36							1	2	3							
	Gravity	F/C				xxx	18	36	72	36							1	2	3							
	Geochemical Survey	F					7	11	21	11							2	3	6							
	Data Compilation & Go-No Go Decisions	O				X	11	32	140	32							3	6	9							
	Stratigraphic Drilling Test	F				X	0	75	250	25							0	3	6				0		6	
	Land Acquisition													5K		20K										
	Total						135	368	822	318							9	21	30	0		12	0	1	6+	

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Sheet 2 of 2

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Discordant-Porphyry
Typical Ores: Copper, Molybdenum

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 3: Detailed Surface Investigation of Target Area	Geologic Mapping	F					11	28	42	28	2	3	5	5K	10K	20K	3	8	12	0	2	6				
	Geochemical Sampling	F					7	11	21	11							2	3	6							
	Induced Polarization Survey	F					25	70	100	70							3	8	12							
	Prelim Envir Impact Statement	F/C					4	7	11	7							1	2	3							
	Petrographic-Mineralogic Studies	L					4	4	7	4							1	1	2							
← Concurrent →	Alteration-Structure-Mineralogical Zoning Interpretation-Compilation Reserve	O					21	35	63	35							2	4	6							
	Drilling-Logging	F					500	750	1000	250							12	18	24	1	4	6	1	3	6	
	Geophysical DH Logging	F/O					20	30	40	20							2	3	4							
	Total						59z	935	1284	425							18	24	32	1	5	12	1	3	6	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling-Logging	F				x	000	1500	2000	500	1	2	3	2K	2 5K	3K	12	18	24	1	4	6	1	3	6	
	Mineralogical, Chemical, etc Tests on Core	L				x	4	4	7	4							1	1	2							
	Down-Hole Geophysical Logging	F				xx	20	20	20	20							3	3	3							
	Reserve Computation	O					7	14	21	14							2	4	6							
	Prelim Metallurgical Testing	L				x	25	50	100	50							1	2	6							
← Concurrent →	Prelim Feasibility Invest	O				x	4	7	11	7							1	2	3							
	Plant Site Investigation	F				x	4	7	11	7							1	2	3				0		inf	
	Environmental Impact Statement	F O					21	63	84	63							6	18	(3							
	Shaft Sinking	F				x	1500	2000	3300	200							11	11	11	2	5	12	2		12	
	Metallurgical Testing	L				x	200	1000	2000	500							3	6	12							
	Feasibility Study	O				xxx	25	70	100	70							2	6	12							
	Total						2810	4735	7654	1435							23	36	48	3	9	18	3	3	18+	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Discordant-Biogenic Replacement
Typical Ores: Native Sulphur

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of geological literature & maps, selection of geologically, economically & politically favorable target regions	O		10	30	60	2	6	12	3	10K	100K	00C				1	3	6							
	Total						2	6	12	3							1	3	6							
Stage 2: Detailed Reconnaissance	Study of geological literature and maps, selection of specific target areas	O		10	30	60	3	9	18	3	1	12	50					3	6							
	Aerial photography, surface geologic study and sampling	F					5	12	30	5	1	12	50					4	12							
	Total						8	21	48	8							2	6	14							
Stage 3: Detailed Surface Investigation of Target Area	Geologic mapping & sampling	F			40	60	3	9	12	3	1	4	12	600	26K	OK	1	3	8				0	1	6	
	Gravity surveys	F					4	8	60	2	1	4	12	600	26K	OK	1	2	4							
	(Land acquisition)	F					(10)	(50)	(300)	(5)	1	4	12	600	26K	OK	1	3	8				0	6	48	
	Total						7	17	72	5							·	6	16				0	7	54	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling, sampling	F			40	60	12	80	500	6		4	2	600	26K	10K	1	3	36				0	6	48	
	Analyses of samples	L					1	2	6	1							1	3	36							
	Compilation and study of data	O					2	12	40	·		4	2	600	26K	10K	1	4	24							
	Feasibility study	O			30	70	10	25	100								1	6	12							
	Marketing study	O					6	12	50								1	6	12							
	Total						31	31	696								3	12	48				0	6	48	
Stage 5: Development																										
Stage 6: Production																										

Geologic Environment: Discordant-Vein and Replacement Deposits
Typical Ores: Silver-Copper

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of records concerning old mining camps	O	25	25	25	25	5	12	50	5%	1	10	20	0	0	0	6	12	60	0	0	0	0	0	0	
	Logging old drill holes, if any	F	25	25	25	25	1	2	5	5%	1	10	20	0	0	0	1	2	4	0	0	0	0	0	0	
	Compilation		25	25	25	25					1	10	20	0	0	0	1	2	4	0	0	0	0	0	0	
	Total						6	14	55	5%							6	12	60	0	0	0	0	0	0	
Stage 2: Detailed Reconnaissance	Geological mapping	F	25	25	25	25	2	10	25	5%	1	10	20	0	0	0	1	6	12	0	0	0	0	0	0	
	Sampling old dumps	F	25	25	25	25	01	1	2	5%	1	10	20	0	0	0	1	6	12	0	0	0	0	0	0	
	Total						2	11	27	5%							1	8	16	0	0	0	0	0	0	
Stage 3: Detailed Surface Investigation of Target Area	(Land acquisition)	O	25	25	25	25	(5)	(50)	(150)	5%	0	3	5	[illegible]	1K	5K	6	12	36	6	6	6	4	24*	?	
	Surface trenching	F	40	40	10	10	1	10	20	5%	0	1	3				1	6	24	1	3	9	3	6	12	
	Geological Mapping	F	40	40	10	10	1	10	25	5%	0	1	3				1	6	12	1	3	9	0	0	0	*Requirements variable. Step often omitted in acquired federal lands
	Deep penetration geophysics	F	0	10	45	45	1	5	15	5%	0	1	3				1	2	4	0	1	3	0	0	0	
	Total						3	25	60	5%							7	20	60	6	10	24	6	24	12+	
Stage 6: Production																										

Geologic Environment: Discordant-Massive Sulphide Pipes
Typical Ores: Copper, Zinc, Lead, Silver, Gold

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Field inspection of typical occurrences (possibly in other regions)	F	5	15	30	50	0	2	25	25%	<1	1	10K	—	—	—	—	0.5	12	—	—	—	—	—	—	
	Geologic compilation	O	1	9	30	60	1	5	50	25%	100	2K	100K	—	—	—	0.5	2	12	—	—	—	—	—	—	
	Photogeologic Study	L	0	5	30	65	2	25	500	25%	100	1000	50K	—	·	—	0.5	3	12	—	—	—	—	—	—	many groups omit these steps
	Visual Airborne Survey (for color anomalies)	F	5	10	35	50	0.2	2	10	25%	50	1000	30K	—	—	—	0.01	0.2	1	0.01	0.5	3	—	—	—	
	Field inspection of area selected	F	5	20	30	45	0.5	4	50	25%	20	1000	10K	—	—	—	0.1	0.5	2	—	0.5	4	—	0.2	4	
	Total						3.7	38	635	25%							0.5	1.5	18	0.01	1	6		0.2	4	
Stage 2: Detailed Reconnaissance	Examination of known mineral prospects & submittals	F	5	25	35	35	0.2	5	50	25%	<1	10	100	20	1K	5K	0.1	0.5	4	—	0.5	4	—	0.2	1	
	Reconnaissance mapping (geologic)	F	1	10	39	50	1	25	1K	25%	10	500	10K	—	—	—	0.5	5	24	—	2	12	—	0.5	12	
	Stream sediment & geochemistry	F	1	10	39	50	1	25	150	25%	10	500	10K	—	—	—	0.2	5	24	—	2	12	—	0.5	12	
	Airborne magnetic & electromagnetic surv	F	0	5	30	65	20	48	300	25%	50	300	2K	—	—	—	0.05	0.3	3	—	1	12	—	0.2	1	
	Field inspect of anomalous areas	F	0	5	30	65	0.2	10	40	25%	1	20	200	—	—	—	0.05	3	12	—	2	12	—	0.5	12	
	(Land acquisition) (Staking or optioning)	F/O	10	25	30	35	(0.5)	(50)	(500)	25%	0.1	5	50	40	2K	40K	0.05	3	12	—	5	36	—	5	Sev Yrs	
	Total						22.2	113	1540	25%							0.5	9	48	0	9	60	0	6	40	

COMMENTS RE Massive Sulphide Pipes in Form 1

1. The first three stages of exploration for massive sulphide pipes are really applicable to the exploration for strata-bound massive sulphide deposits. In fact no one searches directly for pipes (as opposed to the massive lenses). The pipes are normally incidental by-products of exploration for the stratabound massive deposits. Some pipes however, are found as a result of exploration for porphyry copper deposits.
2. Many areas of exploration interest on public lands are held by individuals or small companies. Therefore, they must be acquired by option agreement or purchase prior to doing exploration.
3. The forms do not have time limits. Therefore I have taken the "time" to mean that from inception of the program to proving a discovery.
4. Many of the separate activities listed, and assigned times are, in fact, carried out simultaneously, particularly in the period of detailed, three-dimensional target exploration.
5. There are no massive sulphide pipe systems per se in production in North America. Should any be brought into production, they could be evaluated on the basis of small porphyry copper systems insofar as the grades, style of mineralization, and shapes are similar.

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Discordant-Massive Sulphide
Typical Ores: Copper, Zinc, Lead, Silver, Gold

	Main Activities and Methods, in Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage									Additional Comments
																	Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 3: Detailed Surface Investigation of Target Area (If old workings are present & accessible, they are mapped & all available drill core logged during the geologic mapping phase.)	Detailed geologic, structural alteration mapping of outcrops	F	1	15	25	54	1	10	100	25%	0.1	5	40	40	2K	40K	0.1	2	12	—	2	2	—	0.2	12	
	Detailed soil, rock and/or silt geochemical survey	F	2	10	28	60	3	20	150	25%	0.1	3	20				0.2	2	5	—	1	5	—	0.2	2	
	Detailed geophysical surveys (magnetic, electromagnetic, induced polarization, self potential)	F	1	8	31	60	1	10	75	25%	0.1	3	20				0.1	2	6	—	2	12	—	0.2	infinity	
	Petrographic, petrochemical, mineralogic study of rock samples	L	1	5	24	70	0.1	1	25	25%	0.1	3	20				1	3	12	1	3	5	—	—	—	
	Total						5.1	41	350	25%							0.3	7	26	1	5	20	0	0.2	14+	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Rehabilitate and sample old workings	F	5	15	35	45	5	75	1000	25%	0.1	0.5	2	40	500	2K	2	5	12	1	3	12	—	3	infinity	
	Drilling & Logging	F	1	10	29	60	15	250	2000	25%							2	8	24	2	3	5	—	3	infinity	
	Assays & mineralogical chemical & physical tests of cores & cuttings	L	1	10	29	60	0.1	20	150	25%							0.1	0.5	4	3	8	24	—	—	—	
	Amenability tests of ore grade mineralization	L	1	2	23	70	1	5	100	25%							0.1	1	10	1	2	4	—	—	—	
	Reserve computations	O	1	10	29	60	1	5	20	25%							0.2	2	4	—	1	2	—	—	—	
	Prelim. valuation	O	1	10	29	60	0.5	2	10	25%							0.2	0.5	1	—	1	2	—	—	—	
	Environ. studies	F/O	1	5	34	60	0.5	10	40	25%							0.5	3	15	1	2	5	—	—	—	
	Study water problems & availability	F/O	1	5	34	60	0.5	2	4	25%							0.5	1	3	1	2	2	—	—	—	
	Study area for plant sites, tailings disposal, dump & townsite	F	1	10	30	60	0.5	20	150	25%							0.1	3	7	1	2	3	—	—	—	
	Tunneling or sinking for bulk tests & dp exploration	F	1	2	35	62	50	150	3000	25%							1	3	30	2	2	36	1	2	infinity	
	Bulk ore tests	F	1	2	35	62	2	10	150	25%							0.5	2	6	2	2	12	—	2	infinity	
	Total						76.1	549	6624	25%							6	20	72	6	12	90	1	8	infinity	

Geologic Environment: Discordant-Mafic-Ultramatic
Typical Ores: Nickel-Copper, etc.

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of geological literature & maps. selection of geologically economically & politically favorable target regions	O		20	40	40	2	6	12	3	10K	100K	1000K				1	3	6							
	Total						2	6	2	3							1	3	6							
Stage 2: Detailed Reconnaissance	Study of geological literature and maps. selection of specific target areas	O		20	40	40	3	9	18	3	1	5°0	5K				1	6	24							
	Aerial magnetic surveys & aerial photography	F					12	100	500	0	4	00	1K				1	4	12							
	Surface geologic study & geochem sampling	F					5	20	60	6	1	5oo	500				1	6	24							
	Total						20	129	578	19							2	12	36							
Stage 3: Detailed Surface Investigation of Target Area	Geologic mapping. detailed sampling. ground geophysics (magnetics. EM)	F		20	40	40	8	2°	50	6	1	4	50	'80	2.5K	30K	1	6	'2				o	2	24	
	(Land acquisition)	F					10)	25)	300)	(5)	1	4	50	.00	2.5K	30K	1	2	·2				o	2	48	
	Total						8	20	5°	6								6	20				o	4	72	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Drilling. sampling	F		10	40	50	20	100	500	6	1	4	50	100	2.5K	30K	1	6	24				o	2	48	
	Analyses of samples	1					1	5	25	2							1	6	24							
	Beneficiation studies	1					8	20	100	5							2	6	24							
	Compilation and study of data	O					4	12	30	2	1	4	50				2	6	24							
	Feasibility study	O			30	70	25	100	300	10							1	6	12							
	Marketing study	O					12	26	60	5							2	6	12							
	Sink test pit or shaft	F					100	500	2000	20							3	6	24							
	Total						170	763	3K	50							9	24	48				o		. o	
Stage 5: Development					30	· o																				
	Total																									

Geologic Environment: Discordant-Anorthosite Complexes
Typical Ores: Iron, Vanadium, Titanium

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Study of favorable regions, geological, economical and political selection of broad regions	O		20	30	50	1	2	3	1	10K	100K	1000K	—	—	—	1	2	3	—	—	—	—	—	—	
Stage 2: Detailed Reconnaissance	Study of known magnetic anomalies (published & public data)	O		20	30	50	1	2	3		500	2K	5K	—	—	-	1	2	3	—	—	—	—	—	—	
	Reconnaissance geologic study	F					5	10	25	F	100	200	1K	—	-	—	1	2	3	—	—	—	—	—	—	
	Airborne magnetic surveys	F					10	30	100	5	100	200	1K	—	—	—	1	2	3	—	—	—	—	—	—	
	Total						16	42	128	1							1	3	9							
Stage 3: Detailed Surface Investigation of Target Area	(Land acquisition)	F	—	10	30	60	(21)	(5)	(20)	(3)	2	4	20	1K	2.5K	10K	1	3	6	—	—	—	0	1	10	
	Geologic mapping, sampling	F					10	15	30	3	2	4	20				1/2	1	3	—	—	—	0	1	3	
	Magnetic (+ other geophysical) surveys	F					10	15	40	3	2	4	20				1	2	3	—	—	—	0	1	3	
	Total						20	30	70	6							1	3	6				0	1	10	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Areas	Reconnaissance drilling	F			25	75	25	30	50	2	[illegible]	[illegible]	[illegible]	K	2.5K	10K		2	5				0		15	
	Detailed drilling	F					100	300	600	10	[illegible]	4	[illegible]				3	15	25							
	Analyses of samples	L					1	3	8	1							[illegible]	2	3							
	Establishing geology	O					2	5	10	2	2	4					1	3	5							
	Economic and engineering feasibility study	O			10	90	15	20	40	5							[illegible]	4	15		NA			NA		
	Marketing study	O					10	15	25	5							[illegible]	2	5		NA			NA		
	Check drilling, drilling for bulk sample	F					10	15	50	2								4	8		—	—	H	—	—	
	Sinking of test shaft or pit	F					50	75	100	3		NA					3	6	15				0	0	25	
	Total						213	463	883	30							9	24	40				0	1	50	
Stage 5: Development					10	90																				
	Total																									
Stage 6: Production																										

Geologic Environment: Discordant-Veins in Ultramafic Rocks
Typical Ores: Asbestos, Talc

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 1 of 2

	Main Activities and Methods, In Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic Comp at	O			1	85		6	25		1	10K	5K				0.5	2	12			3			—	
	Photogeology	O			1	85	1	8	100	25	10	3K	00K				0.5	.	5		2	5			—	
	Field Checks	F			1	85	.	6	30	25		500	2K				0.5	2	10		2	5			2	
	Total						4		5	25								5	22	0	4	8	0	1	2	
Stage 2: Detailed Reconnaissance	Geologic mapping	F		5	10	85	2	10	150	25%	10	200	!				0.5	3	8			24		2	5	
	Airborne magnetic survey	F		1	9	90	3	12	250	25%	5	150	2K		—		0.1	0.5	2		2	24		1	5	
	Total						5	2	400	25%							0.5	3	18	0	2	36	0	2	8	
Stage 3: Detailed Surface Investigation of Target Area	Detailed mapping	F		5	10	85					1		100	—		—	1	5	36		2	24	—	1	12	All work beyond this stage is done on the company's property or claims
	Land acquisition	F		.	10	85	1	5	1K	25			—	100	1K	10K	1	.	36		3	24	—	3	24	
	Detailed ground magnetic survey	F		1	11	88	1		150	25	0.1		18	100	1K	10K	0.2	.	0		2	5	-	1	10	
	Trenching	F		1	11	88	0.5		20	25	0.1		10	100	1K	10K	0.05	.	2	0.5	2	12	1	3	infinity	
	Reconnaissance drilling	F		-1	11	88	5	10	200	25	0.1		10	100	1K	10K	1	5	2	1	2	5	1	3	infinity	
	Total						6.5	15	370	25							2	10	90	5	7	60	1	6	46 +	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Grid diamond drilling and logging	F			10	90	00	500	1500	25%	0.1	4		100	1K	10K	3	18	24	2	6	12	1	3	infinr	
	Mill Tests	L			10	90	1	10	40	25%	—			100	1K	10K	0.5	2	4	1	2	3	—	1	2	
	Resrve computation	O			10	90	1	3	25	25%	.		I	100	1K	10K	0.3	1	4	1	4	10	.	—	—	
	Valuation	O			10	90	1	2	5	25%	—			100	1K	10K	0.1	0.5	1	1	2	5	—	—	—	
	Shaft sinking or pitting for bulk sample	F			10	90	50	400	3000	25%	..			100	1K	10K	1	3	2	2	3	12	3	6	infini	
	Investigation of water problems	F			10	90	5	8	40	25%	—			100	1K	10K	0.1	1	.	1	3	6	1	3	12	
	Investigate placement of townsite, plants, tailings dumps, etc.	F			10	90		5	20	25%	—			100	1K	10K	0.1	1	4	1	2	4	1	3	12	
	Total							128	4630	25								20	92		9	48		8	36 +	

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

Geologic Environment: Discordant-Veins in Ultramafic Rocks
Typical Ores: Asbestos, Talc

	Main Activities and Methods, in Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development	Obtain approval to mine (environmental impact statements, etc.) Strip overburden and prepare pit				0	30	00	500	2000	25%							2	4	8	2	4	12	5	3	infinity	
	Business aspects arrange financing, find customer, hire contractors, staffing, etc				10	90	50	300	1000	25%							3	6	36	2	5	12	0	3	12	
	Fill-in drilling				10	90	100	000	3000	25%							3	12	36	2	12	24	3	5	infinity	
	Plan open pit				10	90	10	60	150	25%							3	6	12	—	3	12	—	2	5	
	Build mill, shops, office, etc				10	90	6000	20000	400X 10^3	25%							12	24	48	3	12	infinity	5	12	infinity	
	Total						6 1K	21 9K	406 2K	25%							18	36	84	5	28	50+	8	20	20+	
Stage 6: Production	Operate Mine and Mill																									
	Total																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Geologic Environment: Discordant-Veins in Metamorphosed Dolomite
Typical Ores: Talc

	Main Activities and Methods, In Chronological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Overhead	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Geologic compilation	O	40	40	20		2	6	2	10%	100	500	1K				1	3	6							
	Geologic field check	F	40	40	20			2	7								0.5	0.5	1							
	Photogeologic study	O	40	40	20		1	2									0.5	1	2							
	Total						3	10	9	10%								4	8							
Stage 2: Detailed Reconnaissance	Geologic mapping of outcrops and mapping of metamorphic zones	F	40	40	20		5	10	20								2	4	8							
	Detailed visual prospecting	F	50	40	10		6	14	25								3	[illegible]	12							
	Total						11	24	45								4	9	17							
Stage 3: Detailed Surface Investigation of Target Area	Detailed geologic and structure mapping	F	20	50	30		1	3	6					40	100	500	0.5	1	2							
	Chemical analysis of all samples	L	20	50	30		1	4	10					40	100	500	0.5	0.5	1							
	Total						2	7	16								1	1.5	3							
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Trenching	F	[illegible]	50	40		2	3	5					40	100	500	0.5	0.5	2							
	Drilling and logging	F					5	25	75					40	100	500	1	3	6							
	Chemical & physical tests of ore samples	L	0	50	40		4	6	10					40	100	500	0.5	2	6							
	Reserve calculations	O	0	50	50		1	2	4								0.5	1	2							
	Preliminary evaluation	O	0	50	50		1	2	4								0.5	1	2							
	Pit bulk sampling and testing of sample	FL		40	60		0	30	50								2	4	6							
	Total						2	68	48								4	[illegible]	21							
Stage 5: Development				40	60																					
	Total																									
Stage 6: Production				40	60																					
	Total																									

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet of 2

Geologic Environment: Discordant-Carbonatite-Alkalic
Typical Ores: Phosphate, Rare Earths, Columbium, etc.

	Main Activities and Methods, In Chrological Sequence	O, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
			I	S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 1: Regional Appraisal	Defining carbonatite rich provinces selecting most favorable regions	O	—	20	40	40	1	2	5	1	10K	20K	50K	—	—	—	1	2	3	—	—	—	—	—	—	
	Investigating & selecting individual complexes for follow-up	O					3	5	10	1	300	500	700	—	—	—	2	3	6	—	—	—	—	—	—	
	Total						4	7	15	1							3	5	9							
Stage 2: Detailed Reconnaissance	Reconnaissance geology selected complexes	F	—	10	45	45	20	30	80	5	20	50	200	—	—	—	3	5	10	—	—	—	—	—	—	
	Airborne magnetic survey	F	—				30	40	80	2	20	50	200	—	—	—	2	3	8	—	—	—	—	—	—	
	Total						50	70	160	7							3	6	12							
Stage 3: Detailed Surface Investigation of Target Area	(Land acquisition)	F		10	45	45	(5)	(15)	(50)	(3)	5	40	80	3.2K	15K	30K	2	5	15	—	—	—	0	2	20	
	Geologic mapping & sampling	F					10	20	50	4	5	40	80				3	6	10	—	—	—	0	1	6	
	Geophysical survey & line cutting	F					30	40	80	8	5	40	88				3	6	10	—	—	—	0	1	6	
	Sample analyses	L					5	10	25	1	5	40	88				1	2	3	—	—	—	—	—	—	
	Geologic study & target selection	O					2	3	5	1	5	40	88				1	2	4	—	—	—	—	—	—	
	Total						47	73	160	14							6	15	35				0	3	28	
Stage 4: Detailed Three-Dimensional Physical Sampling of Target Area	Reconnaissance drilling	F		5	40	55	25	30	50	2	5	40	88	3.2K	15K	30K	2	3	8	—	—	—	0	1	15	
	Detailed drilling	F					100	300	600	10	3	6	15	1K	3K	10K	4	15	25	—	—	—	—	—	—	
	Sample analyses	L					1	3	8	1		NA			NA		1	2	3		NA			NA		
	Establishing geology	O					2	5	10	2	3	6	15	1K	3K	10K	1	3	5		NA			NA		
	Economic & engineering feasibility study				50	50	10	15	40	4							2	4	15		NA			NA		
	Marketing study				50	50	5	10	20	4							1	2	5		NA			NA		
	Obtaining bulk samples pilot plant study				50	50	50	100	150	8							6	10	25		NA		0	6	25	
	Total						193	463	878	31							12	24	50				0	6	25	

Geologic Environment: Discordant-Carbonatite-Alkalic Complexes
Typical Ores: Phosphate, Rare Earths, Columbium. etc.

Form 1
Summary Mineral Exploitation Statistics
for a Specific Mineral Occurrence Type

Sheet 2 of 2

	Main Activities and Methods, in Chrological Sequence	U, F, or L	Percentage of Each Activity Done by				Direct Cost ($000) of Each Activity or Method, Excluding Overhead				Area (Sq. Mi.) Being Investigated			Area (Acres) Under Claim, Option, Lease, Etc.			Duration (Months) of Each Stage: Without Any Delays			Plus Non-Regulatory Delays			Plus Delays Due Solely to Regulation			Additional Comments
				S	M	L	Min	Avg	Max	Over-head	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	
Stage 5: Development					50	50																				
	Total																									
Stage 6: Procution																										
	Total																									