Ernst & Ernst

Planning Manual for Energy Resource Development on Indian Lands

Volume I - Benefit-Cost Analysis

Prepared for the

U.S. Department of Energy

March 1978

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

PLANNING MANUAL FOR
ENERGY RESOURCE DEVELOPMENT
ON INDIAN LANDS

(FORMERLY "COMPREHENSIVE ANALYSIS OF ISSUES REGARDING
ENERGY RESOURCE DEVELOPMENT ON INDIAN RESERVATIONS")

VOLUME I -- BENEFIT-COST ANALYSIS

PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY

MARCH 1978

ERNST & ERNST
WASHINGTON, D.C.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

This report was prepared by Ernst & Ernst under contract (EC-76-C-01-8659) for the U.S. Department of Energy (DOE), and does not necessarily state or reflect the views, opinions, or policies of the DOE or the federal government.

PREFACE^{1/}

This is one of five volumes constituting the "Planning Manual for Energy Resource Development on Indian Lands." (The title of the final draft report, dated October 1977, was "Comprehensive Analysis of Issues Regarding Energy Resource Development on Indian Reservations.") The other four volumes produced under this contract are:

"Volume II -- Management and Contractual Arrangements"

"Volume III -- Manpower and Training"

"Volume IV -- The Environment"

"Volume V -- Energy Information and Clearinghouse Design"

In addition to these five separate reports, there is an Executive Summary covering the key points from each of the individual task reports. The Executive Summary is intended for wide distribution and has been written in non-technical language.

^{1/} The reader should be aware that the Energy Research & Development Administration (ERDA), Federal Energy Administration (FEA), Federal Power Commission (FPC), and some divisions of the Department of the Interior (DOI) were reorganized into a consolidated U.S. Department of Energy (DOE) effective October 1, 1977. The DOE is in the process of being organized, and its several information dissemination services are being reassigned accordingly. As a result, some of the sources and/or telephone numbers listed in this manual may have been changed. If information of a specific nature is desired, and this manual does not provide sufficient detail to obtain it, the reader should call the DOE general information number: (202) 252-5000.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF EXHIBITS	v
I. INTRODUCTION	I-1
II. BENEFIT-COST ANALYSIS FRAMEWORK	II-1
Introduction	II-1
Resource Allocation Decision Process	II-1
Benefit-Cost Analysis and Its Use in Making Resource Allocation Decisions	II-12
Introduction	II-12
Overview of Benefit-Cost Analysis Methodology for Energy Resource and Other Land Development Options	II-13
Examination of Resource Characteristics	II-16
Estimation of Production Levels	II-18
Estimation of Direct Benefits from Energy and Alternative Resource Development	II-20
Estimation of Direct Costs of Energy Development	II-24
Estimation of Indirect Benefits and Costs of Energy Development	II-27
Summarization of Benefits and Costs of Energy Development versus Other Land-Use Options	II-29
Estimation and Summarization of Fiscal Impacts and Their Incorporation into the Benefit-Cost Calculations	II-31
Summary: How Benefit-Cost Analysis Can Be Applied to Energy Development Decisions	II-33
III. DETAILED APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: COAL DEVELOPMENT	III-1
Introduction	III-1
Background	III-1
Assumptions	III-2

	<u>Page</u>
Estimation of Direct Benefits to the Tribe	III-3
Overview	III-3
Royalty Lease Arrangement	III-3
Summary of Contract Arrangement Calculations	III-22
Tribal Jobs and Income	III-23
Summary of Benefits	III-25
Estimation of Direct Costs to the Tribe	III-25
Opportunity Costs of Land Conversion	III-26
Administrative Costs to Tribal Government	III-29
Summary of Environmental Costs	III-30
Summary of Direct Costs	III-32
Overview of Indirect Benefits, Costs, and Fiscal Impacts	III-33
Potential Employment and Income Multiplier Effects	III-34
Estimation of Population Increases	III-35
Potential Fiscal Impacts Resulting from the Increased Demand for Public Services	III-37
Impact of Water Consumption Related to Coal Development	III-40
Summary of Benefit-Cost Analysis for Coal Development.	III-40
IV. APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: OIL AND GAS DEVELOPMENT	IV-1
Introduction	IV-1
Background	IV-1
Assumptions	IV-1
Estimation of Direct Benefits to the Tribe	IV-6
Overview	IV-6
Royalty Lease Arrangements	IV-7
Carried Interest Joint Venture	IV-17
Tribal Revenues--Comparison of Royalty and Carried Interest Joint Venture	IV-24
Estimates of Direct Cost to the Tribe of Oil and Gas Development	IV-30
Opportunity Costs of Land Conversion	IV-30
Relocation Costs	IV-31
Administrative Costs to Tribal Government	IV-32
Environmental Costs	IV-33
Summary of Indirect Benefits and Costs and Fiscal Impacts	IV-34
Summary of Benefits and Costs of Oil and Gas Development	IV-35

	<u>Page</u>
V. APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: URANIUM, OIL SHALE, AND GEOTHERMAL DEVELOPMENT	V-1
Uranium Development	V-3
Overview	V-3
Assumptions	V-3
Estimate of the Direct Benefits of Uranium Development	V-4
Estimate of Direct Costs to the Tribe	V-16
Summary of the Indirect Benefits and Costs and Fiscal Impacts	V-20
Summary of Uranium Development	V-20
Oil Shale Development	V-22
Overview	V-22
Estimation of the Direct Benefits of Oil Shale Development	V-23
Tribal Jobs and Income	V-26
Estimation of Direct Costs of Oil Shale Development	V-26
Summary of Indirect Benefits and Costs and Fiscal Impacts	V-30
Summary of Oil Shale Development	V-30
Geothermal Resources Development	V-31
Overview	V-31
Estimation of Direct Benefits to the Tribe	V-33
Estimation of Direct Costs to the Tribe	V-36
Summary of Geothermal Resources Development	V-39

LIST OF EXHIBITS

<u>Exhibit No.</u>	<u>Title</u>	<u>Page</u>
II-1	Tribal Resource Planning and Decision Process	II-8
II-2	Application of Tribal Resource Planning and Decision Process to Specific Project	II-10
II-3	Summary of Benefit-Cost Analysis Methodology for Energy Resource and Other Land Development Options. . .	II-15
II-4	Detailed Steps Involved in Benefit-Cost Analysis: A. Examination of Resource Characteristics	II-17
II-5	Detailed Steps Involved in Benefit-Cost Analysis: B. Estimation of Levels of Production	II-19
II-6	Detailed Steps Involved in Benefit-Cost Analysis: C. Estimation of Direct Benefits from Energy and Other Land Resources	II-22
II-7	Detailed Steps Involved in Benefit-Cost Analysis: D. Estimation of Direct Costs of Energy Development. .	II-25
II-8	Detailed Steps Involved in Benefit-Cost Analysis: E. Estimation of Indirect Benefits and Costs of Energy and Land Development	II-28
II-9	Detailed Steps Involved in Benefit-Cost Analysis: F. Summarization of Benefits and Costs of Energy Develop- ment (Production Level X or Y) versus Other Land-Use Options	II-30
II-10	Detailed Steps Involved in Benefit-Cost Analysis: G. Estimation and Summarization of Fiscal Impacts and Their Incorporation into the Benefit-Cost Calculations	II-32

<u>Exhibit No.</u>	<u>Title</u>	<u>Page</u>
III-1	Royalties from Lease Arrangement	III-6
III-2	Analysis of Cash Flows for Alternative Royalty and Discount Rates	III-8
III-3	Calculations for Carried-Interest Joint-Venture Arrangement	III-13
III-4	Explanation of Exhibit III-3	III-16
III-5	Analysis of Cash Flow to Tribe	III-20
III-6	Analysis of Cash Flow to Operating Company	III-21
III-7	Estimation of Opportunity Cost of Diverting Land to Coal Mining	III-28
III-8	Coal-Related Environmental Impacts	III-31
III-9	Estimation of Energy-Related Population Increases . . .	III-36
III-10	Incremental Services, Capital Outlays, and Operating Expenses for Energy-Impacted Local Governments	III-38
III-11	Summary of Dollar-Valued Benefits and Costs from Coal Development	III-41
III-12	Other Benefits and Costs Not Valued in Monetary Terms	III-43
IV-1	Royalties from Current Development of Oil	IV-8
IV-2	Deflated, Discounted Royalties from Current Development of Oil	IV-9
IV-3	Royalties from Gas as a By-Product of Current Oil Development	IV-10
IV-4	Deflated, Discounted Royalties from Gas as a By-Product of Current Oil Development	IV-11
IV-5	Royalties from Additional Development of Oil	IV-13
IV-6	Deflated, Discounted, Royalties from Additional Development of Oil	IV-14
IV-7	Royalties from Gas as a By-Product of Additional Development of Oil	IV-15

<u>Exhibit No.</u>	<u>Title</u>	<u>Page</u>
IV-8	Deflated, Discounted Royalties from Gas as a By-Product of Additional Oil Development	IV-16
IV-9	Carried Interest Joint Venture for Additional Development of Oil: Cash Flow to Tribe and Operating Company	IV-18
IV-10	Deflated, Discounted Joint Venture Cash Flow from Oil . .	IV-21
IV-11	Joint Venture Revenues of Gas as a By-Product of Additional Oil Development	IV-22
IV-12	Deflated, Discounted Revenues from Gas as a By-Product of a Carried Interest Joint Venture for Additional Oil Development	IV-23
IV-13	Cumulative Tribal Revenue from Oil and Gas Development Under Various Contract Arrangements (Constant Dollars, Not Discounted)	IV-25
IV-14	Manpower Required for Oil and Natural Gas Production . .	IV-29
IV-15	Summary of Revenue Benefits to Tribe from Oil under Various Development Arrangements	IV-36
IV-16	Summary of Revenue Benefits to Tribe from Gas By-Product Under Various Development Arrangements over 24 Years . .	IV-37
IV-17	Summary of Dollar Valued Benefits and Costs From Oil and Gas Development	IV-39
V-1	Cash Flow to Tribe from Lease Arrangement with 5 Percent Royalty	V-6
V-2	Carried-Interest, Joint-Venture Arrangement	V-9
V-3	Phasing of Employment	V-13
V-4	Potential Indian Employment and Income	V-15
V-5	Direct Environmental Costs to the Tribe from Uranium Mining and Milling	V-18
V-6	Tribal Revenues from Oil Shale Royalties	V-25
V-7	Environmental Impacts to the Tribe from Shale Oil Development	V-29
V-8	Summary of Environmental Costs of Geothermal Development	V-38

I. INTRODUCTION

This volume presents the application of benefit-cost analysis to the issue of energy resource development by Indian nations. The five specific resources for which examples are provided include (1) coal, (2) oil and gas (treated as a single resource because they are often developed in combination), (3) uranium, (4) oil shale, and (5) geothermal.

Section II is entitled "Benefit-Cost Analysis Framework." The analytical framework deals with two major steps involved in assessing the pros and cons of energy resource development (or any other type of development). The first is to identify and describe the overall tribal resource planning and decision process. The second is to develop a detailed methodological approach to the assessment of the benefits and costs of energy development alternatives within the context of the tribe's overall planning process.

The overall tribal resource planning and decision process consists of two parts: (1) the development of a decision-making framework by each tribe, and (2) the formulation of a system for assessing the feasibility of specific energy development projects. The decision-making framework is depicted in flow-chart form in Exhibit II-1, and the application of the framework to specific projects is depicted in Exhibit II-2. The major elements of the framework are the tribal objectives with respect to such factors as economic impacts, environmental effects, and socio-cultural considerations; the

types of impacts expected from a specific project as a function of the type of resource developed and the type of contractual arrangement made (e.g., royalty, "carried-interest" joint venture -- see Volume II for a more detailed description); and the specific valuation or weight applied by tribal leaders and members to each type of impact experienced. In the application of the framework to a specific project or set of projects, the sequence of events involves:

- Project formulation
- The conduct of a feasibility study (focusing on tribal impacts; the energy company would conduct its own feasibility study to determine the project's economic viability)
- The determination of the project's desirability by applying a set of decision rules developed as the end product of a decision-making framework to the results of the feasibility study
- The acceptance, rejection, or modification (and reassessment) of the project(s) in question.

The methodological approach recommended to provide the analytical support necessary to implement the tribal decision-making framework is benefit-cost analysis. The second part of Section II describes this technique and the ways in which it can be used to quantify the benefits (pluses) and costs (minuses) of energy resource development. Exhibit II-3 summarizes the key elements in conducting a benefit-cost analysis and describes how they fit together to help tribal leaders make decisions about specific projects. The major steps involved in applying the methodology include:

- (1) Examination of resource characteristics (e.g., determining what resources are on the reservations and their quantity and quality)
- (2) Estimation of likely production levels

- (3) Estimation of direct benefits (particularly royalty payments to the tribal government and potential incomes that can be earned by tribal members through job creation) and direct costs (environmental effects, opportunity costs through the diversion of land from other uses, administrative costs to the tribe)
- (4) Indirect benefits (e.g., from potential multiplier effects) and costs (e.g., from indirect impacts on cultural values and the environment)
- (5) Fiscal impacts on both tribal revenues and expenditures (so-called "boom town" impacts related to energy development in largely rural areas).

The section concludes with a check list of factors to be considered in the use of benefit-cost analysis.

Two important issues emphasized in Section II and in the sections dealing with the application of the benefit-cost methodology to the development of specific resources (Sections III, IV, and V) are the timing of benefits, costs, and fiscal impacts and the difficulty in placing dollar values on them (particularly environmental impacts). Timing is of concern in considering when benefits will be received and costs incurred and is discussed throughout Section II and subsequent sections, in which such time-related terms as "present value analysis" and "boom town" impacts are defined and discussed. The inability to measure specific types of impacts, particularly environmental effects, is also discussed throughout the volume with emphasis placed on the potential biases that can result in the assessment of benefits and costs if a significant effort is not made to quantify all important impacts on both sides of the ledger.

Sections III, IV, and V present the application of the benefit-cost analysis methodology to coal; oil and gas; and uranium, oil shale, and geothermal development, respectively. The way we have chosen to apply the methodology is to create hypothetical examples that illustrate realistic development opportunities for the majority of tribes that have

significant reserves of one or more of the resources that are economical to develop. Some of the major points that emerge from the individual resource analyses can be summarized as follows:

- Coal
 - Revenues sensitive to choice of contractual arrangement
 - Uncertainty of restoring land productivity after surface mining
 - Leachates from mine may pollute surface and ground water
 - Possible related developments on reservation: coal liquefaction, coal gasification, and power plants
- Oil and Gas
 - Choice of contractual arrangement depends on relative chance of oil field success, which should be determined by geological and seismic surveys before contractual arrangements are made.
 - Successful fields permit high revenues under carried-interest joint venture.
 - Small work force requirements
 - Minor environmental impacts
- Uranium
 - Severe adverse health impacts on workers
 - Very high profits on yellowcake make carried-interest joint venture attractive.
 - Great uncertainties in future uranium prices (and, hence, profits)
 - Delay in receipt of revenues from long pre-production period.

- Oil Shale
 - Present extraction technologies not competitive with other resources' technologies
 - Surface retorting has significant negative environmental impacts
 - Large work force required by oil shale facilities
 - If oil prices increase sufficiently, potential for economic production and high revenues for large-scale operations
- Geothermal
 - Hot dry rock technology still in experimental stages
 - Essentially non-polluting
 - Output has dual use: space heating and electrical power generation (competitive with small-scale fossil fuel power plants)
 - Very small work force requirement.

Finally, it is again emphasized strongly that the estimates provided in Sections III, IV, and V are intended only to illustrate the types of benefits and costs an individual tribe could expect if it were to undertake (or is already involved in) energy development. A tribe contemplating either an initial undertaking in the energy development area or a significant increase in the scale of operations already under way would be well advised to invest the necessary resources in the establishment of a comprehensive minerals management capability. The nature of such a capability is the central focus of Volume II of this study.

II. BENEFIT-COST ANALYSIS FRAMEWORK

INTRODUCTION

The development and application of a method to assess energy resource development (or any other type of development) involve two steps. The first is to identify and describe the overall tribal resource planning and decision process. In other words, a tribe must identify its overall objectives and priorities concerning resource development and structure them into a set of decision-making rules that can be applied to a specific development situation. Since it is likely that in any development decision certain tradeoffs among economic, social, or other tribal objectives will be necessary, identification of the tribal decision process will assist in making these tradeoffs. The second step is to develop a detailed methodological approach to the assessment of the benefits and costs of energy development alternatives within the context of the tribe's overall planning process. We address each of these areas in detail below before we proceed to assess specific resource development issues in subsequent sections.

RESOURCE ALLOCATION DECISION PROCESS

The resource planning and decision process consists of two steps or stages. The first is development of a decision-making framework by each tribe, in which objectives (e.g., revenue maximization, tribal employment

maximization, environmental protection) are carefully weighed for all types of economic development decisions (e.g., agriculture and forestry as well as energy). The second is the formulation of a system for assessing the feasibility of specific energy development projects. Each of these steps is discussed below.

In the first step the tribe must become involved in setting up a resource development planning program in line with its needs. As mentioned above, the purpose of a resource planning program is to identify overall tribal objectives (e.g., economic, social, environmental, etc.) and structure them in a system of priorities so that the tribe can choose among development alternatives.

Determining the level of effort and the delegation of authority that would be required is a tribal function and is not discussed here. A large tribe with several resources on the reservation will need to devote a greater effort to planning than a small tribe with limited resources, simply because of the number of people and the quantity of natural resources that will be affected. However, a discussion of alternative tribal resource management models and the qualifications that would be desirable for persons involved in a resource planning role is presented in Volume II.^{1/}

In most cases, the tribe's overall objective in making development decisions is to maximize the net social returns from its investment of labor (wages), land (rental income), and/or capital (interest

^{1/} Volume II emphasizes the function of contract formation and monitoring more than the actual planning and decision-making aspects.

income).^{1/} In some cases, the tribe is investing only its land and minerals and is looking for the highest return (discounted to present value)^{2/} per acre. In other cases, both land and capital could be invested (e.g., a joint venture), so joint returns to land and capital must be considered. In any case, there are many factors that must be considered by the tribe to ensure that a decision outcome will be in keeping with the overall goals of the tribe. The major factors considered here include:

- Direct economic impacts: Examples of major economic factors that would be affected by a development decision are tribal employment and income, tribal revenues from development contracts, potential return on invested capital, and the loss of income from agricultural or other land uses as a result of land conversion for resource development (opportunity costs). The extent to which the tribe will realize benefits and/or incur costs depends on such factors as the type and level of development pursued, the qualifications of tribal members necessary to fill new jobs, and the extent to which mineral-rich land is currently used for other activities.

1/

This concept has also been developed in the report of Task Force Seven of the American Indian Policy Review Commission in a slightly different fashion (Fitch, James B., and Ronald L. Trosper, Report on Reservation and Resource Development and Protection, Appendix IV: "A Case Study of Project Evaluation for an Indian Reservation," 1976).

2/

"Present-value analysis" is a method of comparing the future returns and costs generated by an investment on a present-day basis. For example, it is clear that a dollar received five years from now is not worth the same as a dollar received today, because the dollar received today can be invested (or merely put in an interest-bearing account in a savings bank) and earn interest that would increase its value considerably within the five-year period (e.g., it would be worth \$1.28 at a 5 percent interest rate compounded annually or \$1.61 at a 10 percent interest rate). The specific interest or "discount" rate used by a tribe to compare the future returns and costs from its investments will depend on the productivity of these resources and the time preferences of tribal members (i.e., the desire of tribal members to wait for future income as opposed to having the income today). In addition, future returns and costs must be corrected for the general rate of inflation (i.e., converted to "constant" dollars), either before or as a part of the discounting procedure. The use of present-value analysis in the area of tribal energy resource development is discussed in greater detail later in this section and in subsequent sections.

- Direct socio-cultural impacts: As a result of past development projects, many tribal members have expressed concern over several areas of social and cultural effects resulting from energy development. These include maintaining a sense of belonging to the land; continuing agriculture and grazing as a way of life; and maintaining the quality of education available to Indian children if resource development significantly increases population influxes and school enrollment. In addition to the discussion in this volume, detailed coverage of socio-cultural impacts and other environmental issues is presented in Volume IV.

- Direct environmental impacts: The range of environmental impacts that may affect the tribes because of resource development is extensive and includes impacts to air, water, land, health, and worker safety. Each type of energy development results in certain environmental impacts that are characteristic of that type of development (e.g., strip mining of coal may result in the loss of land productivity for many years; large-scale geothermal-power generation may result in local fogging). However, the extent of the impacts even for the same type of project may vary significantly among sites and with the level of development.

- Direct fiscal impacts: The tribe may be faced with fiscal impacts as a result of development. These include the costs of educating and training tribal members for energy-related jobs; administrative costs of setting up and operating a tribal minerals office; and revenues versus investments involved with expanding and maintaining municipal services. Again, these impacts vary with the type and level of development and among demographic areas.

- Indirect impacts: The above four areas may have indirect impacts through multiplier effects. With the development of energy resources, a significant indirect economic impact would be the creation of jobs for tribal members in service industries attracted to the area. In addition, increased spending on the reservation may result in an increase in profits from retail sales and services. These impacts may either benefit or be detrimental to tribal enterprises and individuals, depending on the level of business attracted to non-Indian enterprises. Similarly, indirect socio-cultural impacts (e.g., through additional immigration of non-Indians to the reservation), environmental impacts (e.g., additional congestion and dust), and fiscal impacts (e.g., additional demands for public capital expenditures exceeding the immediate supply of available funds) would result.

In addition, the distribution of impacts among tribal members, tribal units of government, and non-Indians varies significantly among project types. The tribe may not wish to pursue development if it means tribal members will have to bear significant socio-cultural, economic, or environmental costs, while no similar costs will be borne by the developer or non-Indians attracted to the reservation by job opportunities who choose not to reside there. An example of an imbalance in the distribution of impacts is the cost to the tribe of financing municipal services to support the population attracted to the reservations (Indian and non-Indian), while the developing company bears no part of this burden. While distributional effects are not considered directly in the estimation of the project impacts described above, they should be considered in making decisions regarding energy resource development; the question of who gains from development and who bears the costs must be considered in addition to measuring what the estimated benefits and costs will be.

While the direct benefits of energy development (e.g., tribal income, income to tribal members employed by the energy company) can be estimated relatively accurately and put in dollar units, several major cost items (most notably the environmental impacts) are both difficult to measure and not easily converted from physical units of measure to dollar terms.

One major cost element that can be estimated is the opportunity cost of land conversion for energy development. In the case of oil and gas, it is possible to preserve multiple land uses with some land utilized for wells and related operations. However, when strip mining of coal or uranium mining is considered, the land is essentially removed from any alternative use until the area is "mined out." This land can then be put to alternative uses only if reclamation is attempted and is successful. In other words, the lost productivity of the land in alternative uses (i.e., its potential "value added") becomes an opportunity cost should the mining option be

selected. The costs of interest are jobs, wages and salaries, rental income, and/or profits lost should the land be removed from, for example, agricultural production. Other cost elements that are quantifiable in dollar terms include: costs to the tribe and individuals of relocating families and businesses from proposed development land (those costs can generally be estimated in dollar amounts per family or business relocated), and administrative costs to the government for setting up and operating a minerals office (which can be estimated in dollars).

One cost item of particular significance to western tribes in making energy development decisions pertains to the scarcity of water. This scarcity limits the potential for energy development (this would vary by reservation and types of development undertaken) and would reduce the quantity of drinkable water available to tribal members, thereby increasing its price. The special role played by water in the energy development process is discussed in greater detail in each of the resource-specific sections (Sections III, IV, and V).

As mentioned previously, the types and extent of impacts that result from development (e.g., agriculture, forestry, energy resources) vary significantly among project types and with levels of development. Since some of the factors discussed above may be more important to one tribe than another, a relative weighting system would be useful to assess the advantages and disadvantages of one or several projects being considered. The weights applied would represent value judgment on the importance of the tribe's economy, culture, etc., and would also reflect tribal development objectives. For example, one tribe may feel that the potential increase in mining jobs and income that would result from coal development on the reservation is not as important as preserving the land and the tribe's way of life as an agricultural society. The actual definition of these factors and the weight placed

on them can be determined only by the tribe, however. An example that illustrates this concept is presented at the conclusion of this section. The weighting system could then be applied to individual project proposals to rate them and either reject or accept each proposal. This step in the planning and decision process is illustrated in Exhibit II-1.

EXHIBIT II-1

TRIBAL RESOURCE PLANNING AND DECISION PROCESS

* The circled letters indicate points where Exhibit II-1 relates to Exhibit II-2.

The application of the tribal resource planning and decision process to a specific project requires that a detailed study be performed to determine the potential impacts of the projects. For most large-scale projects on Indian lands, an environmental impact statement (EIS) is prepared by a federal agency. In the EIS all the potential impacts of the proposed project and alternatives to the project are supposed to be presented. Although important in concept, the use of these documents for tribal decision making is generally limited because many tribe-specific impacts (especially social and cultural impacts) are not accurately or adequately assessed and because there is generally insufficient time given the tribes to review the EIS's and comment on them.^{1/} Where this is true, the tribe may need to conduct either a full or a supplementary feasibility analysis to use as a decision-making tool. In either case, the results of the feasibility analysis should include the best possible measurement of the types and extent of the proposed project's impacts as they relate to the tribes. Impacts that are advantageous to the tribes are labeled benefits; disadvantages are labeled costs. Conceptually, all the benefits and costs from a project would be compared on a common basis in a feasibility study so that the tribe could decide whether to accept, reject, or modify a project. If accepted, the conditions under which the tribe and developing company would decide how to distribute the potential project benefits and costs would be included in a formal contract agreement between the two parties.^{2/} Exhibit II-2 illustrates this process.

1/ In Volume IV, we discuss the purpose and requirements of an environmental impact statement and relate them in depth to specific issues concerning development on Indian lands.

2/ Examples of different contract agreements and examples of benefits and costs that result under different contract agreements are presented in this volume. Volume II is a detailed discussion of alternative contract arrangements.

EXHIBIT II-2

APPLICATION OF TRIBAL RESOURCE PLANNING AND DECISION PROCESS
TO SPECIFIC PROJECT

* Reference points from Exhibit II-1.

We present the above discussion to set the stage for development of the benefit-cost analysis framework that follows in the next part of this section. We have not finalized a resource allocation process, nor have we assigned weights to specific project characteristics and impacts. Each tribe must take on that responsibility individually. What we have attempted to do is to establish a framework or context within which resource allocation decisions can be made. The steps that would be undertaken by a tribe are:

- (1) Identify all the impact variables of interest.
- (2) Determine how to measure these variables for each type of project considered.
- (3) Establish a weight for each of the variables of interest (e.g., 100 points out of 1,000 possible points for income effects).
- (4) Establish a rating system so that measures can be put in comparable units.
- (5) Develop criteria for project evaluation (e.g., the total value of benefits versus the total value of costs).
- (6) Develop decision rules for project selection, rejection, or modification.

Comparison of unquantifiable benefits and costs is discussed again at the end of this section as part of the discussion on the application of weights to the benefit and cost estimates.

BENEFIT-COST ANALYSIS AND ITS USE IN MAKING RESOURCE ALLOCATION DECISIONS

Introduction

The preceding subsection has identified and described the elements of a tribal process for deciding how to use the tribe's natural, human, and other resources. The question now is how to tie the elements together so that decisions can be made on a basis that ensures the attainment of tribal objectives. The methodology we would propose to fill this gap is "benefit-cost analysis." It has been used very successfully by government agencies to compare the potential returns from major investments with the costs incurred and is analogous to "break-even" or "rate-of-return" analysis used by private businesses. The major feature of benefit-cost analysis is that it provides a methodology for evaluating projects whose impacts may be felt on the reservation for 20, 50, or even hundreds of years. While it does not provide all the answers (e.g., environmental impacts remain difficult to estimate and convert to dollar terms), it provides a framework for arraying all future benefits and costs so that informed decisions can be made and the results of those decisions closely monitored. What benefit-cost analysis really attempts to do is simulate a "bottom line" for a public sector investment by first comparing future benefits and costs that are measurable in dollar terms on a present-value basis. Benefits and costs that are difficult to measure in dollars (most notably, environmental costs) are then quantified and considered in the overall decision process to the extent possible (an illustration of how they are considered is presented at the end of this section). Similarly, positive and negative fiscal impacts are considered and included in the final decision process. The following subsections present

the steps involved in conducting benefit-cost analyses for energy development projects. In discussing the steps, we address the problems of measuring and comparing both quantifiable and non-quantifiable impacts on an individual project and inter-project basis. The presentation is organized around a series of exhibits and descriptive narratives.

Overview of Benefit-Cost Analysis Methodology for Energy Resource and Other Land Development Options

The following subsections present the steps involved in our benefit-cost analysis methodology for considering multiple land-use options. We first examine available energy resource information to determine what resources are recoverable and where land-use conflicts may be imminent. Next, estimates of alternative levels of production of recoverable reserves over some time period must be made. In this case we have used 20 years as a reasonable period for analysis. We then proceed to estimate the direct and indirect benefits and costs that would result under various levels of production and alternative contract arrangements. The major direct benefits include tribal revenues from contract agreements and tribal jobs and income. These are all estimable in dollar amounts. The results of the tribe and tribal members receiving such benefits as increased economic self-sufficiency and increased educational opportunities (because of the likely availability of more funds per-student) are not readily quantifiable and must be valued by the tribe using the relative weights discussed earlier in this section. The direct costs that can be estimated in dollar terms include the opportunity cost of alternative land uses (i.e., the net income that could be earned if the land remained in agricultural use) and the costs of relocating tribal families. The major cost that cannot be estimated in dollar terms results from environmental impacts. Water is given special attention because of its

high degree of use in energy-related enterprises and its relative scarcity on the majority of reservations. The indirect benefits and costs result primarily from "multiplier" effects and can only be estimated in dollar amounts utilizing specific case study information dealing with such factors as labor force characteristics, population increases, and commuting distances for the area. Based on the estimated population increases in reservation towns, a range of fiscal impacts that will result from the need to supply additional public services can also be estimated.

Finally, a summary is made of the total benefits and costs that would result from each energy resource or alternative land-use development option. These results are estimates of direct and indirect benefits and costs measurable in dollars and respective sets of unquantified benefits and costs (e.g., such factors as increased self-sufficiency, environmental costs). The dollar benefits can be compared directly with the dollar costs. However, to include the unquantified benefits and costs in the final summary, the tribe must rely on the system of relative weights developed earlier in the tribal resource planning and decision process. Fiscal impacts are also summarized and treated separately because they deal with potential revenue and expenditure patterns on the reservation, the timing of the revenues and expenditures, sources of funding for front-end infrastructure investments, and related issues. We emphasize again that, in comparing an identifiable stream of future benefits and cost dollars, present value discounting should be utilized in order that future benefits and costs will be accorded their proper value in making investment decisions at a given time. Exhibit II-3 summarizes the steps needed to reach a well-reasoned land-use decision for each energy project being considered.

EXHIBIT II-3

SUMMARY OF BENEFIT-COST ANALYSIS METHODOLOGY FOR ENERGY RESOURCE AND OTHER LAND DEVELOPMENT OPTIONS

A. Examine energy resource reserves data for each reservation in terms of feasibility of recovery (e.g., depth of deposit, quality of mineral, production history). Examine available data for other land use options.

B. For each resource on a reservation select alternative levels of production that illustrate low to high intensity development (e.g., 1,5, and 10 million tons of coal mined per year).

C. For each development alternative, identify direct benefits that accrue to Tribal members individually or collectively over time and quantify, where possible, in monetary or other terms (e.g., increase in the number of jobs and income, potential for additional funds for education)

D. Identify direct costs to the Tribe in monetary or other terms (e.g., direct environmental impacts, relocation costs associated with conversion of land from agricultural to mining use, administration). If the Tribe were to enter into a joint venture, its share of capital outlays and annual operating expenses would also be considered.

E. Identify indirect benefits (e.g., induced employment and income through multiplier effects) and indirect costs (e.g., secondary environmental effects) and quantify where possible.

F. Summarize the benefits and costs for each development level that will aid Tribal decision-making using discounted values of future benefits and costs where appropriate.

G. Estimate and summarize fiscal impacts: revenues (e.g., severance taxes, sales/property tax in addition to royalties/profit-sharing) vs. costs (e.g., additional expenses for such public services as water and sewer, roads, education, police and fire protection, health care)

A.

B.

C. Estimate Direct Benefits

D. Estimate Direct Costs

E. Estimate Indirect Benefits and Costs

F. Summarize Benefits and Costs

G. Summarize Fiscal Impacts and Incorporate into Benefit-Cost Calculations

Mineral Reserve Characteristics	
- depth	- production
- quality	- history
	- demand

Alternative Land Development Options	
- agriculture	- other
- timber	- no development

Alternate Levels of Production		
Mineral A		Other
Produce X(T/yr)	Produce Y(T/yr)	
1,2,3,...years	1,2,3,...years	

Alternative Land Use(s)		
Agriculture	Timber	Other
Acres	Acres	
1,2,3,...years	1,2,3,...years	

Examination of Resource Characteristics (Step A)

The first step in energy resource development planning is to identify the quantity and quality of each resource on the reservation.^{1/} Once the reserves are clearly identified and described, they would be mapped to provide visual clarity. These maps could then be overlaid against existing land-use maps and maps showing potential land uses available from such sources as the tribal planning office, the Bureau of Indian Affairs (BIA), the U.S. Geological Survey (USGS), and the U.S. Department of Agriculture's Soil Conservation Service (SCS). The overlaying of maps identifies areas of existing/potential land-use conflict. For example, if a coal mine were proposed for a certain amount of tribal acreage currently used for agricultural purposes, the maps and additional information from tribal records could be utilized to identify the numbers of ranchers/farmers currently occupying the land, their characteristics, and the amount of net income they have earned in recent years.^{2/} Exhibit II-4 illustrates the concept of resource characteristics discussed above. It describes the specific types of reserve estimate and production information needed by the tribe to estimate a range of recoverable mineral reserves. In addition, it describes alternative uses of the land that should be considered by the tribe in describing how a particular tract should be developed.

1/

Information of this type is available to many of the energy resource tribes through public sources, such as the Bureau of Mines and U.S. Geological Survey.

2/

Some of this information is recorded by the BIA Branch of Real Property Management on Form 50-1.

EXHIBIT II-4

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

A. Examination of Resource Characteristics

Energy Resources

Alternative Land Use(s)

Notes: For each reservation, examine available resource reserve estimates, production histories, and available land-use and productivity data. Indicate ranges of recoverable energy resource reserves based on reserve characteristics or production history characteristics. Determine alternative land-use options from available land-use data.

Estimation of Production Levels (Step B)

From the framework established in Exhibit II-4, specific development scenarios are considered given the reserve characteristics that the tribe will have obtained during Step A. The benefits and costs to the tribe can then be estimated for each of the development scenarios, with the no-development scenario (e.g., continued agricultural use) serving as the base comparison case. Exhibit II-5 illustrates this step further. It divides the recoverable reserves into two production-level alternatives and describes the elements of each alternative level. Also shown is the alternative of continuing the current agricultural land use.

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

B. Estimation of Levels of Production

61-11

Notes: For each energy resource on the reservation, select rates of production that illustrate low to high levels of development (two cases are used). A low level of production per year may permit longer term development. High-intensity development may require extensive development effort and may involve production rates that will deplete reserves at a fast rate. Available technology, prices, and demand are factors included in determining cases for low and high levels of development. For alternative land uses (e.g., grazing) estimate either lease income (if land is leased) or value added from the land by year. This lost income/value added is an opportunity cost of developing energy resources (except in the case of oil and gas, where multiple land uses are possible). In this case 20 years has been selected as a reasonable period of analysis.

1/ MTY indicates millions of tons per year.

Estimation of Direct Benefits from Energy and Alternative Resource Development (Step C)

This step is organized into two parts. Part 1 addresses income earned by the tribal government representing tribal members collectively. The revenues earned would be a bonus payment and monthly rentals plus royalty income under a lease agreement; a share of profits under a net profits interest operating agreement or joint-venture arrangement;^{1/} and a residual ownership share under a service-type contract. These revenues can be utilized in one of three general ways:

- (1) Per capita payments to tribal members
- (2) General or special fund expenditures on such additional public services as health care and education
- (3) Tribal savings and investment for contingencies (e.g., unforeseen environmental problems) or for future generations (to maintain a higher standard of living once the resources are depleted).

The indirect impacts to the tribe discussed below (e.g., multiplier effects) will depend to a degree on how the tribe allocates its income from minerals activities.^{2/}

Part 2 of this step describes the means of calculating the direct income benefits derived from jobs that would be obtained by tribal members. The percentage of this income plus the tribal income paid out on a per capita basis that is spent on current consumption on the reservation would

^{1/} As discussed in considerable detail in Volume II, several arrangements ("deals") the tribes have either made recently or are currently negotiating that are labeled joint ventures are really combined royalty/net profits interest arrangements.

^{2/} The complex question of land ownership on reservations is also discussed in Volume II.

provide a direct infusion of dollars into the tribal economy. In the short run, current consumption could exceed earnings through established borrowing mechanisms (e.g., a tribal credit union). Step C is illustrated in Exhibit II-6.

EXHIBIT II-6

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

C. Estimation of Direct Benefits from Energy and Other Land Resources

Mineral A

Alternative Land Uses

Production level X (Tons/year) 1, 2, 3 _____ X years	Production level Y (Tons/year) 1, 2, 3 _____ Y years	Agricultural Production 1, 2, 3 _____ years	Timber Production 1, 2, 3 _____ years
--	--	--	--

1. Annual/Cumulative Revenues to Tribal Government/Tribal Members

Revenues/Year _____	Revenues/Year _____
years _____	years _____
(a) Gross revenues from production	(c) Tribal joint-venture cash flow
(b) Total cash flow after taxes	(d) Tribal royalty cash flow

Revenues/Year _____	Revenues/Year _____
years _____	years _____
(a) Agricultural land is privately held	(c) If leased timber operation, royalty cash flow to tribe (based on annual board-feet of timber)
(b) If tribal timber operation, net income or (loss) from operation	

Notes: Revenues to tribal government vary mainly with the rate of production, the unit value of the resource, and the type of contractual arrangement (i.e., joint-venture or lease agreement). Revenues received under alternative contractual agreements and production levels are estimated over time. Revenues from other land-use activities will be estimated by projecting current levels into the future.

EXHIBIT II-6 (Cont.)

Energy Resources

Alternative Land Uses

Production level X

Production level Y

Agriculture

Timber Production

2. Direct Jobs and Personal Income:

a. number of jobs generated:

X Tons/year x jobs/ton
= # jobs generated

Y Tons/year x # jobs/ton
= # jobs generated

b. personal income from jobs

(# management jobs
X (average salary)
= total annual income

(# management jobs)
X (average salary)
= total annual income

(# field jobs)
X (average salary)
= total annual income

(# field jobs)
X (average salary)
= total annual income

agricultural jobs

forestry jobs

(# jobs) X (average salary) = total annual income
or
if privately leased, rental income

(# jobs) X (average salary) = total annual income
or
if privately leased, rental income

Estimation of Direct Costs of Energy Development (Step D)

This step is also divided into two parts, distinguishing between direct cost impacts from energy development and cash outlays that would be required of the tribe in a joint-venture arrangement. In the first category of costs, estimates of lost jobs and income are provided in the detailed examples that follow. This type of impact pertains primarily to large coal strip mines and uranium mines that consume large numbers of acres in their entirety during the lifetime of the mine and in subsequent years, depending upon the extent and degree of success of reclamation efforts. The other economic, socio-cultural, and environmental impacts are significantly more difficult to estimate. Nevertheless, their magnitude and the way in which the tribe weights them could be the critical factor in determining whether a specific project is undertaken.

The second category of costs pertains to tribal financial responsibilities under a joint-venture arrangement. In the context of this report, a joint venture involves a financial contribution by the tribe to the operation, in addition to tribal minerals. Joint-venture contributions (or costs) are assigned directly in the cash-flow and rate-of-return analyses presented as part of the detailed examples. Exhibit II-7 further illustrates both types of costs.

EXHIBIT II-7

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

D. Estimation of Direct Costs of Energy Development

GENERAL COSTS (Regardless of Type of Contractual Arrangement)

1. Economic and Socio-cultural Impacts

- a. Lost jobs and income resulting from conversion of land (opportunity cost)
- b. Costs of forced relocation (e.g., moving, new housing)
- c. Other socio-cultural impacts as described in detail in Volume V, "Analysis of Environmental Issues" (e.g., disruption of the tribal way of life, a loss of the land as a cultural element, reduced quality of education in potentially overcrowded schools)
- d. Increased cost/lack of availability of residential and agricultural water supply as a result of competing demands
- e. Administrative cost of planning and enforcement activities through expanded minerals office

2. Physical Environmental Impacts

- a. Air emissions
- b. Water effluents
- c. Deteriorated ground water quality
- d. Terrestrial impacts and reclamation (irreversible land uses such as open pits, solid waste disposal)
- e. Ecological disruption (wildlife, flora disruption)

EXHIBIT II-7 (Cont.)

DIRECT COSTS OF ENERGY ENTERPRISE (Tribal Share of Joint-Venture Outlays Only)

<u>Production Level X</u>	<u>Production Level Y</u>
1. Capital outlays for mineral development	Unit costs (per acre) remain fairly constant
a. Costs for exploration:	
(Total cost = cost per acre x no. of acres x % tribal operating interest)	
b. Capital outlays = outlays for equipment and buildings, trans- portation access routes, etc. x % tribal operating interest (initial outlay to be amortized over life of equipment and buildings)	Unit costs (per ton) decrease as rate of production/size of mine increase
2. Operating expenses: (labor, materials, general and administrative, transportation- related) x % tribal operating interest (venture may not be subject to income and severance taxes if at least 51% tribally owned)	Unit costs (per ton) decrease as rate of production/size of mine increase
3. Reclamation expense: cost of reclamation x % tribal operating interest	

Estimation of Indirect Benefits and Costs of Energy Development (Step E)

Indirect benefits and costs are distinguished from the direct benefits and costs primarily in their timing and the extent to which they impact the reservation economy. For example, income multiplier effects result from the continued spending of the dollars earned and first spent by people directly involved in a mining enterprise. In terms of the reservation, the first question pertains to how much is spent on the reservation as opposed to off the reservation. A second question pertains to what types of items are purchased (e.g., food, clothing, housing). If goods purchased on the reservation are manufactured elsewhere, the majority of the dollars are "leakages" off the reservation going to pay the wages, salaries, and owners of the manufacturing concern.

A second important issue pertains to measurability. The majority of indirect benefits and costs are extremely difficult to measure, and we have relied on information contained in other studies in our more detailed analysis. Hence, we can provide only "ball-park" estimates based on similar patterns observed in the past for selected geographic areas. The result is a set of planning factors that can be used by tribal staff to assess these indirect impacts in specific situations. Exhibit II-8 illustrates the estimation of indirect benefits and costs.

EXHIBIT II-8

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

E. Estimation of Indirect Benefits and Costs of Energy and Land Development

1. Benefits

- Multiplier effects resulting from additional spending created by:
 - mining jobs/income
 - spending of royalty income through per capita distribution
 - spending of royalty income by tribal government (e.g., on education and health services)
- If a tribe takes a portion of royalty payment in kind and passes it on to tribal members, a benefit would be realized in the form of increased comfort and/or savings, with the cash savings realized from them spent on additional goods and services
- Additional purchases of goods and services on the reservation by mining employees residing off the reservation (could lead to expansion of such existing tribal businesses as grocery stores, gas stations, and restaurants, and to creation of new businesses)
- Increase in residential construction activity/rehabilitation on the reservation should housing demand (other than mobile homes) increase

2. Costs

Additional economic (e.g., costs of financing expanded tribal educational programs in business training or other areas to develop other areas of the tribal economy), socio-cultural (e.g., changes in major occupations and life-styles), and environmental costs (e.g., additional environmental pollution from increased commuting traffic, residential sewage, etc.) associated indirectly with increased activity on the reservation that were not directly measurable under Step D.

Summarization of Benefits and Costs of Energy Development versus Other Land-Use Options (Step F)

This summary provides the framework for the comparison of benefits and costs and the application of the resource allocation model to specific projects (described in Exhibits II-1 and II-2). The major problem that exists in energy development is that although the direct benefits can be estimated with a reasonable degree of accuracy, the direct costs (particularly the environmental costs) cannot be projected accurately. The result is that a project could be expected to generate \$100 million of benefits to a tribe over a 20-year period (discounted to present value) with the dollar value of the majority of project costs unknown. As discussed in the detailed examples and in Volumes II and IV, this situation elevates the degree of importance of the tribe's minerals office and planning staff as well as dependence of tribal leaders on the results of environmental impact statements (EIS's), feasibility studies, and other reports. Exhibit II-9 summarizes this step.

EXHIBIT II-9

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

F. Summarization of Benefits and Costs of Energy Development (Production Level X or Y) versus Other Land-Use Options

1. Estimate benefits by year for, say, a 20-year time period (1977-1996) and record in a 20-year grid.
2. Estimate costs by year and record in same manner. Include opportunity cost, which is potential value added lost from alternative uses.
3. Select a discount rate (10% or higher) that reflects current opportunity cost of capital and time preferences of tribal members (the more a tribe values preservation of resources for future generations, the lower the discount rate will be because it is assumed that the financial return of undeveloped land will be very low compared with most other investment options).
4. Where benefit measures can be translated into dollars, discount benefits and costs to present value and compare. If benefits exceed costs, the generally accepted decision rule would be to approve the project.
5. The most difficult area is to factor in the nonquantifiable benefits and costs before arriving at a final decision.

Estimation and Summarization of Fiscal Impacts and Their Incorporation into the Benefit-Cost Calculations (Step G)

We have made an attempt in this study to distinguish between economic and sociocultural impacts resulting from energy development and the governmental fiscal impacts. The former measure the ways in which resources are utilized as a direct result of economic activity and whether the net result is beneficial (benefits exceed costs) or detrimental (costs exceed benefits). The fiscal impacts deal with governmental involvement in the process as a provider of services that require the raising of revenues for their support. As an example, there is a distinction between the costs of extracting and selling coal and the cost to the tribal government of providing such services as police and fire protection and water and sewer service to handle additional business and residential demands. While both are significant aspects of the energy development decision process, the fiscal impact area involves a whole series of questions regarding the quantity and quality of services, methods of financing, and other areas of concern. The fiscal impact area should not be confused with direct project-related social benefits and costs. The summarization of expected impacts and planning options in both areas, however, is necessary to provide a fully integrated tribal resource allocation decision process. Exhibit II-10 summarizes many of the potential fiscal impacts that could be expected in the revenue and expenditure areas.

EXHIBIT II-10

DETAILED STEPS INVOLVED IN BENEFIT-COST ANALYSIS

G. Estimation and Summarization of Fiscal Impacts and Their Incorporation into the Benefit-Cost Calculations

1. Revenues

- Rentals, bonus payments received by tribal government not included in Step C less per capita distributions
- Severance taxes received
- Other tax revenue possible, particularly pertaining to non-Indians living/working on reservation:^{1/}
 - property tax
 - sales and use tax
 - payroll/income tax
 - license fees
 - fines
- User charges from enterprise accounts (where applicable):
 - water and sewer system
 - telephone company
 - electric utility
 - other commissions/authorities (parking, recreation, education, etc.)

2. Expenditures

- Cost of operating minerals, planning, economic development and other offices (also addressed under direct costs)
- Cost of providing additional public services (capital outlays and annual operating expense)
 - water and sewer
 - education
 - police protection
 - fire protection
 - public health
 - recreation
 - etc.

Fiscal impacts can be estimated year by year in a manner similar to benefits and costs to determine where front-end financing will be required, using such techniques as front-end property tax payments as described in several boom-town studies. Sources of planning funds are discussed in Volume II.

^{1/} The issue of tribal taxation of non-Indians living or working on a reservation has not been resolved.

SUMMARY: HOW BENEFIT-COST ANALYSIS CAN BE APPLIED TO ENERGY DEVELOPMENT DECISIONS

The objective of this section has been to set the stage for the more detailed analyses that follow. While several areas in benefit-cost analysis (particularly its application to energy development issues) are not entirely resolved, the planning framework provided here addresses the important issues and provides a basis for tribal planners to fill in specific numbers, weights, and other information. In this way, well-informed decisions regarding energy resource development can be made. For example, by using the benefit-cost analysis methodology, the tribe would be able to answer questions similar to the following, using one or more of the analysis steps listed:

Economic (and Fiscal) Impacts:

- What levels of income would be realized by the tribe and for how long?
- How much land or capital will the tribe risk if technological or environmental problems affect the project adversely?
- Should the tribe develop other resources (e.g., agriculture or timberlands) instead of or in addition to energy resources?

Socio-Cultural Impacts:

- Will tribal members benefit from higher employment rates and better salaries?
- Will a significant influx of non-Indians occur?

Environmental Impacts:

- What is the nature of the impacts that can not be easily quantified as compared with some of the measurable benefits and costs?
- How will the cost of measurable environmental impacts change over the life of the project?

The following steps would be included in a tribal "check list" for the use of benefit-cost analysis:

- Review available reserve data and determine areas of potential land-use conflicts.
- Estimate alternative levels of production for energy resources and alternative land uses.
- Estimate such direct benefits from energy development as tribal revenues and income from jobs. Identify other benefits that are not easily measured and quantify to the extent possible.
- Estimate direct costs and identify other costs that are not easily measured (e.g., quantify environmental damage in physical units for possible future conversion to dollars).
- Estimate indirect benefits and costs and fiscal impacts in a similar manner.
- Add up the quantifiable benefits and compare with the sum of the quantifiable costs (i.e., where both are measured in dollar terms).
- Apply relative weights to each of the unquantifiable impact areas and judge whether the total benefits outweigh the total costs.
- If the benefits exceed costs, the project should be considered for acceptance. If the costs significantly exceed benefits, the project should probably be considered for rejection. If the costs only slightly exceed the benefits, the tribe may wish to accept the project with additional modifications.

In applying weights to compare unquantifiable impacts for a final decision, a tribal weighting scale could be modeled after the Navajo Tribe's Method for Evaluating Development Projects.^{1/} Where several

^{1/} Eric Natwig, A Method for Evaluating Proposed Navajo Development Projects: Criteria and Weights for Investment Decisions, Navajo Nation Office of Program Development, March 1975. The proposed Navajo model assigns 350 points to economic impacts, 300 points to physical impacts (including the environment), and 350 points to social-cultural impacts (a total of 1,000 points). These points are then broken down and assigned to more specific areas (e.g., number of jobs created, effect on water quality). More detail is not provided in this report because the model has not yet been tested.

projects are considered, a rating scale could be established (e.g., 0 to 10 or -5 to +5) to determine how the project rated on each attribute. The scores multiplied by the weights would yield aggregate ratings for projects as a whole. The tribe would then judge which projects are worth undertaking.

Stated more simply, suppose a project is expected to provide \$50 million^{1/} in benefits to the tribe and its members over an expected 25-year project life span, plus some amount of benefits not measurable in dollars. The tribe and its members, however, will bear \$10 million in direct costs, plus environmental damage and other costs not measurable in dollars, over the same time span. Since the measurable benefits exceed the measurable costs by \$40 million (\$50 million minus \$10 million), the major question is whether the environmental and other unmeasurable costs exceed the unmeasurable benefits by more than \$40 million. The tribe should hire planners, environmental scientists, and other professionals (refer to Volume II for more details) to determine what impacts are likely to occur and explain them to tribal decision makers so that the tribe can determine whether or not the total benefits exceed the total costs, and hence whether or not the project should be undertaken. In terms of the weighting system discussed previously, the question is whether the expected environmental damage should be assigned a value equal to, greater than, or less than four times the measurable costs (\$10 million multiplied by

^{1/} All dollar figures represent estimates of future values discounted to present value.

four would equal \$40 million). Stated differently, the \$40 million could be expressed as 0.8 multiplied by the measurable benefits (\$40 million equals \$50 million multiplied by 0.8). While the decision rules of a specific tribe may vary (e.g., tribes wary of energy development may require benefits to be twice the costs in order to undertake a project), the same approach would be used.

One point cannot be overemphasized. While benefit-cost analysis provides a methodology that identifies what has to be measured and the way in which measurable project impacts can be compared, it does not provide any additional insight into how unquantifiable benefits and costs can be quantified and converted to dollars. This is a very difficult problem with which such federal agencies as the Environmental Protection Agency (EPA) and the Department of the Interior (DOI) are now dealing. It requires detailed analysis by a tribe contemplating development of its energy resources on a project-by-project basis.

With an overview of the benefit-cost framework in mind, Sections III, IV, and V consider the application of the methodology to each of five energy resources. Section VI then summarizes the findings of those sections.

III. DETAILED APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: COAL DEVELOPMENT

INTRODUCTION

Background

This section presents a detailed application of the benefit-cost analysis framework developed in Section II to the development of coal resources. The examples are based on a hypothetical tribe that has substantial coal reserves on land that at present is used primarily for agriculture (ranching, dry farming). The purpose of presenting a hypothetical example is to illustrate the types of benefits and costs that any tribe with coal reserves may experience if it chooses to develop those reserves. The word "illustrate" cannot be overemphasized because each resource and tribal situation will vary, depending upon such factors as coal characteristics (e.g., rank, heat content) and the attitude of tribal members toward development. Similar illustrations are presented in Section IV for oil and gas, and in Section V for uranium, geothermal, and oil shale. Section VI summarizes the results for the five types of energy resources, highlighting the similarities and differences.

Assumptions

Specific assumptions were made in formulating the coal development examples. Unless otherwise noted, resource estimates are purely hypothetical and are not intended to resemble any tribe in particular. Assumptions made were:

- The tribe has 100 million tons of coal that can be recovered through surface mining.
- 5 million tons per year (MTY) will be recovered from a single surface mine for a period of 20 years. This scale of operation would be appropriate for the coal resources of several tribes who are members of CERT.
- The heat content (Btu value) of the coal is relatively low (characteristic of Northern Great Plains coal).
- The sulfur content of the coal is low (less than 0.75%).
- Seam thickness is deep (over 20 feet).
- The stripping ratio (cubic yards of overburden removed per ton of coal mined) is 3:1.
- Two years elapse between the decision to develop the mine and the actual mining of coal. Thus, the project will extend over 22 years (2 years for startup and 20 years for mining).

These assumptions combine to make the coal economically worthwhile to mine and marketable in out-of-state markets as low-sulfur utility fuel. Under this scenario, one mine will produce enough coal to supply an 800-megawatt (MW) power plant, or a 3-MTY coal liquefaction plant. (A coal gasification plant would require at least 6.5 MTY.) It is presumed that the tribe will not receive any revenues from the operation or ownership of the energy conversion facilities to which the coal is supplied.^{1/}

^{1/} However, if the energy conversion facilities are constructed on the reservation, the tribe would receive annual rental payments for the land. This potential additional revenue is not included in the analyses that follow.

ESTIMATION OF DIRECT BENEFITS TO THE TRIBE

Overview

As discussed in Section II, the most significant benefit that will accrue to the tribe will be in the form of income from contracts with mineral development firms. Several different forms of contracts are possible. In the past, most contracts have been leases, under which the tribe received revenue in the form of royalties. Another type of arrangement is a "carried-interest joint venture," in which a tribe receives a portion of the revenues and uses these revenues to purchase ownership in the venture. Still other variations are possible, such as "net profits interest" and "service contract" arrangements. These are discussed in detail in Volume II.

In the subsections that follow, tribal income from the hypothetical mining venture is estimated for two different arrangements: a lease arrangement, and a carried-interest joint-venture arrangement. These two examples will serve to illustrate the application of benefit-cost analysis as an aid to decision-making. It is important to realize that these are only two of the many possible arrangements, and that tribal income under any particular arrangement depends on the exact nature of each project.

The other major type of direct benefit will accrue to tribal members in the form of jobs and personal income that result from construction and operation of mine and conversion facilities. Each of these major types of benefit is analyzed in a subsequent subsection.

Royalty Lease Arrangement

In the past, most coal leases on Indian lands have included payments to the tribe on a flat royalty basis (a specified amount per ton produced, regardless of the market value of the coal). In more recent leases

royalties have been computed as a percentage of market value of the coal. Some leases also have escalation clauses, under which the percentage used to calculate the royalty increases over time. Under most lease agreements, there is no tribal involvement in the management of the mining operation.

The example is based on the following additional assumptions:

- In the first year of production (year 3), the coal is sold for \$6.00 per ton, a price that is appropriate for low-Btu coal. The future price will escalate at 8.5 percent per year. This is to account for inflation (assumed to be 6 percent per year) and increased production costs, as easily mined coal is depleted and it becomes necessary to extract economically less attractive coal.^{1/}
- A lease rental of one dollar per acre per year will be paid to the tribe for all leased land, including that not developed. A total of 47,000 acres is assumed to be leased under this scenario.^{2/} Therefore, the annual rental fee will amount to \$47,000. This amount is small compared with potential royalties or profits.
- A lump sum lease bonus of \$1 million is paid to the tribe at the start of the project.

Under the above assumptions, and the general assumptions developed in the introduction to this section, tribal revenues can be estimated for different royalty rates. Exhibit III-1 shows revenue calculations for three royalty rates: 7 percent, 12½ percent, and 18 percent. The 7 percent rate is comparable to that currently received by some tribes. The 12½ percent rate is used because it is the rate specified for federal lands in the Federal Coal Leasing Act Amendments of 1976. The 18 percent rate is used

^{1/} These figures are based on a recent analysis of long-term mining costs and inflation rates: Energy and Economic Impacts of H.R. 13950 ("Surface Mining Control and Reclamation Act of 1976," 94th Congress), ICF, Inc., 1977, Draft Final Report.

^{2/} Based upon numbers provided in recent Environmental Impact Statements (EIS's).

because it is above the 12½ percent rate by the same amount the 7 percent rate is below the 12½ percent rate. It should be stressed that 18 percent is not necessarily a realistic royalty rate for a tribe to seek. It is used here simply for comparison purposes.^{1/}

^{1/} The primary reason it may not be realistic is that a mining company may not be able to pay as much as 18 percent to the tribe "off-the-top" and still earn a sufficient rate of return on its investment to warrant undertaking the project.

EXHIBIT III-1

ROYALTIES FROM LEASE ARRANGEMENT

Year	MTY	Price (\$/Ton)	Gross Revenues (\$ Millions)	Royalties Received (\$ Millions) ^{1/}		
				7%	12½%	18%
1	0 ^{2/}	--	--	\$ 1.047	\$ 1.047	\$ 1.047
2	0	--	--	0.047	0.047	0.047
3	5	\$ 6.00	\$ 30.00	2.147	3.797	5.447
4	5	6.510	32.550	2.325	4.116	5.906
5	5	7.063	35.317	2.519	4.462	6.404
6	5	7.664	38.319	2.729	4.837	6.944
7	5	8.315	41.576	2.957	5.244	7.531
8	5	9.022	45.110	3.205	5.686	8.167
9	5	9.789	48.944	3.473	6.165	8.857
10	5	10.621	53.104	3.764	6.685	9.606
11	5	11.524	57.618	4.080	7.249	10.418
12	5	12.503	62.516	4.423	7.861	11.300
13	5	13.566	67.830	4.795	8.526	12.256
14	5	14.719	73.595	5.199	9.246	13.294
15	5	15.970	79.851	5.637	10.028	14.420
16	5	17.328	86.638	6.112	10.877	15.642
17	5	18.800	94.002	6.627	11.797	16.967
18	5	20.398	101.992	7.186	12.796	18.406
19	5	22.132	110.662	7.793	13.880	19.966
20	5	24.014	120.068	8.452	15.055	21.659
21	5	26.055	130.274	9.166	16.331	23.496
22	5	28.269	141.347	9.941	17.715	25.489
Total				\$103.624	\$ 183.900	\$ 263.269

^{1/} Royalties received include: a \$1 million lease bonus in year 1, plus \$47,000 each year for land rental, in addition to the specified percentage of gross revenues.

^{2/} Two years elapse between the start of the project and the actual mining of coal.

In Exhibit III-2, the cash flow projections from Exhibit III-1 are examined in two ways. First, each annual figure is restated in constant dollars, so as to remove the distortions caused by inflation. In this example, it was assumed that inflation occurs throughout the 22 years at an annual rate of 6 percent. Second, the present values of the streams of cash flows are computed, using discount rates of 10 and 15 percent.^{1/} As explained in Section II, present-value analysis is the best way to compare the benefits from alternative projects over time.

^{1/} A real discount rate of 10 percent is that recommended in Office of Management and Budget (OMB) Circular A-94 as a "standard discount rate." A second, slightly higher discount rate (15 percent) is also used to reflect the riskiness of mining ventures and illustrate the sensitivity of the benefit and cost calculations to the choice of discount rate.

EXHIBIT III-2

ANALYSIS OF CASH FLOWS FOR ALTERNATIVE ROYALTY AND DISCOUNT RATES
(All Figures in Millions of Dollars)

Year	7% Royalty		12½% Royalty		18% Royalty	
	Royalty Income In:		Royalty Income In:		Royalty Income In:	
	Current \$	Constant \$	Current \$	Constant \$	Current \$	Constant \$
1	\$ 1.047	\$ 0.988	\$ 1.047	\$ 0.988	\$ 1.047	\$ 0.988
2	0.047	0.042	0.047	0.042	0.047	0.042
3	2.147	1.803	3.797	3.188	5.447	4.573
4	2.325	1.842	4.116	3.260	5.906	4.678
5	2.519	1.882	4.462	3.334	6.404	4.785
6	2.729	1.924	4.837	3.410	6.944	4.895
7	2.957	1.967	5.244	3.488	7.531	5.009
8	3.205	2.011	5.696	3.567	8.167	5.124
9	3.473	2.056	6.165	3.649	8.857	5.242
10	3.764	2.102	6.685	3.733	9.606	5.364
11	4.080	2.149	7.249	3.819	10.418	5.488
12	4.423	2.198	7.861	3.907	11.300	5.616
13	4.795	2.248	8.526	3.997	12.256	5.746
14	5.199	2.300	9.246	4.090	13.294	5.880
15	5.637	2.352	10.028	4.184	14.420	6.017
16	6.112	2.406	10.877	4.282	15.642	6.157
17	6.627	2.461	11.797	4.381	16.967	6.301
18	7.186	2.518	12.796	4.483	18.406	6.448
19	7.793	2.576	13.880	4.588	19.966	6.599
20	8.452	2.635	15.055	4.694	21.659	6.753
21	9.166	2.695	16.331	4.804	23.496	6.911
22	9.941	2.759	17.715	4.916	25.489	7.073
Undiscounted						
Total	\$103.624	\$45.914	\$183.900	\$80.803	\$263.269	\$115.692
Present Value of Cash Flows:						
Discounted at 10%		\$15.683		\$27.116		\$38.548
Discounted at 15%		\$10.552		\$18.032		\$25.510

8-III

The "bottom line" in this example is the present value of the stream of royalty cash flows after it has been adjusted for inflation; this is shown for each royalty rate, and for the two discount rates (10 and 15 percent) in Exhibit III-2. Clearly, the choice of both the royalty rate and the discount rate will make a vast difference in the estimation of direct cash benefits from the project.

Carried-Interest Joint-Venture Arrangement

Another of the many possible contractual arrangements between a tribe and a mineral development firm is a carried-interest joint venture. In essence, the mining company pays all the costs of development, i.e., in financial terms, it "carries the interest" of the tribe. When the mine begins operation, the tribe pays back the mining company (with interest) out of its share of revenues from production. The most obvious advantage of this arrangement is that it gives the tribe an immediate ownership position, without requiring it to finance development from its own funds. Usually, it entitles the tribe to participate in the operating decisions. Most carried-interest projects also require the mining company to sell the tribe's share of production on its behalf, if the tribe does not want to engage directly in marketing.

The following assumptions are used in formulating the numeric example of a carried-interest joint venture:

- The tribe has a 50 percent carried interest. This means that the tribe will eventually pay back to the operating company one-half the investment required to develop the mine, plus accrued interest. It also means that the tribe and operating company will share equally the revenues and costs of operations. The size of the carried interest may vary with the specific contract. For example, it would be possible for the tribe to have only a 30% carried interest in the venture if that represented the share of ownership desired.

- The tribe uses all of its initial revenue from operations to repay the carried interest (investment plus accrued interest), until the balance is 0. Thus, the tribe receives no net revenue (with the exception of a bonus at the start of the project) until all of the carried interest has been repaid. This is another area for negotiation: Specific contracts may require that only a portion of revenue from each year's operations be devoted to repayment of the carried interest.^{1/}
- Interest is assessed at an annual rate of 10 percent on the portion of the carried interest that has not been repaid. Again, the interest rate charged may vary from contract to contract.
- The price of coal starts at \$6.00 per ton and escalates at a rate of 8.5 percent per year. This is the same assumption employed above in the lease arrangement analysis.
- Production costs start at \$2.58 per ton, and also escalate at a rate of 8.5 percent per year (6 percent for inflation and 2½ percent for the increase in cost as the most easily mined coal is depleted). This estimate is based on Bureau of Mines 1972 data (Publication IC-8535), updated with the Marshall & Swift Mining and Milling Equipment Cost Index and the Chemical Engineering Plant Cost Index. The \$2.58 figure represents the average production cost for a 5 MTY Northern Great Plains surface mine.
- Included in the \$2.58 per ton is \$0.36 per ton for reclamation costs (ICF, Inc., op. cit.). An area is reclaimed as soon as it is mined. The Surface Mining Control and Reclamation Act of 1977 (PL 95-87) requires that reclamation occur as soon as possible after mining.
- A severance tax of 30%^{2/} is levied by the state on gross income (the money received from sale of the coal).

^{1/} However, the longer the tribe takes to pay back the carried interest, the greater will be the total interest payments.

^{2/} Taxes levied against coal extraction by states in the study area are summarized in Volume II. The 30 percent figure corresponds to the severance tax rate in Montana (which is high in comparison to other states).

- The tribe is not required to pay income taxes. Although this assumption is employed here, it is not always the case. The tax-exempt status of tribal revenues is a complicated issue and depends on the specific provisions of the contract and the laws of the state.
- The operating company pays the tribe a bonus of \$1 million at the start of the project.
- The initial investment required to develop the mine is \$22.3 million. This is based on Bureau of Mines 1972 cost data for a 5-MTY Northern Great Plains surface mine, updated to 1977 using cost index data. Half of the development costs are incurred in each of the first two years.
- For computation of the operating company's income tax, 75% of the initial investment is capitalized, and the remainder is expensed. This proportion was derived from 1972 Bureau of Mine estimates. The capitalized investment is depreciated using the straight-line method over 20 years. The effective income tax rate is 50 percent (48 percent federal and 2 percent state).

It must be stressed that the parameters of each specific situation may well be different. The assumptions employed here--regarding the size and timing of revenues and costs, interest rates, capital costs, and so forth--were chosen to approximate a realistic situation; but one cannot assume that the same assumptions can be applied to the analysis of any specific mining project. It is impossible to overemphasize the importance of obtaining good data--on reserves, likely capital costs, tax laws of the state in which the mine is located, etc.--before a benefit-cost analysis of a project is attempted.

Exhibit III-3 presents the financial analysis of the carried-interest joint venture, based on the assumptions presented above. This exhibit begins with the gross income from sale of the coal, and follows through the series of calculations required to compute the net cash flows to the tribe and operating company. Exhibit III-4 details how each column in Exhibit III-3 is calculated.

EXHIBIT III-3

CALCULATIONS FOR CARRIED-INTEREST JOINT-VENTURE ARRANGEMENT
(All Figures in Millions of Dollars Unless Otherwise Indicated)

	A	B	C	D	E	F	G	H	I	
	Quantity of Coal Mined (MTY)	Price (\$/Ton)	Gross Income (AxB)	Severance Tax (30% of C)	Unit Production Cost (\$/Ton)	Total Production Cost (AxE)	Contribution To Income From Operations (C-D-F)	Contribution To Tribe (50% of G)	Contribution To Operating Company (50% of G)	Year
1										1
2										2
3	5	\$6.00	\$30.00	\$9.000	\$2.58	\$12.90	\$8.100	\$4.050	\$4.050	3
4	5	6.51	32.55	9.765	2.80	14.00	8.785	4.393	4.393	4
5	5	7.06	35.30	10.590	3.04	15.20	9.510	4.755	4.755	5
6	5	7.66	38.30	11.490	3.30	16.50	10.310	5.155	5.155	6
7	5	8.32	41.60	12.480	3.58	17.90	11.220	5.610	5.610	7
8	5	9.02	45.10	13.530	3.88	19.40	12.170	6.085	6.085	8
9	5	9.79	48.95	14.685	4.21	21.05	13.215	6.608	6.608	9
10	5	10.62	53.10	15.930	4.57	22.85	14.320	7.160	7.160	10
11	5	11.52	57.60	17.280	4.96	24.80	15.520	7.760	7.760	11
12	5	12.50	62.50	18.750	5.38	26.90	16.850	8.425	8.425	12
13	5	13.57	67.85	20.355	5.83	29.15	18.345	9.173	9.173	13
14	5	14.72	73.60	22.080	6.33	31.65	19.870	9.935	9.935	14
15	5	15.97	79.85	23.955	6.87	34.35	21.545	10.773	10.773	15
16	5	17.33	86.65	25.995	7.45	37.25	23.405	11.703	11.703	16
17	5	18.80	94.00	28.200	8.08	40.40	25.400	12.700	12.700	17
18	5	20.40	102.00	30.600	8.77	43.85	27.550	13.775	13.775	18
19	5	22.13	110.65	33.195	9.52	47.60	29.855	14.928	14.928	19
20	5	24.01	120.05	36.015	10.33	51.65	32.385	16.193	16.193	20
21	5	26.05	130.25	39.075	11.20	56.00	35.175	17.588	17.588	21
22	5	28.27	141.35	42.405	12.16	60.80	38.145	19.073	19.073	22

III-13

EXHIBIT III-3 (Cont.)

Year	J Tribe's Share of Development Costs	K Balance of Carried Interest	L Interest Charges (10% of K)	M Carried-Interest Repayments	N Net Cash Flow To Tribe (H-M)	Year
1	\$5.575	\$5.575	\$0.558		\$1.0 ^{1/}	1
2	5.575	11.708	1.171		0	2
3		12.878	1.288	\$4.050	0	3
4		10.116	1.012	4.393	0	4
5		6.735	0.673	4.755	0	5
6		2.653	0.265	2.918	2.237	6
7		0			5.610	7
8					6.085	8
9					6.608	9
10					7.160	10
11					7.760	11
12					8.425	12
13					9.173	13
14					9.935	14
15					10.773	15
16					11.703	16
17					12.700	17
18					13.775	18
19					14.928	19
20					16.193	20
21					17.588	21
22					19.073	22

^{1/} \$1 million lease bonus.

EXHIBIT III-3 (Cont.)

Year	O Operating Company's Share of Development Costs	P Expensed Development Costs (25% of O)	Q Capitalized Development Costs (75% of O)	R Depreciation	S Taxable Income Before Depletion (I-P-R)	T Depletion (5% of C, Up To (50% of S)	U Taxable Income (S-T)	V Income Taxes (50% of U)	W Operating Company's Net Income (U-V)	X Net Cash Flow to Operating Company (M+R+T+W-J-O)	Year
1	\$5.575	\$1.394	\$4.181		\$ (1.394)		\$ (1.394)		\$ (1.394)	\$ (13.544) ^{2/}	1
2	5.575	1.394	4.181		(1.394)		(1.394)		(1.394)	12.544	2
3				\$0.418	3.632	\$1.500	2.132	\$1.066	1.066	7.034	3
4				0.418	3.975	1.628	2.347	1.174	1.174	7.612	4
5				0.418	4.337	1.765	2.572	1.286	1.286	8.224	5
6				0.418	4.737	1.915	2.822	1.411	1.411	6.662	6
7				0.418	5.192	2.080	3.112	1.556	1.556	4.054	7
8				0.418	5.667	2.255	3.412	1.706	1.706	4.379	8
9				0.418	6.190	2.448	3.742	1.871	1.871	4.737	9
10				0.418	6.742	2.655	4.087	2.043	2.043	5.117	10
11				0.418	7.342	2.880	4.462	2.231	2.231	5.529	11
12				0.418	8.007	3.125	4.882	2.441	2.441	5.984	12
13				0.418	8.755	3.393	5.362	2.681	2.681	6.492	13
14				0.418	9.517	3.680	5.837	2.918	2.918	7.017	14
15				0.418	10.355	3.993	6.362	3.181	3.181	7.592	15
16				0.418	11.285	4.332	6.952	3.476	3.476	8.227	16
17				0.418	12.280	4.700	7.582	3.791	3.791	8.910	17
18				0.418	13.357	5.100	8.257	4.128	4.128	9.647	18
19				0.418	14.510	5.533	8.977	4.489	4.489	10.439	19
20				0.418	15.775	6.003	9.772	4.886	4.886	11.307	20
21				0.418	17.170	6.513	10.657	5.329	5.329	12.259	21
22				0.418	18.655	7.068	11.587	5.794	5.794	13.279	22

^{2/} Includes \$1 million lease bonus paid to tribe.

EXHIBIT III-4

EXPLANATION OF EXHIBIT III-3

<u>Column Heading</u>	<u>Column Letter</u>	<u>Description</u>
Quantity of Coal Mined	A	The example assumes that 5 MTY is mined in each of 20 years.
Price	B	The price per ton begins at \$6.00, and escalates at a rate of 8.5% per year (see text).
Gross Income	C	Gross income is the product of quantity and price ($A \times B$).
Severance Tax	D	A severance tax equal to 30% of gross income is levied by the state.
Unit Production Cost	E	The production cost per ton starts at \$2.58, and escalates at a rate of 8.5% per year. The cost of reclamation is included in this figure (see text).
Total Production Cost	F	The product of quantity and unit production cost ($A \times E$).
Contribution to Income from Operations	G	Total production cost and severance tax are subtracted from gross income ($C - D - F$).
Contribution to Tribe	H	Since the example assumes a 50% carried-interest joint venture, the tribe is entitled to half of the contribution to income from operations (50% of G).
Contribution to Operating Company	I	The operating company receives the remainder of the total contribution (50% of G).
Tribe's Share of Development Costs	J	Since this is a 50% carried-interest joint venture, the tribe is ultimately responsible for half of the development costs. Total development costs of \$22.3 million are split between the tribe and the operating company; each share (\$11.15 million) is further split evenly between the two pre-production years.

EXHIBIT III-4 (Cont.)

<u>Column Heading</u>	<u>Column Letter</u>	<u>Description</u>
Balance of Carried Interest	K	<p>The operating company carries the interest of the tribe until it can be repaid out of the tribe's share of contribution to income from operations. In the first year, the company pays the tribe's share of development costs; thus, \$5.575 million is the opening balance. In year 2, the company again pays the tribe's share; this is added to the first year balance, plus interest accrued during the year. Year 3 is the first period in which the tribe has funds available to begin repaying the carried interest; this repayment reduces the balance. Thus, for any year, the balance is equal to the previous year's balance, plus interest from the previous year, less repayments made in the previous year, plus any development costs paid by the operating company for the tribe in the current year. Mathematically, using t to indicate the time period,</p> $K_t = K_{t-1} + L_{t-1} - M_{t-1} + J_t$
Interest Charge	L	Interest is assessed on the current carried-interest balance at a rate of 10% (10% of K).
Carried- Interest Repayments	M	The full amount of the tribe's share of contribution to income from operations (Column H) is devoted to repayment of the carried interest, until the balance (Column K) is zero.
Net Cash Flow to Tribe	N	Since all of the tribe's share of contribution to income is devoted to repayment of the carried interest, the net cash flow is zero until the entire carried interest has been repaid. Year 1, however, is an exception; the example assumes that the tribe receives a bonus of \$1 million when the project is begun.
Operating Company's Share of Development Costs	O	Since this is a 50% carried-interest joint venture, this column is identical to that for the tribe (Column J).
Expensed Development Costs	P	25% of the operating company's share of pre-production development costs is expensed in the year in which they occur. This proportion corresponds to 1972 Bureau of Mines estimates (IC-8535).

EXHIBIT III-4 (Cont.)

<u>Column Heading</u>	<u>Column Letter</u>	<u>Description</u>
Capitalized Development Costs	Q	The remainder of the operating company's share of pre-production development costs is assumed to consist of tangible plant and equipment which is capitalized.
Depreciation	R	The capitalized plant and equipment (Column Q) is depreciated over the 20 years of mine operation using the straight-line method.
Taxable Income Before Depletion	S	This information is needed for computation of depletion. Taxable income before depletion consists of the operating company's share of contribution to income from operations, less additional expensed items and depreciation (I - P - R).
Depletion	T	For income tax purposes, depletion of coal is computed as 10% of gross income, up to a maximum of 50% of taxable income before depletion. Column C shows gross income to the entire joint venture; 10% of the operating company's share of gross income is equivalent to 5% of gross income to the entire joint venture, since the firm has a 50% interest. Therefore, depletion is computed as 5% of Column C, up to a maximum of 50% of Column S.
Taxable Income	U	This is simply taxable income before depletion, less actual depletion (S - T).
Income Taxes	V	Income taxes are assumed to be assessed at an effective rate of 50% (48% federal and 2% state). (50% of U).
Operating Company's Net Income	W	This is simply the difference between taxable income and income taxes (U - V).
Net Cash Flow to Operating Company	X	<p>This consists of 6 items, although at least 2 items are zero in every year. They are:</p> <ol style="list-style-type: none"> Net income (a positive flow) Depreciation (deducted from income for tax purposes, it is added back because it is a non-cash expense) Depletion (also added back because it is a non-cash expense) Carried interest repayment (a positive flow from the tribe to the operating company) Tribe's share of development costs (a negative flow, since it is covered by the operating company) Operating company's share of development costs (a negative flow).

- A typical rural multiplier^{1/} cannot always be used in projecting population and employment figures on reservations because the towns on most reservations are usually not the trade centers for the reservations. The larger cities (40 or 50 miles away) generally handle all the commercial business. As a result, the majority of increased service jobs will not be located on the reservation and therefore probably would not benefit the tribe.
- Impacts on public services and facilities may occur twice as a result of development. The first impact will occur at the time the project begins, when a large number of workers inundate the area. The second impact will occur when the project winds down and ends. There is little consideration given to the impacts that will occur at this second stage. The communities will be placed in a dilemma because they must choose whether to sacrifice services during the project period and suffer the consequences that overutilization of public facilities and utilities will create or to extend these facilities and utilities, which would result in either underutilization when the project ends, or provide the incentive for further development in the future.
- Involvement in the regional planning process is not always a solution to the problem of making tribal concerns public. Tribal representatives are typically in a minority position on planning bodies, causing their views to be given insufficient weight in planning decisions.
- Education. The influx of population to a reservation or the area surrounding it will increase the enrollment in the schools. Most EIS's only consider the impact this increased enrollment will have on the facilities themselves. There is no consideration given to the fact that this might aggregate the problems that Indian children face as minorities in their schools.

^{1/} A multiplier of 1.6 (16 induced jobs for every 10 direct jobs) for mining activities located in rural areas is considered to be a typical rural multiplier. This estimate is based on the assumption that most service activities in rural areas utilize excess labor and can expand service without increasing the number of employees.

Some EIS's state that an increased enrollment is expected to cause a decrease in the quality of education. If the quality of education deteriorates at the elementary and high school levels, Indian children will not have the skills needed to pursue higher education.

- Employment. The EIS's address increased employment and income, better standards of living, and training programs as being the beneficial attributes of development projects. However, there is no consideration of the change in the economic situation at the project's end nor the resulting changes in life-style.
 - Changes in the labor force participation rate may be twofold. As noted earlier, there will be an impact at the beginning of the project and another at the end. The beginning will bring jobs and income to the area, and training will enhance the opportunities of the employees. When the project winds down and is completed, the trained employees might find that their particular expertise is obsolete on the reservation. This may result in unemployment or transience. Since mobility is not prevalent on the reservation, the pressure to follow the job market could result in greater personal conflict between one's job and one's culture.

SUMMARY CHECKLIST

Our review of the comments from both the FES's and our site visits has brought out the fact that the concerns raised by individuals during our site visits were more extensive than those found in the FES's. These areas of concern may be summarized as follows:

FES'sSite VisitsEnvironmental

Air Quality
Water Quantity and Quality
Reclamation
Health

Air Quality
Water Quality (leaching)
Reclamation
Health Hazards
Deprioritizing of Water-Rights
Issues and Water Usage
Underestimation of Impact Area
Size
Destruction of Impacts
Disruption of Wildlife Habitat

Social and Cultural

Planning
Law Enforcement
Employment
Tribal Finances
Market Analysis
Culture
Legal Responsibility

Planning
Increased Crime
Employment
Tribal Finances
Market Analysis of Minerals
Extent of Culture Loss
Jurisdictional Problems
Relocation
Checkerboard Land Ownership
Urbanization
Conflicts of Interest within DOI
Educational and Language Barriers
Religious Beliefs

The comments from the site visits are a source of information that the EIS preparers should take into consideration in future analyses of sociocultural issues. Our review of the EIS's revealed that these issues are addressed only superficially as impacts on Indian tribes. The CEQ guidelines for the preparation of environmental impact statements have not resulted in analyses that go into sufficient detail for the concerns of Indian Nations. Table III-1 showed which impacts were generally addressed in the EIS's we reviewed and which were not. The table indicates that the preparer's interpretation of "social and cultural impacts" may differ from that of Indian tribes.

Exhibits III-5 and III-6 take the cash flows to the tribe and operating company from Exhibit III-3, adjust them for 6 percent inflation, and compute present values.

EXHIBIT III-5

ANALYSIS OF CASH FLOW TO TRIBE

Year	Net Cash Flow to Tribe	
	Current \$ (Millions)	Constant \$ (Millions)
1	\$ 1.0	\$0.943
2	0	0
3	0	0
4	0	0
5	0	0
6	2.237	1.577
7	5.610	3.731
8	6.085	3.818
9	6.608	3.911
10	7.160	3.998
11	7.760	4.088
12	8.425	4.187
13	9.173	4.301
14	9.935	4.394
15	10.773	4.495
16	11.703	4.607
17	12.700	4.716
18	13.775	4.826
19	14.928	4.934
20	16.193	5.049
21	17.588	5.174
22	19.073	5.293
Undiscounted Total	\$180.726	\$74.042
Present Value of Cash Flow		
Discounted at 10%		\$20.599
Discounted at 15%		\$12.281

EXHIBIT III-6

ANALYSIS OF CASH FLOW TO OPERATING COMPANY

Year	Net Cash Flow to Operating Company	
	Current \$ (Millions)	Constant \$ (Millions)
1	\$ (13.544)	(12.778)
2	(12.544)	(11.164)
3	7.034	5.906
4	7.612	6.029
5	8.224	6.145
6	6.662	4.696
7	4.054	2.696
8	4.379	2.747
9	4.737	2.804
10	5.117	2.857
11	5.529	2.913
12	5.984	2.974
13	6.492	3.044
14	7.017	3.104
15	7.592	3.168
16	8.227	3.239
17	8.910	3.309
18	9.647	3.380
19	10.439	3.450
20	11.307	3.526
21	12.259	3.606
22	13.279	3.685
Undiscounted Total	\$128.413	\$49.336
Present Value of Cash Flow		
Discounted at 10%		\$ 7.556
Discounted at 15%		\$ 0.529

Summary of Contract Arrangement Calculations

The preceding pages have illustrated how the monetary benefits from alternative contract arrangements can be estimated. Given detailed data on a specific situation, the same methodology (but not the same assumptions) can be applied to facilitate comparisons between different options. The present value of each option is the basic yardstick for comparison. However, it alone is insufficient for making intelligent judgments. Two other aspects of each arrangement must also be considered: the risk, or potential variability, inherent in the arrangement; and the shape, or timing, of the cash flows.

Different contractual arrangements entail different levels of risk. For example, both the lease and joint-venture examples are predicated on forecasts of the market price of coal. Since the price cannot be forecast with certainty, there is some risk--inherent under either arrangement--that the price, and resulting cash flow to the tribe, will fail to meet expectations. There is a similar risk that production costs will diverge from projections; however, this would affect only the joint-venture case because revenues to the tribe in the lease arrangement are based solely on the market value of the coal. On the one hand, this simplified view suggests that a joint venture is inherently more risk-laden than a lease, because the tribe in a joint venture will be affected by any variability in the cost of operations. On the other hand, it is important to realize that only through a joint venture would the tribe be able to exert some influence over operating decisions, possibly reducing production costs and thereby reaping greater financial rewards.

The timing of the projected cash flows must also be taken into consideration. In theory, the application of a discount rate to determine present values accounts for differences in timing: If projects under

consideration have identical present values, one should (in theory) be indifferent between them. In practice, however, it is difficult to select a discount rate that exactly removes timing effects in all instances. Furthermore, there may well be advantages or disadvantages that cannot be assigned a monetary value. To the extent that these factors cannot be assigned monetary values, they will not be reflected in the computed present value.

Tribal Jobs and Income

Employment estimates from the literature on western surface mine construction and operation show that no simple relationship exists between the scale of operation and the number of employees required. Four such studies are summarized below.

<u>Source</u>	<u>Number of Employees</u>	<u>Size of Mine Studied (MTY)</u>	<u>Number of Employees/ MTY</u>
U.S. Bureau of Mines ^{1/}	66	1	66
Bechtel Corporation ^{2/}	276	6	46
Bureau of Indian Affairs ^{3/}	390	19	21
Northern Great Plains Resources Program (NGPRP) ^{4/}	450	20	22.5

^{1/} Projects to Expand Fuel Sources in Western States, Bureau of Mines, IC-8719, 1976.

^{2/} Manpower, Materials, Equipment, and Utilities Required to Operate and Maintain Energy Facilities, Bechtel Corporation, 1975.

^{3/} Crow Ceded Area Coal Lease, DOI, Bureau of Indian Affairs, 1976.

^{4/} Indians in the Northern Great Plains: Anticipated Socio-Economic Impact of Coal Development, prepared by the Bureau of Indian Affairs for the Northern Great Plains Resources Program, 1974.

These figures suggest that mines of smaller size require proportionately more employees. This is to be expected, as a larger mine can be operated more efficiently (at least up to the 20-MTY size).

The Bechtel study indicating 46 employees/MTY is based on a mine size (6 MTY) that is close to that of the hypothetical mine used for the examples in this section (5 MTY). Using the 46 employees per MTY figure as an approximation, a 5-MTY mine would require 230 employees. Within the limits of the available tribal work force, it is assumed that half of these jobs will be filled by Indians, with average annual earnings of \$18,700 per job.^{1/} Therefore, personal income accruing to tribal members from direct employment in mining activities will be \$2.15 million annually. If this amount is earned each year of mining operations, the present value of the stream of income, discounted at 10 percent, is \$15.1 million. Discounted at 15 percent the income's present value is \$10.2 million. Of course, this figure may vary considerably, depending upon the actual number and types of jobs filled by tribal members, and their rate of advancement.

In cases in which coal conversion facility construction and operation occur in the mineral area, additional employment opportunities will be created. Between 1,125 and 2,750 employees are required for the construction of a 6-MTY coal liquefaction plant.^{2/} Between 600 and 625 employees are needed for operating a gasification plant.^{3/} A liquefaction plant is assumed to require approximately the same construction and operation force as a gasification plant. Since a power plant may be included in each conversion complex, these estimates may increase by several hundred employees for power plant construction and for operation.

^{1/} Crow Ceded Area Coal Lease, loc. cit. The types of jobs that would be available to tribal members are described in Volume III.

^{2/} Bureau of Mines, loc. cit.

^{3/} Crow Ceded Area Coal Lease, loc. cit.

Summary of Benefits

The overall benefits to be received by the tribe have two components: Revenues received by the tribal governing organization from the coal mine operation and personal income received by people employed directly by the mine operation.

The low end of the range of benefits is represented by a 7 percent royalty arrangement discounted at 15 percent. Tribal revenues under this contract arrangement and discount rate would be \$10.5 million. Personal income from mining employment discounted at 15 percent would be \$10.2 million. The two figures sum to \$20.7 million.

The high end of the range of benefits is represented by the carried-interest joint venture discounted at 10 percent. Tribal revenues from this arrangement would total \$20.5 million, and the employment income to individuals would be approximately \$15.1 million. The benefits at the high end of the range add up to \$35.6 million in present value.

With this range of benefits estimated, we now turn to the estimation of costs.

ESTIMATION OF DIRECT COSTS TO THE TRIBE

In this example we discuss several types of costs.^{1/} The opportunity cost of converting the land from agricultural to mining. Use is examined as an important cost to the tribe. In addition, we discuss briefly the relocation costs associated with land conversion and the administrative costs to the tribe in developing a minerals program. These latter costs are developed more extensively in Volume II. The types of environmental impacts expected

^{1/} The types of costs considered here were also discussed in Section II.

are also identified and discussed in the context of the overall benefit-cost analysis. Specific socio-cultural impacts are discussed in more detail in Volume IV.

Opportunity Costs of Land Conversion

The development and operation of a surface mine rule out the use of a certain amount of land for other purposes. By diverting this land to mining, the potential income from farming, grazing, or forestry on this land is lost and is an opportunity cost to the tribe.

Continuing with our hypothetical example, the following assumptions are applied to estimate this opportunity cost:

- For each million tons mined, approximately 21 acres of land will be disturbed. Thus, for the 5-MTY scenario, 105 acres per year will be disturbed (for a period of 20 years).
- Since the feasibility of reclamation is still being evaluated, it is pessimistically assumed that crop and grazing land will not be returned to normal productivity (at least over the 20-year period in which the mine operates).
- Land that will be disturbed is distributed in the following proportion: cropland, 3 percent; grazing land, 89 percent; timberland, 8 percent.
- Current land-use patterns would not have changed significantly in the future if coal resources were not developed.
- Timber that reaches optimal harvest age would be harvested regardless of whether coal is developed. Although mining activity will delay for several years the planting of more timber, the long-run impact of this delay on income is minimal because of the long rotation period (50-80 years) characteristic of Northern Great Plains timber.^{1/}

^{1/} National Forest Products Association.

- Land removed from dryland agriculture is valued at \$350 per acre; land removed from grazing is valued at \$100 per acre.^{1/}

Exhibit III-7 shows the calculations of the opportunity cost of land conversion based on these assumptions. The present value of the opportunity cost of diverting land from its present use is estimated to be \$88,950. This is an indirect cost resulting from coal development that should be considered directly by a tribe in making its benefit-cost estimates.

^{1/} Crow Ceded Area Coal Lease, loc. cit. It is assumed that the price of land approximates the present value of the net income (gross income less operating costs) that could be earned if the land were retained in its present use.

EXHIBIT III-7

ESTIMATION OF OPPORTUNITY COST OF DIVERTING LAND
TO COAL MINING

Acres Diverted per Year:

Dry Farm	3.15 (3%)
Grazing	93.45 (89%)
Timber	<u>8.40 (8%)</u>

Total 115

Opportunity Cost per Year (constant dollars):

Dry Farm	\$1,103	(3.15 acres @ \$350)
Grazing	9,345	(93.45 acres @ \$100)
Timber	--	

Total \$10,448

Present Value of \$10,448 per Year in Years 3-22, Discounted at 10%:

\$73,512

Present Value of \$10,448 per Year in Years 3-22, Discounted at 15%:

\$49,450

Administrative Costs to Tribal Government^{1/}

The tribe may incur a significant cost to set up and operate a tribal minerals office to manage and monitor minerals development activities on the reservation. The types of personnel and the size of the office needed would vary with the level of production and type of activities pursued. Examples of three alternative management approaches are presented in Volume II. Under these three different sets of assumptions about the tasks to be undertaken and tribal workload, the annual costs range from less than \$25,000 to \$250,000. At a 10 percent discount rate the range of these costs over 22 years is \$219,299 to \$2,192,885; at 15%, the range is \$158,967 to \$1,589,666. These cost estimates include salaries, office space, motor vehicles, equipment, and other indirect expenses.

In addition, to obtain its own estimates of reserves before proceeding with any contractual arrangements, the tribe may wish to pay for mineral exploration on the reservation. While an interested mineral company will pay for exploration, all of the findings may not be available to the tribe. Exploration of the entire reservation by aerial photography followed by seismic exploration might cost the tribe from \$150,000 to \$350,000,^{2/} depending on the detail required and topography.

Another potential administrative cost to the tribe would be that required to relocate families that live in the mining area as the mine is developed and expanded. However, for the example used, it is likely that only one or two families (on an average) would be affected.

^{1/} See Volume II for a more detailed discussion.

^{2/} Estimate by industry personnel interviewed confidentially by Ernst & Ernst.

Summary of Environmental Costs

Coal development on any reservation will result in a variety of physical and socio-cultural environmental impacts. These potential effects have been described in detail for low- and high-development scenarios in environmental impact statements that have been prepared for the development projects on several reservations.^{1/} The literature on environmental damage relationships (e.g., crop losses that result from increased power plant emissions) is abundant, but not advanced. Therefore, many of the direct potential losses to the tribe have not been quantified in environmental statements.

The most significant costs include increased health costs from deteriorated air or water quality, maintenance costs from the soiling of buildings, decreased hunting and fishing, decreased soil productivity from wind and water erosion, and decreased revenues from tourism.

Effects on the physical environment may also represent some loss to tribal cultural values and beliefs, including aesthetic and cultural losses. These losses are not directly quantifiable. Exhibit III-8 summarizes the direct effects on the tribe of potential environmental impacts that are attributable to coal development. At least one direct cost--that of reclamation--has already been considered as an operating cost in strip mining.

^{1/} See Volume IV.

EXHIBIT III-8

COAL-RELATED ENVIRONMENTAL IMPACTS

<u>Environmental Factor Affected</u>	<u>Description of Impact</u>
Air Quality	Dust may be blown from development sites to the surrounding area. Sources of dust include vehicular traffic, blasting, coal preparation, coal loading, transportation, stockpiling, reclamation, etc. Impacts with associated costs to the tribe include soiling of buildings, reduced visibility, and health hazards.
Topographic Effects	Some soil will be lost from the mining area as a result of surface disturbance wind and water erosion. A loss of soil reduces productivity of reclaimed agricultural, grazing, and timber land.
Water Quality	Minimal impacts on surface and ground water quality are expected to result from mine drainage, sediment erosion, solid waste drainage, leaching of disturbed materials, etc., if proper pollution control measures are utilized at mine site. Some incremental water supply treatment costs may be incurred by downstream users if deterioration of stream water quality occurs.
Wildlife	Wildlife will be disturbed on a large scale with the development of mining areas. Costs to the tribe will be incurred with reduced hunting of game animals. In addition, reduction in fishing may occur if aquatic damage is caused by runoff or leaching of mine wastes, or drainage from the mine itself.
Other Environmental Impacts	Blasting noise, less attractive environment, threats to endangered species, etc., result in noticeable but unquantifiable costs to the tribe.

Note: This list is not meant to be all-inclusive since the type and extent of coal-related impacts depend on individual project characteristics. Instead, this exhibit is intended to describe the type of impacts that might occur. The actual types and magnitudes of impacts depend on site-specific characteristics and should be assessed on a project-by-project basis.

Significance of Quantifying Environmental Impacts. There is a crucial need to quantify the potential environmental impacts of coal development so that an analysis biased in favor of development will not result.

Unfortunately, the state of the art has not advanced to the point where an approximate dollar value can be placed on many of these impacts. This is an area in which the tribes, individually and/or collectively, may want to invest in further impact research to determine whether environmental effects may in fact offset the income earned from mining. Alternatively, a percentage of royalty income could be placed in a contingency fund to hedge against the potential adverse impacts on occupational health and safety, health of the general population, land productivity, and other aspects of environmental quality. As discussed in Volume II, lease or joint-venture agreements could also require compensation for measurable damages with strict enforcement provisions.

Summary of Direct Costs

There are two types of costs for which values were readily estimable: opportunity costs of land-use changes, and tribal administrative costs (including exploration). The low cost estimates are \$49,450 for opportunity costs (discounted at 15 percent) and \$308,967 for administrative costs (also discounted at 15 percent), for a total cost of \$358,417 in present-value terms. The high cost estimates are \$73,512 for opportunity costs (discounted at 10 percent) and \$2,192,885 for administrative costs (discounted at 10 percent), for a total cost of \$2,339,909.

Beyond these estimates of direct monetary costs (and the direct monetary benefits summarized earlier in this section), there are indirect benefits

and costs as well as fiscal effects to be taken into consideration. These indirect effects are the focus of the next subsection.

OVERVIEW OF INDIRECT BENEFITS, COSTS, AND FISCAL IMPACTS

The potential indirect economic impacts and direct and indirect fiscal impacts from coal mining (or, more generally, any major project leading to a "boom-town" effect) were summarized in Section II. In this subsection, we briefly describe first the values estimated for job and income multipliers using the literature developed for a sample area in the Northern Great Plains. Other types of indirect benefits listed in Exhibit II-8 are not estimated, nor are any of the costs. These types of estimates are highly speculative and would vary considerably from project to project and location to location, depending upon the assumptions used.

A second area we briefly examine are the procedures used to estimate potential population increases that would result from energy development. Sources from the Northern Great Plains region are used in this discussion.

Third, we examine potential increases in the demand for public services using a study developed for the Northern Great Plains area. These types of impacts should be interpreted as "ball-park estimates" or "general planning factors." Again, although they may have been developed on the basis of empirical evidence (looking at a sample of communities before and after energy development), the results vary considerably.

Finally, we highlight the effects of increased water consumption from coal development activities on future development in the area.

Potential Employment and Income Multiplier Effects

With the development of coal on the reservation, a significant number of jobs are expected to be generated as service industries expand or are attracted to the area. Multiplier factors used to estimate additional employment generally range from 1.5 to 3.0. In the Northern Great Plains region a factor of 2.7 has been estimated, ^{1/} but for a rural area reservation where the range of available services is limited, a factor of 2.0 may be more appropriate. A multiplier of 2.0 means that for each coal development job, one additional job (in a variety of sectors) would be created. Additional numbers of transportation workers; employees of quarry operations (and other mine-associated services); and education, health care, and law enforcement personnel are included in the multiplier effect. With a 5-MTY development, a total of 230 additional jobs might be created on the reservation or in the immediate area, several of which may be obtained by tribal members. If the level of development increases significantly, the total tribal work force might become a constraining factor in the number of indirect jobs retained by tribal members.

Indirect convenience benefits, e.g., improved transportation and communication facilities that may be constructed to meet the needs of significantly increased activity levels, cannot be readily quantified. Sophisticated techniques, which estimate the value of such benefits by determining the price a user would potentially pay for using a facility, are one way of estimating indirect benefits. No data of this type, however, are available for this analysis.

^{1/} U.S. Department of the Interior, Indians in the Northern Great Plains Anticipated Socio-Economic Impacts of Coal Development.

As the creation of new jobs leads to a reduction of unemployment, and some residents shift from their present jobs into newly created higher-paying jobs, per capita income will increase and the standard of living will improve. At least some of this new income will be spent locally, leading to an increase in the income of owners of business on the reservation. Local businesses will also benefit from purchases made by non-residents who have come to the reservation because of the coal development activity.

Estimation of Population Increases

An estimation procedure used in projecting population impacts that result from coal development has been taken from recent studies of energy-impacted communities in the Northern Great Plains. This procedure is illustrated in Exhibit III-9. Based on employment estimates derived earlier, population estimates can be generated for the coal development area as a whole. Allocation of population projections among towns and rural areas ideally requires an analysis of commuting distances from alternative residential locations for employees, physical barriers that would affect commuting, and local community and utility distribution development policies. Based on estimates of population increases, the fiscal impacts on municipal or county governments (perhaps including the tribal government) can be estimated.

EXHIBIT III-9

ESTIMATION OF ENERGY-RELATED POPULATION INCREASES

Energy-Related
Employment
Projections

Projection of
Population-to-
Population-
Employment
Ratio^{2/}

Distribution among
Communities

^{1/} State of Montana estimates.

^{2/} Boom Town Financing Study, Volume II, Estimates of Public Sector Financial Needs, Six Western Colorado Communities, Colorado Department of Local Affairs, July 1976.

^{3/} 50% will be filled by households in the area.

Potential Fiscal Impacts Resulting from the Increased Demand for Public Services

A summary of county and municipal per capita operating and capital outlay requirements that may be used to estimate fiscal impacts on communities in the development area is included in Exhibit III-10. The figures presented are based on observations made in past studies of energy-impacted communities in the Northern Great Plains. These effects will primarily be felt in off-reservation towns where transient construction crews and non-Indian permanent employees and their families will reside. To the extent that the Indian population on the reservation grows (perhaps by attracting tribe members who had previously left for better employment opportunities elsewhere, or by encouraging young people not to leave in the first place), these effects may be experienced by tribal governments as well.

EXHIBIT III-10

INCREMENTAL SERVICES, CAPITAL OUTLAYS, AND OPERATING EXPENSES FOR ENERGY-IMPACTED LOCAL GOVERNMENTS

Public Service	Incremental Need For Capital Outlay	Potential Incremental Per Capita Costs ^{1/}	
		Operating (\$ per year)	Capital Outlay (\$)
Administrative	Additional space needs are projected at 250 square feet (S.F.) per 1,000 new residents at \$50 per S.F.	15-40	12-48
Education	Seven new classrooms and teachers and a gym per 140 new students equaling 21,000 S.F. at \$34 per S.F. ^{3/} School enrollment to population ratio of 1:(2.9-4.5).	1,225-1,890 ^{2/}	2,068 ^{2/}
Fire Protection	Additional space needs projected at 1,000 S.F. per additional 1,000 residents at \$60 per S.F. up to 15,000 population total. Subsequent increases based upon 700 S.F. per 1,000 residents.	20	770-100
Health Care	Additional facilities requirements are projected at 3 beds per 1,000 new residents and \$55.00 per bed.	10	162
Law Enforcement	Additional space needs projected at 400 S.F. per additional 1,000 residents at \$60 per S.F. 1 new police vehicle projected for each 2,500 population increment at \$7,000. \$60,000 for detention facility.	35-36	25-69

^{1/} Ranges estimated for towns with base population of 450-2,500 people.

^{2/} Per-pupil expenditures.

^{3/} Socioeconomic Longitudinal Monitoring Project, Vol. 1-Summary Reports.
Old West Regional Commission, April 1977.

EXHIBIT III-10 (Cont.)

Public Service	Incremental Need For Capital Outlay	Potential Incremental Per Capita Costs ^{1/}	
		Operating (\$ per year)	Capital Outlay (\$)
Library	Additional facilities needs are projected at 550 S.F. and 3,000 volumes per 1,000 new residents at \$45 per S.F. and \$3 per volume.	NA	NA
Municipal Courts	500 S.F. facility at \$70 per S.F. equals \$35,000 per 1,000 increment.	NA	NA
Recreation	<u>Quantity per new resident</u> 1. Active/improved parks (e.g., ball fields, tennis courts, etc.) -5 acres-one per 1,500 new residents. 2. Municipal swimming pool-one per 10,000 new residents. 3. Municipal golf course (9 holes)-one per 10,000 new residents.	5-10	34-49
Streets and Bridges	NA	10-13	NA
Sewer	NA	14-30	101-146
Water	NA	50-85	362-418
Other	NA	2-7	NA

^{1/} Ranges estimated for towns with base population of 450-2,500 people.

NA indicates not available.

General Sources: Colorado Department of Local Affairs, loc. cit.

Impact of Water Consumption Related to Coal Development

Finally, the tribe may have to temporarily forego the development of water-dependent tribal enterprises if water consumption for coal development activities increases significantly. For example, dust control at a 5-MTY coal mining operation would require about 15-30 acre feet of water per month (or up to 180 acre feet per year) during the summer months. Water usage for a coal gasification or liquefaction plant complex could require over 50,000 acre feet per year. As development increases, only small industries and commercial establishments that can be supplied by individual wells are likely to be developed. Thus, the tribe essentially may be faced with a choice of trade-offs between industrial, commercial, or agricultural development and coal development. Of course, after coal development is phased out in the distant future more extensive water use for these other purposes would again be possible. The effect of current coal development may be to delay other kinds of development requiring water.

SUMMARY OF BENEFIT-COST ANALYSIS FOR COAL DEVELOPMENT

When minimum and maximum estimates for benefits and costs are combined, the range of net benefits for coal development is obtained. The results of these calculations, shown in Exhibit III-11, is a range of \$18.5 million to \$53.3 million for net dollar-valued benefits. The minimum estimates assume that the tribe will negotiate a low royalty rate and that tribal members will fill predominantly low-paying jobs. The maximum or "optimistic" estimates assume that a carried-interest joint venture will be

EXHIBIT III-11

SUMMARY OF DOLLAR-VALUED BENEFITS AND COSTS
FROM COAL DEVELOPMENT 1/

(Present Value in Millions of \$)

	<u>Minimum</u>	<u>Maximum</u>
Cash flow to tribe from coal development	\$ 10.6 ^{2/}	\$ 38.5 ^{3/}
Personal income from direct employment	10.2	15.1
Opportunity cost of diverting land	(0.1)	(0.0)
Administrative costs	<u>(2.2)</u>	<u>(0.3)</u>
TOTAL	\$ 18.5	\$ 53.3

1/ Current Department of the Interior policy requires a minimum royalty of 12-1/2 percent. The 7 percent "low case" is presented simply for comparison purposes.

2/ From a 7% royalty lease arrangement, discounted at 15%.

3/ From an 18% royalty lease arrangement, discounted at 10%.

negotiated, all plans will proceed as scheduled over the project period, and tribal members will get a share of both higher and lower paying jobs. Both sets of estimates assume a project lead time of two years, an optimistic assumption. However, neither of these estimates takes into account money values of lost life-styles, destroyed aesthetic environments, introduction of an income gap between highly paid and less-well-off tribal members, and a host of other socio-cultural and environmental impacts. Several of these non-dollar-valued benefits and costs are listed in Exhibit III-12. Quantification of these impacts is very complex and will vary from tribe to tribe as much as tribal values, customs, and goals for the future differ. In this light, a complete decision framework would of necessity place a value on these "intangible" costs and make certain that they entered into the final decision regardless of whether a price tag could be put on them. Placing values on a tribe's environment, culture, and social structure is totally in the domain of tribal decision-making and cannot be accomplished outside the tribal context (even using a decision-making tool such as benefit-cost analysis). While the valuation of environmental and socio-cultural costs was not within the scope of this analysis, we emphasize the importance of the tribes' quantifying and valuing environmental and socio-cultural impacts to the maximum extent possible, so they may be viewed in contrast to the dollar benefits of development.

A treatment of oil and gas development follows in Section IV that is similar to this section's treatment of coal. Section V will evaluate uranium, geothermal, and oil shale development in a similar manner.

EXHIBIT III-12

OTHER BENEFITS AND COSTS NOT VALUED IN
MONETARY TERMS

Benefits

- Additional employment during pre-production period
- Additional employment and royalties from other facilities constructed on the reservation (e.g., power plants, coal liquefaction plants, etc.)
- Expansion of local employment and business volume through multiplier effects
- Improved transportation and communication facilities.

Costs

- Possible income taxes on tribal revenues
- Relocation costs for families displaced by development
- Adverse health effects
- Reduced soil productivity
- Adverse effects on aesthetic quality
- Additional public services required for increased population
- Reduced availability of water for other purposes

IV. APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: OIL AND GAS DEVELOPMENT

INTRODUCTION

Background

This section presents an application of the benefit-cost analysis framework developed in Section II to oil and gas development. The analysis assumes that a hypothetical tribe has oil and gas resources in the form of proven oil and gas fields and has the potential for additional oil and gas discoveries. The analysis follows the same format as Section III. Consequently, the procedures used for the analysis in this section are not discussed in as much detail, since the explanations of benefit and cost estimation procedures were provided in Section III.

Assumptions

This specific assumptions made in formulating the oil and gas development example are:

- Several developed oil and natural gas fields currently underlie the reservation. Based on an extrapolation of available production figures for the fields, it is assumed that about 790,000 barrels of oil and about 2 million cubic feet of natural gas remain to be produced over the next 35 years.

- The potential for undiscovered oil and gas resources on the reservation is high. In this analysis, it is assumed that approximately 40 million barrels of newly discovered oil reserves will be developed in the next five years, after which production will continue for about 45 years. For the purposes of this analysis, the development of undiscovered gas reserves will be evaluated separately, assuming prices to begin at a regulated level of \$2.00 per thousand cubic feet and to vary in proportion to oil prices.^{1/}
- All current oil production will be eligible for stripper well or an enhanced recovery status, and an average price of \$12.00 per barrel escalated at 10 percent per year^{2/} will be received for all future production.^{2/}
- Production costs will escalate at 10 percent per year^{3/} from a 1975 cost of \$1.25 per barrel using the water flood recovery method.^{4/}
- In addition to the oil and gas currently being produced, newly discovered tribal crude oil added as reserves will be recoverable using available enhanced recovery techniques and will be of sufficient quality to be marketable.
- All oil and natural gas revenues from the reservation will be considered tribal revenue. No consideration is made for revenues produced from allotted land on the reservation that may go to an individual tribal member.

- ^{1/} In making this analysis, we must caution that the estimation of future production and cost data for natural gas is a highly speculative exercise.
- ^{2/} Price assumptions are derived from the Environmental Policy and Conservation Act, Conference Report, Report No. 94-700, House of Representatives, 94th Congress, 1975.
- ^{3/} Opinion of industry personnel interviewed confidentially by Ernst & Ernst.
- ^{4/} Lewin and Associates, Inc., Review of Secondary/Tertiary Recovery of Crude Oil, prepared for Federal Energy Administration, Washington, D.C., 1975.

Based on the hypothetical known reserve characteristics and the potential for the discovery of additional reserves discussed above, two levels of oil and gas development are discussed and compared. A low level of development would include continued production from proven, currently producing fields. It is assumed that production will continue to decline at rates currently exhibited, and that as production declines it will be uneconomical to operate wells pumping less than one barrel per day using enhanced recovery techniques.^{1/} Gas production on the reservation is declining but at a slower rate than oil production, as is typical of an oil and gas field after it has reached peak production.^{2/}

In the additional development scenario, about 20 million barrels of oil, out of a total of 40 million barrels discovered, will be produced over the next 50 years. In this scenario, a number of additional assumptions must be made concerning the geological characteristics of the area, exploration and field development, and the production methods used. These assumptions greatly affect both the costs of oil development and the time frame of production.

Additional Geological Assumptions--High-Development Scenario:

- The depths of undiscovered reservoirs are comparable to known reservoir characteristics (1,900-4,600 ft.). An average depth of about 3,000 feet is assumed for analytical purposes.

^{1/} The one barrel per well per day break-even point assumed here is a very liberal assumption and allows for a large degree of uncertainty concerning future price and costs. The 1976 direct annual operating expense for producing well-for-water flooding in Texas and California indicates that at a \$12.00 price per barrel, a well would actually become uneconomical to operate at less than 4 barrels per day. National Petroleum Council, Enhanced Oil Recovery, 1976.

^{2/} Production Department, American Petroleum Institute (API), Dallas, Texas.

- Assuming a maximum recovery factor of 50 percent, approximately 20 million barrels out of the total 40 million discovered will be economically recovered using available enhanced recovery techniques.^{1/}
- The quality characteristics of discovered reserves will be similar to those of known reserves.

Exploration and Field Development Assumptions--Additional

Development Scenario:

- Geophysical exploration will include aerial and seismic exploration over about 75 percent of the reservation.
- Oil well spacing is 40 acres per well and gas well spacing is 320 acres per well (USGS spacing requirements).
- All exploration and new field development will occur within an initial five-year time period.
- Production will decline at an average rate of 10.8 percent of remaining reserves produced each year.
- Based on an estimate of ultimately recoverable oil (20 million barrels) and an initial production of about 150 barrels per well per day (characteristic of discovery wells on the reservation),^{2/} an estimated average of 39 wells producing at any one time will yield about 20 million barrels of oil over about a 50-year period.

The American Petroleum Institute reports that gas is produced as a byproduct of most oil wells.^{3/} At first, the ratio of gas to oil is

^{1/} Lewin and Associates, Inc., Review of Secondary/Tertiary Treatment of Crude Oil, prepared for Federal Energy Administration, Washington, D.C., 1975.

^{2/} These figures are characteristic of oil production from wells on one reservation, whose residents requested that it not be identified.

^{3/} Production Department, API, Dallas, Texas.

low, and then it increases until production ceases. Absolute production of gas declines after peak production of oil is reached. A commonly used rule-of-thumb in the industry to estimate average gas production to oil production is 1.0 mcf (one thousand cubic feet) to one barrel of oil.

Using the parameters of decreasing absolute production of gas and increasing production of gas relative to oil, we have estimated the gas to oil production ratios. The API cautions that any gas production estimate not based on known geologic characteristics of a particular oil reservoir is really a "guesstimate." It is with this caution in mind that our subsequent analysis of gas production should be viewed.

- The total number of wells that might be drilled during wildcatting and field development can be estimated using recent drilling statistics for the state. The wildcat success rate for the study area is 15 percent.^{1/} If 26 wildcat wells are drilled, four will be successful and the remaining 22 wildcat wells will be dry. In Montana, 60 percent of the non-wildcat development wells drilled in 1975 were productive (IPAA-1976). If 58 such wells are drilled, 35 development oil wells will be productive and 23 additional wells drilled will be dry. The total number of productive wells (wildcat and nonwildcat) is 39. In addition, within five years after field development, 39 additional injection wells will be drilled to support water-flood-enhanced recovery techniques (using a one-to-one injection to producing well ratio). For the entire period, a total of 45 dry wells, 39 producing wells, and 39 injection wells will be drilled.
- Peak production will occur in five years, allowing two years for exploration and three years for field development.

^{1/} The Oil Producing Industry in Your State, Independent Petroleum Association of America, Washington, D.C., 1976.

With each of the development scenarios described, there are certain risk factors that may affect the overall attractiveness of entering an oil venture. The most significant of these include the discovery of potentially poor-quality or low-volume reservoirs and shortages of drilling rigs, materials, and manpower. The risks involved in oil and gas development are more short-term (one to three years) than long-term (ten or more years). Significant financial risks are involved in exploration and wildcat drilling, as can be inferred from some of the drilling statistics presented above. Once a field is brought into production, risks are inherent in managing production (through sophisticated oil field engineering techniques) to achieve maximum profits over the long run. It is assumed here, however, that these risks will not affect the outcome of developing tribal oil sources.

ESTIMATION OF DIRECT BENEFITS TO THE TRIBE

Overview

As discussed in the coal development example, the most significant direct benefits that will accrue to the tribe are production revenues. The general methods for estimating these benefits are the same for oil and gas development as for coal development; however, the relative magnitude of the benefits may differ. Again, two types of contractual agreements are considered--royalty and joint-venture. An analysis of the direct benefits is provided below.

Royalty Lease Arrangements

The total tribal revenues that will accrue from oil and gas production depend on the type of contractual agreement entered into and also on the level of production. Estimates are provided below of potential tribal revenues that may accrue under lease arrangements for each of the development scenarios described (current and additional development), assuming that prices of the resources will increase 10 percent per year. The lease arrangement considered is one in which the tribe receives a royalty on the market value of crude oil (or natural gas) produced at the wellhead.

Current Level of Development (Base Case). Royalty percentages of 12.5 percent, 16-2/3 percent, and 20 percent have been considered under the current development scenario to demonstrate the range of income benefits the tribe may realize under existing alternative contract arrangements. In the current development scenario, the range of revenues is large: a royalty of 12-1/2 percent of the market value of oil produced would yield a total income--deflated at 6 percent and then discounted at 10 percent--to the tribe of \$515,000 over 24 years, compared with \$823,000 under a 20 percent royalty agreement. For gas, a by-product of oil production, the range is from \$137,000 to \$217,000. Exhibits IV-1, IV-2, IV-3, and IV-4 use the techniques discussed in Section III and illustrate the derivation of these estimates (providing estimates at a 15 percent discount rate as well).

EXHIBIT IV-1

ROYALTIES FROM CURRENT DEVELOPMENT
OF OIL

Year	A	B	C	D	E		F
	Production (1,000 barrels)	Price (\$ per barrel)	Operation's Gross Revenue (\$ 1,000's)	At 12.5% (\$ 1,000's)	Tribal Royalties		At 20.0% (\$ 1,000's)
					At 16.7% (\$ 1,000's)		
1	49	\$12.00	\$ 588	\$ 73	\$ 98		\$118
2	46	13.20	607	76	101		121
3	44	14.52	639	80	107		128
4	41	15.92	653	82	109		131
5	37	17.57	650	81	108		130
6	36	19.33	696	87	116		139
7	33	21.26	702	88	117		140
8	31	23.39	725	91	121		145
9	31	25.73	798	100	133		160
10	29	28.30	821	103	137		164
11	23	31.13	716	90	119		143
12	22	34.24	753	94	126		150
13	21	37.66	791	98	132		158
14	20	41.43	829	104	138		166
15	19	45.57	866	108	144		173
16	18	50.13	902	113	150		181
17	17	55.14	937	117	156		187
18	16	60.65	970	121	162		194
19	15	66.72	1,001	125	167		200
20	14	73.39	1,027	128	171		205
21	14	80.73	1,130	141	188		226
22	13	88.80	1,154	144	192		230
23	13	97.68	1,270	159	212		253
24	17	107.45	1,289	161	215		258

EXHIBIT IV-2

DEFLATED, DISCOUNTED ROYALTIES FROM CURRENT DEVELOPMENT OF OIL

Year	12.5%		16.7%		20.0%	
	\$1,000's Current	\$1,000's Deflated	\$1,000's Current	\$1,000's Deflated	\$1,000's Current	\$1,000's Deflated
1	\$73	\$ 69	\$ 98	\$ 92	\$ 118	\$ 111
2	76	68	101	90	121	108
3	80	67	107	90	128	107
4	82	65	109	86	131	104
5	81	61	108	81	130	97
6	87	61	116	82	139	98
7	88	59	117	178	140	93
8	91	57	121	75	145	91
9	100	59	133	79	160	95
10	103	58	137	77	164	92
11	90	47	119	63	143	75
12	94	47	125	62	150	75
13	98	46	131	61	158	74
14	104	46	138	61	166	73
15	108	45	144	60	173	72
16	113	44	150	59	181	71
17	117	43	156	58	187	69
18	121	42	161	56	194	68
19	125	41	166	55	200	66
20	128	40	171	53	205	64
21	141	41	188	55	226	66
22	144	40	192	53	230	64
23	159	42	211	55	253	66
24	161	40	214	53	258	64
Total (Undis-						
counted)						
	\$2,564	\$1,229	\$3,413	\$1,634	\$4,106	\$1,964
Total (Dis-						
counted to Year 0)						
At 10%		515		686		823
At 15%		384		511		614

6-AT

EXHIBIT IV-3

ROYALTIES FROM GAS AS A BY-PRODUCT OF CURRENT OIL DEVELOPMENT

Year	A	B	C	D	E	F
	Production (1,000 mcf)	Price (\$/mcf)	Gross Revenue (\$1,000's)	Tribal Royalties		
				At 12.5% (\$1,000's)	At 16.7% (\$1,000's)	At 20.0% (\$1,000's)
1	78	\$ 2.00	\$ 156	\$ 19	\$ 26	\$ 31
2	74	2.20	163	20	27	33
3	70	2.42	169	21	28	34
4	66	2.66	176	22	29	35
5	60	2.93	176	22	29	35
6	58	3.22	187	23	31	37
7	53	3.54	188	23	31	38
8	50	3.90	195	24	33	39
9	50	4.29	215	27	35	43
10	46	4.72	217	27	36	43
11	37	5.19	192	24	32	38
12	35	5.71	200	25	33	40
13	34	6.28	214	27	36	43
14	32	6.90	221	28	37	44
15	30	7.59	228	29	38	46
16	29	8.35	242	30	40	48
17	27	9.19	248	31	41	50
18	26	10.11	263	33	44	53
19	24	11.12	267	33	44	53
20	22	12.23	269	33	45	54
21	22	13.45	296	37	49	59
22	21	14.80	311	39	52	62
23	21	16.28	342	43	57	68
24	19	17.91	340	43	57	68

EXHIBIT IV-4

DEFLATED, DISCOUNTED ROYALTIES FROM GAS AS A BY-PRODUCT OF CURRENT OIL DEVELOPMENT

Year	At 12.5% (\$1,000's)	Deflated (At 6%)	At 16.7% (\$1,000's)	Deflated (At 6%)	At 20.0% (\$1,000's)	Deflated (At 6%)
1	\$ 19	\$ 18	\$ 26	\$ 25	\$ 31	\$ 29
2	20	18	27	24	33	29
3	21	18	28	24	34	29
4	22	17	29	23	35	28
5	22	16	29	22	35	26
6	23	16	31	22	37	26
7	23	15	31	21	38	25
8	24	15	33	20	39	24
9	27	16	35	21	43	25
10	27	15	36	20	43	25
11	24	13	32	17	38	20
12	25	12	33	16	40	20
13	27	12	36	16	42	20
14	28	12	37	16	44	19
15	29	12	38	16	46	19
16	30	12	40	16	48	19
17	31	12	41	16	50	19
18	33	11	44	15	53	18
19	33	11	44	15	53	18
20	33	11	45	14	54	17
21	37	11	49	15	59	18
22	39	11	52	14	62	17
23	43	11	57	15	68	18
24	43	11	57	14	68	17
Total (Undiscounted)	\$683	\$315	\$910	\$437	\$1,094	\$525
Total Discounted)						
At 10%		137		184		217
At 15%		102		137		163

Additional Development. The 12.5 percent royalty rate was not used in the additional development scenario because 16-2/3 percent is the minimum allowed under new BIA regulations for wells not already in production. Twenty percent represents the highest rate that could probably be negotiated based on the opinion of experts in the field.^{1/} Deflated discounted oil income under the additional development scenario would range from \$19,307,000 under a 16-2/3 percent royalty arrangement to \$23,163,000 under a 20 percent royalty arrangement. Gas income would range from \$2,413,000 to \$2,890,000 for the additional resource development.

Exhibits IV-5, IV-6, IV-7, and IV-8 show how these estimates were derived along with a set of estimates using a 15 percent discount rate. These exhibits employ the same procedures and computations used for analogous estimates in Section III.

^{1/} Source: Charles Lipton, Inc. Dave Baldwin, BIA Division Chief.

EXHIBIT IV-5

ROYALTIES FROM ADDITIONAL DEVELOPMENT OF OIL

Year	A Production (1,000 bbls.)	B Price (\$ per bbl.)	C Gross Revenue (\$1,000's)	D Tribal Royalties		E
				At 16.7%	At 20.0%	
1	0	\$12.00	\$ 0	\$ 0	\$ 0	
2	0	13.20	0	0	0	
3	0	14.52	0	0	0	
4	500	15.97	7,985	1,331	1,597	
5	1,300	17.57	22,841	3,808	4,568	
6	2,160	19.33	41,753	6,960	8,351	
7	1,926	21.26	40,947	6,826	8,189	
8	1,720	23.39	40,230	6,706	8,046	
9	1,530	25.73	39,366	6,562	7,873	
10	1,371	28.30	38,799	6,468	7,760	
11	1,221	31.13	38,010	6,336	7,602	
12	1,091	34.24	37,356	6,228	7,471	
13	970	37.66	36,530	6,090	7,306	
14	866	41.43	35,878	5,981	7,176	
15	772	45.57	35,180	5,865	7,036	
16	689	50.13	34,540	5,758	6,908	
17	614	55.14	33,856	5,644	6,771	
18	548	60.65	33,236	5,540	6,647	
19	489	66.72	32,626	5,439	6,525	
20	436	73.39	31,998	5,334	6,400	
21	389	80.73	31,404	5,235	6,281	
22	347	88.80	30,813	5,137	6,163	
23	309	97.68	30,183	5,032	6,037	
24	276	107.45	29,656	4,944	5,931	

EXHIBIT IV-6

DEFLATED, DISCOUNTED ROYALTIES FROM ADDITIONAL
DEVELOPMENT OF OIL

Year	16.7%		20.0%	
	\$1,000's Current	\$1,000's Deflated	\$1,000's Current	\$1,000's Deflated
1	\$ 0	\$ 0	\$ 0	\$ 0
2	0	0	0	0
3	0	0	0	0
4	1,331	1,054	1,592	1,265
5	3,808	2,846	4,568	3,413
6	6,960	4,907	8,351	5,887
7	6,826	4,540	8,189	5,446
8	6,706	4,207	8,046	5,048
9	6,562	3,884	7,873	4,660
10	6,468	3,612	7,760	4,333
11	6,336	3,338	7,602	4,005
12	6,228	3,095	7,471	3,713
13	6,090	2,855	7,306	3,425
14	5,981	2,645	7,176	3,174
15	5,865	2,477	7,036	2,936
16	5,758	2,267	6,908	2,719
17	5,644	2,096	6,771	2,515
18	5,540	1,941	6,647	2,329
19	5,439	1,798	6,525	2,157
20	5,334	1,663	6,400	1,996
21	5,235	1,540	6,281	1,848
22	5,137	1,426	6,163	1,710
23	5,032	1,317	6,037	1,580
24	4,944	1,221	5,931	1,465
Total (Undis-				
counted)				
	\$111,700	\$ 54,699	\$126,426	\$ 65,624
Total (Dis-				
counted to				
Year 0)				
At 10%		19,307		23,163
At 15%		12,718		13,618

EXHIBIT IV-7

ROYALTIES FROM GAS AS A BY-PRODUCT OF ADDITIONAL DEVELOPMENT OF OIL

Year	A	B	C	D		E
	Production (1,000 mcf)	Price (\$/mcf)	Gross Revenues (\$1,000's)	Tribal Royalties		
				At 16.7% (\$1,000's)		At 20.0% (\$1,000's)
1	0	\$ 2.00	\$ 0	\$ 0		\$ 0
2	0	2.20	0	0		0
3	0	2.42	0	0		0
4	200	2.66	532	89		106
5	598	2.93	1,752	293		350
6	1,123	3.22	3,616	604		723
7	1,117	3.54	3,954	660		791
8	1,101	3.90	4,294	717		859
9	1,071	4.29	4,595	767		919
10	1,042	4.72	4,918	821		984
11	1,001	5.19	5,195	868		1,039
12	960	5.71	5,482	915		1,096
13	912	6.28	5,727	956		1,145
14	866	6.90	5,957	998		1,195
15	818	7.59	6,209	1,037		1,242
16	772	8.35	6,446	1,077		1,289
17	725	9.19	6,663	1,113		1,333
18	680	10.11	6,875	1,148		1,375
19	636	11.12	7,072	1,181		1,414
20	593	12.23	7,252	1,211		1,450
21	552	13.45	7,424	1,240		1,485
22	514	14.80	7,607	1,270		1,521
23	476	16.28	7,749	1,294		1,550
24	442	17.91	7,916	1,322		1,583

IV-15

EXHIBIT IV-8

DEFLATED, DISCOUNTED ROYALTIES FROM GAS AS A BY-PRODUCT OF ADDITIONAL
OIL DEVELOPMENT (1,000's)

Year	At 16.7%	Deflated	At 20.0%	Deflated
1	\$ 0	\$ 0	\$ 0	\$ 0
2	0	0	0	0
3	0	0	0	0
4	89	70	106	84
5	293	219	350	262
6	604	426	723	510
7	660	439	791	526
8	717	450	859	539
9	767	454	919	544
10	821	458	984	549
11	868	457	1,039	547
12	915	455	1,096	545
13	956	448	1,145	537
14	998	441	1,195	529
15	1,037	433	1,242	518
16	1,077	424	1,289	507
17	1,113	413	1,333	495
18	1,148	402	1,375	482
19	1,181	390	1,414	467
20	1,211	378	1,450	452
21	1,340	365	1,485	437
22	1,270	352	1,521	422
23	1,294	339	1,550	406
24	<u>1,322</u>	<u>327</u>	<u>1,583</u>	<u>391</u>
Total (Undis- counted)	\$19,581	\$8,140	\$23,449	\$9,223
Total (Discounted)				
At 10%		2,413		2,890
At 15%		1,486		1,780

Carried-Interest Joint Venture

Considering the late stage in the productive life of currently producing fields on the reservation, it is not likely that this arrangement should be reorganized as a carried-interest joint venture.

For additional development, a carried-interest joint venture similar to that discussed in the coal operating agreement analysis might be negotiated. In at least one joint venture currently in effect, the stipulation of a minimum royalty has been accepted. Royalties during initial nonproductive years have been advanced out of future joint-venture payments. It is assumed here that the terms of the contract will be of the more common straight joint-venture type, such as was discussed for coal development. Briefly, the estimation procedure to calculate the flow of income that will be received by the tribe under the joint-venture agreement includes the calculation of an investment cash flow for the venture and an income cash flow, which are summed to provide an estimate of the net cash flow of the project. Based on the assumptions discussed above, an estimate of total net income (deflated at 6 percent and discounted at 10 percent) that will accrue to the tribe over 24 years for oil is \$42,738,000. For gas as a by-product of oil development, the estimate is \$7,227,000. The total for oil and gas together is \$49,965,000. Exhibits IV-9 through IV-12 illustrate the calculations used to derive these estimates of the present value of net tribal cash flow. The cash flow to the operating company is calculated in columns O through X of Exhibit IV-9 to demonstrate the profitability of such an arrangement to the developer (and thus the possibility of a tribe negotiating such an arrangement).

EXHIBIT IV-9

CARRIED-INTEREST JOINT VENTURE FOR ADDITIONAL DEVELOPMENT OF OIL:
CASH FLOW TO TRIBE AND OPERATING COMPANY
(\$1,000's)

	A	B ^{1/}	C	D	E ^{2/}	F	G	H	I	
	Production	Price	Gross	Unit	Unit	Total	Contribution	Contribution	Contribution	
Year	(1,000 bbls)	(\$/bbl.)	Income	Severance	Production	Production	To Income	To Tribe	To Operating	Year
			(AxB)	Tax	Cost	Cost	From	To Tribe	To Operating	
				(.068xC)	(\$/bbl.)	(AxE)	Operations	(50% of G)	Company	
							(C-D-F)		(50% of G)	
1	0	\$ 12.00	\$ 0	\$ 0	\$ 1.51	\$ 0	\$ 0	\$ 0	\$ 0	1
2	0	13.20	0	0	1.66	0	0	0	0	2
3	0	14.52	0	0	1.83	0	0	0	0	3
4	500	15.97	7,985	543	2.01	1,005	6,437	3,219	3,219	4
5	1,300	17.57	22,841	1,553	2.21	2,873	18,415	9,207	9,207	5
6	2,160	19.33	41,753	2,839	2.43	5,249	33,665	16,832	16,832	6
7	1,926	21.26	40,947	2,784	2.68	5,162	33,001	16,500	16,500	7
8	1,720	23.39	40,231	2,736	2.94	5,057	32,438	16,219	16,219	8
9	1,530	25.73	39,367	2,677	3.24	4,957	31,732	15,866	15,866	9
10	1,371	28.30	38,799	2,638	3.56	4,881	31,280	15,640	15,640	10
11	1,221	31.13	38,010	2,585	3.92	4,786	30,639	15,319	15,319	11
12	1,091	34.24	37,356	2,540	4.31	4,702	30,113	15,056	15,056	12
13	970	37.66	36,530	2,484	4.74	4,598	29,448	14,724	14,724	13
14	866	41.43	35,878	2,440	5.21	4,512	28,297	14,463	14,463	14
15	722	45.57	35,180	2,392	5.73	4,424	28,364	14,182	14,182	15
16	689	50.13	34,540	2,349	6.31	4,348	27,843	13,922	13,922	16
17	614	55.14	33,856	2,302	6.94	4,261	27,293	13,646	13,646	17
18	548	60.65	33,236	2,260	7.63	4,181	26,795	13,397	13,397	18
19	489	66.72	32,626	2,219	8.40	4,108	26,300	13,150	13,150	19
20	436	73.39	31,998	2,176	9.24	4,029	25,794	12,897	12,897	20
21	389	80.73	31,404	2,135	10.16	3,952	25,316	12,658	12,658	21
22	347	88.80	30,814	2,095	11.17	3,876	24,842	12,421	12,421	22
23	309	97.60	30,183	2,052	12.29	3,798	24,333	12,166	12,166	23
24	276	107.45	29,656	2,017	13.52	3,732	23,908	11,954	11,954	24

^{1/} Price will increase 10 percent per year under DOE regulation.

^{2/} Production costs may rise approximately 10 percent per year, based on confidential interviews with industry personnel.

8T-AI

EXHIBIT IV-9 (Cont.)

	J	K	L	M	N	
		(rounding errors)				
Year	Tribe's Share of Development Costs	Balance of Carried Interest	Interest Charges (10% of K)	Carried-Interest Repayments	Net Cash Flow To Tribe (H-M)	Year
1	\$ 750	\$ 750	\$ 75	\$ 0	\$ 0	1
2	1,450	2,275	227	0	0	2
3	1,450	3,953	395	0	0	3
4	1,450	5,797	580	3,219	0	4
5	650	3,809	381	4,190	5,017	5
6	650			650	16,182	6
7					16,500	7
8					16,219	8
9					15,866	9
10					15,640	10
11					15,319	11
12					15,056	12
13					14,724	13
14					14,463	14
15					14,182	15
16					13,922	16
17					13,646	17
18					13,397	18
19					13,150	19
20					12,897	20
21					12,658	21
22					12,421	22
23					12,166	23
24					11,954	24

EXHIBIT IV-9 (Cont.)

	O	P	Q	R	S	T	U	V	W	X	
	Operating Company's Share of Development Costs ^{1/}	Expensed Development Costs ^{5/} (Ox.70)	Capitalized Development Costs (Ox.30)	Depreciation (Straight- Line)	Taxable Income Before Depletion (I-P-R)	Depletion 22% of C (Up To 65% of S)	Taxable Income (S-T)	Income Taxes (Ux.5) (rounding errors)	Operating Company's Net Income (U-V)	Net Cash Flow To Operating Company (M+R+T+W-J-O)	Year
1	\$ 750 ^{2/}	\$ 525	\$ 225	\$ 0	\$(525)	\$ 0	\$(525)	\$ 0	\$(525)	\$(2,025)	1
2	1,450 ^{3/}	1,015	435	0	(1,015)	0	(1,015)	0	(1,015)	(3,915)	2
3	1,450 ^{3/}	1,015	435	0	(1,015)	0	(1,015)	0	(1,015)	(3,915)	3
4	1,450 ^{4/}	1,015	435	52	2,804	1,757	1,047	523	523	2,651	4
5	650	455	195	74	8,981	5,025	3,956	1,978	1,978	9,967	5
6	650	455	195	84	16,585	9,186	7,399	3,699	3,699	12,319	6
7	0	0	0	95	16,405	9,008	7,397	3,699	3,699	12,802	7
8	0	0	0	95	16,124	8,851	7,273	3,637	3,637	12,583	8
9	0	0	0	95	15,771	8,660	7,111	3,555	3,555	12,310	9
10	0	0	0	95	15,545	8,532	7,013	3,507	3,507	12,134	10
11	0	0	0	95	15,224	8,362	6,862	3,431	3,431	11,888	11
12	0	0	0	95	14,962	8,218	6,744	3,372	3,372	11,685	12
13	0	0	0	95	14,629	8,037	6,592	3,296	3,296	11,428	13
14	0	0	0	95	14,368	7,893	6,475	3,237	3,237	11,225	14
15	0	0	0	95	14,087	7,740	6,347	3,174	3,174	11,009	15
16	0	0	0	95	13,827	7,599	6,228	3,114	3,114	10,808	16
17	0	0	0	95	13,551	7,448	6,103	3,051	3,051	10,594	17
18	0	0	0	95	13,302	7,312	5,990	2,995	2,995	10,402	18
19	0	0	0	95	13,055	7,178	5,877	2,939	2,939	10,212	19
20	0	0	0	95	12,802	7,040	5,762	2,881	2,881	10,016	20
21	0	0	0	95	12,563	6,909	5,654	2,827	2,827	9,831	21
22	0	0	0	95	12,326	6,779	5,547	2,773	2,773	9,647	22
23	0	0	0	95	12,072	6,640	5,432	2,716	2,716	9,451	23
24	0	0	0	95	11,859	6,524	5,335	2,667	2,667	9,286	24

^{1/} Cost estimates from 1975 Joint Association Survey (American Petroleum Institute, 1975) and Enhanced Oil Recovery (National Petroleum Council, 1976).

^{2/} Geophysical exploration costs.

^{3/} 1978-1980 represents wildcat drilling and field development costs.

^{4/} 1981-1982 represents costs of conversion from primary production to water flood injection.

^{5/} Assumes 70 percent of drilling and development costs are not capitalized (National Petroleum Council, op. cit.).

EXHIBIT IV-10

DEFLATED, DISCOUNTED JOINT-VENTURE CASH FLOW FROM OIL

Year	Net Cash Flow to Tribe		Net Cash Flow to Operating Company	
	\$1,000's Current	\$1,000's Deflated at 6%	\$1,000's Current	\$1,000's Deflated at 6%
1	\$ 0	\$ 0	\$ (2,025)	\$ (1,910)
2	0	0	(3,915)	(3,484)
3	0	0	(3,915)	(3,287)
4	0	0	2,651	2,100
5	5,017	3,749	9,967	7,448
6	16,182	11,408	12,319	8,684
7	16,500	10,973	12,802	8,514
8	16,219	10,176	12,583	7,895
9	15,866	9,391	12,310	7,286
10	15,640	8,733	12,134	6,776
11	15,319	8,070	11,888	6,262
12	15,057	7,483	11,685	5,807
13	14,724	6,903	11,428	5,358
14	14,463	6,397	11,225	4,965
15	14,182	5,918	11,009	4,594
16	13,921	5,480	10,808	4,255
17	13,646	5,068	10,594	3,934
18	13,397	4,694	10,402	3,644
19	13,150	4,346	10,212	3,375
20	12,897	4,021	10,016	3,123
21	12,658	3,723	9,831	2,892
22	12,421	3,447	9,647	2,677
23	12,167	3,185	9,451	2,474
24	11,954	2,952	9,286	2,293
Total (Undiscounted)	\$ 275,380	\$ 126,117	\$ 212,343	\$ 95,675
Total (Discounted to Year 0)				
At 10%		\$ 42,738		\$ 30,239
At 15%		\$ 27,294		\$ 18,297

EXHIBIT IV-11

JOINT-VENTURE REVENUES OF GAS AS A BY-PRODUCT
OF ADDITIONAL OIL DEVELOPMENT

Year	A	B	C	D ^{1/}
	Production 1,000 mcf	Price \$/mcf	Gross Revenues (\$1,000's)	Tribe's Share Cx.5 (\$1,000's)
1	0	\$ 2.00	\$ 0	\$ 0
2	0	2.20	0	0
3	0	2.42	0	0
4	200	2.66	532	266
5	598	2.93	1,752	876
6	1,123	3.22	3,616	1,808
7	1,117	3.54	3,954	1,977
8	1,101	3.90	4,294	2,147
9	1,071	4.29	4,595	2,297
10	1,042	4.72	4,918	2,459
11	1,001	5.19	5,195	2,598
12	960	5.71	5,482	2,740
13	912	6.28	5,727	2,864
14	866	6.90	5,975	2,988
15	818	7.59	6,209	3,104
16	772	8.35	6,446	3,223
17	725	9.19	6,663	3,331
18	680	10.11	6,875	3,437
19	636	11.12	7,072	3,536
20	593	12.23	7,252	3,626
21	552	13.45	7,424	3,712
22	514	14.80	7,607	3,804
23	476	16.28	7,749	3,875
24	447	17.91	7,916	3,958

^{1/} Tribe's revenues are $\frac{1}{2}$ of gross revenues (instead of net revenues) because there are no significant additional costs for gas produced from an oil well. The costs are netted out of gross revenues for oil production.

EXHIBIT IV-12

DEFLATED, DISCOUNTED REVENUES FROM GAS AS A BY-PRODUCT OF A CARRIED-INTEREST JOINT VENTURE FOR ADDITIONAL OIL DEVELOPMENT

Year	Gas Revenues	Deflated at 6%
1	\$ 0	\$ 0
2	0	0
3	0	0
4	266	211
5	876	655
6	1,808	1,275
7	1,977	1,315
8	2,147	1,347
9	2,297	1,360
10	2,459	1,373
11	2,598	1,369
12	2,740	1,362
13	2,864	1,343
14	2,988	1,322
15	3,104	1,295
16	3,223	1,269
17	3,331	1,237
18	3,437	1,204
19	3,536	1,169
20	3,626	1,131
21	3,712	1,092
22	3,804	1,056
23	3,875	1,014
24	<u>3,958</u>	<u>978</u>
Total (Undiscounted)	\$ 58,626	\$ 24,377
Total (Discounted)		
At 10%		\$ 7,227
At 15%		\$ 4,374

Tribal Revenues--Comparison of Royalty and Carried-Interest Joint Venture

Tribal income benefits should also include a comparison of future tribal revenues under the royalty and carried-interest joint venture agreements described above for the additional development scenario. In this case, the tribal income from a carried-interest joint venture far outweighs any of the royalty agreements considered throughout the productive life of the wells, except from years 3 through 5 where the royalty slightly exceeds joint-venture revenues. However, if a well field is not as highly productive as the well in this hypothetical situation, a different relationship would result. For example, if a well were fairly unsuccessful, producing at or below 6.25 percent of the level of the wells in the previous example, royalty revenues would exceed joint-venture revenues throughout the life of the well, except for a brief period at the end. (Exhibit IV-13 shows revenue for the highly productive and less-productive examples and compares the two different types of contractual arrangements for each.)

EXHIBIT IV-13

CUMULATIVE TRIBAL REVENUE FROM OIL AND GAS DEVELOPMENT UNDER VARIOUS CONTRACT ARRANGEMENTS (CONSTANT DOLLARS, NOT DISCOUNTED)

(\$ Millions)

Depending on how much importance the tribe places on present versus future revenues, a joint venture might not be the best arrangement for less productive wells. If the tribe's interest rate is in line with the government discount rate of 10 percent, the revenues from quickly accruing royalties would outweigh the distant future revenues from the joint venture; however, if the tribe's interest rate is very low, perhaps 1 or 2 percent (giving more weight to future revenues than a higher percentage does), then the joint-venture arrangement would be best. (The use of such a low discount rate is unusual, but not unheard of, especially by groups that highly value the experience of future generations.) The importance of this illustration is that the range of productivity of each well field should be estimated before agreeing to contractual arrangements.

A royalty agreement on a field that ends up being fairly productive would unnecessarily forfeit additional revenues obtainable through a joint venture. Conversely, a joint-venture arrangement on unproductive fields would oblige the tribe to pay its share of the initial investment back over a longer period of time (with significant interest charges) and to delay receiving its share of the revenues by the same length of time. Great care should be given to selection of a desired contractual arrangement for which to negotiate. Of course, the actual agreement will depend on the tribe's historical "track record" of dealing with energy corporations and the strength of the tribe with regard to energy supplies (just how badly the oil and gas is needed: If need is high, the tribe can "drive a harder bargain").

The timing of development is just as important as the contractual arrangement negotiated. If the resource price is increasing at a rate higher than the tribe's discount rate (or in the absence of a defined discount rate, higher than the rate of return on the tribe's current investments), then it would be wise to delay development until the rate at which the resource price is increasing drops below the tribal discount rate. Then development could be pursued to the advantage of the tribe.

Tribal Jobs and Income

With the development of oil and gas reserves, a wide range of job types may become available in several petroleum-related activities including exploration, production (extraction), natural gas processing, refining, and transportation. Many of the jobs created will be located at facilities off the reservation (e.g., refining plants and pipeline transportation terminals may be located a substantial distance from the reservation). Some jobs may be of a short-term or transitory nature (e.g., exploration and drilling crews relocate many times in a year). It is assumed here that long-term jobs on the reservation are the most desirable to tribal members. In this analysis of jobs and income, several assumptions have been made:

Assumptions concerning jobs and income:

- Oil and gas production and gas processing jobs, which are relatively long-term and nontransitory, are considered the best opportunities for increased tribal income and employment.
- 50 percent of the jobs created will be filled by tribal members.

- The average manual wage in production in the region is \$6.50 per hour, which translates into an annual income of approximately \$13,500, and the average annual salaries^{1/} for non-manual employees are as follows:-

- 4-year degree - \$20,000
- 2-year degree - \$15,000
- On-the-job training - \$11,000.

If no additional development occurs, no additional jobs or income will be generated. In fact, the number of existing production jobs will decrease as wells are shut down.

The general job categories and approximate number of employees that are required to develop, operate, and maintain an additional producing oil field are not extensive. In this case, it is estimated that 46 employees represent an average number of employees required for about 39 producing wells in the study region (which corresponds to additional development scenario). From available statistics, this number varies among states depending on such factors as the distance between wells and fields, the age and condition of equipment, the type of recovery operations, etc. Assuming that Indians will fill half the jobs, then 23 Indians will be employed by the additional development. The types of jobs filled by tribal members will depend mainly on the training they receive. A summary of training program requirements and availability is provided in Volume IV. Exhibit IV-14 summarizes the job types that would be necessary to develop and operate 39 producing wells.

^{1/} Survey of Oil and Gas Positions and Salaries, prepared by an independent oil company. Released confidentially to Ernst & Ernst.

EXHIBIT IV-14

MANPOWER REQUIRED FOR OIL AND NATURAL GAS PRODUCTION^{1/}

<u>Manual</u>		<u>Nonmanual</u>	
<u>Exploration</u>			
Shot hole driller	1	Geophysicist	1
Shooter	<u>1</u>	Prospecting analyst	1
	2	Observer	<u>1</u>
			3
<u>Gas Processing*</u>			
Compressor operator	1	Plant supervisor	1
Maintenance	<u>1</u>		
	2		
<u>Drilling</u>		<u>Production Field Office*</u>	
Rig builder	1	Petroleum engineer	1
Rig builder's helper	1	Engineering aid	1
Driller	1	Geologist	1
Roughnecks	<u>4</u>	Clerk	1
	7	Field supervisor	<u>1</u>
(x 3 shifts =	21)		5
<u>Well Operation*</u>			
Pumper	2		
Treater	2		
Well tester	1		
Switcher	<u>1</u>		
	6		
<u>Contract Maintenance*</u>			
Roustabouts	2		
Welder	1		
Pipefitter	1		
Electrician	1		
Well puller	<u>1</u>		
	6		
Total Manual Positions	37	Total Non-Manual Positions	9

^{1/} The manpower levels shown are typical manpower requirements for a field of about 40 producing wells, based on information from industry and federal agency sources (based on an average of 1.15 employees per well--46 divided by 39). Actual manual requirements vary significantly among producing regions as described in the text.

* Indicates long-term job categories that could potentially be filled by tribal members.

Source: Bureau of Labor Statistics and industry personnel interviews.

With additional development, 46 long-term jobs will be created to develop, operate, and maintain an average of 39 producing wells that are expected to be producing at any one time. Out of these 46 jobs, 23 may be filled by tribal members. This represents an initial annual income of \$310,000-\$460,000 per year, depending on the mix of jobs, with a potential increase of 6 percent per year (cost of living) for probably more than 24 years. Over a 24-year period, the total income to be received by tribal members would be about from \$15.8 million to \$23.4 million. When discounted to present values using a 10 percent discount rate and adjusted for 6 percent inflation, the added income is worth from \$2.7 million to \$4.1 million.

ESTIMATES OF DIRECT COST TO THE TRIBE OF OIL AND GAS DEVELOPMENT

The potential oil-related direct costs that may accrue to the tribe differ from potential coal-related direct costs in type and magnitude. The oil-related direct costs are discussed below, following the format used in Section III.

Opportunity Costs of Land Conversion

Assuming the tribe does not put up capital to invest in an oil venture, there would be little opportunity cost to the tribe--except, possibly, recreation and tourism in some cases under a royalty or

carried-interest agreement. The amount of land that would be lost to oil well development would not be significant. Based on the estimates of the number of wells that might be drilled on the reservation, the total acreage of land that would be developed is about 5,000 acres (this assumes that oil well spacing will be 40 acres per well; gas well spacing would require 320 acres per well). However, out of the 5,000 acres, only a small portion will be physically disturbed. Out of the 40-acre spacing for each oil well, only one or two acres will actually be disturbed by pumping equipment, treatment facilities, storage tanks, or other equipment. Pipelines can generally be buried below plow depth. Therefore, the actual acreage of land effectively taken out of production would probably be less than 100 acres, which is considered negligible in this analysis. The remaining land wells will still be usable for grazing, growing crops, timberland, or other uses (subject to environmental impacts, discussed below).

It is also not likely that oil and gas will be developed from the same geologic formations as coal, although the technology to extract gas from coal unmined deposits is being studied. This option is not currently available.

Relocation Costs

As mentioned in the discussion on opportunity costs, the amount of tribal land that would be disturbed during oil and gas development would be minimal. In fact, USGS oil and gas drilling regulations place restrictions on drilling near buildings or other facilities. As a result, potential relocation costs are likely to be minimal.

Administrative Costs to Tribal Government^{1/}

The major costs to the tribal government from pursuing oil and gas development, assuming the tribe does not decide to finance a venture on its own, will be the costs of setting up a minerals office that oversees regular monitoring, accounting, etc. Annual operating and maintenance costs may begin at about \$25,000 for a manager and office space the first year and run up to \$250,000 per year depending on the level of development. Over a period of 24 years, the present value of a yearly expenditure of \$25,000 is \$224,619 when discounted at 10 percent, and \$160,844 when discounted at 15 percent. For a \$250,000 yearly expenditure, the discounted present values at 10 and 15 percent are \$2,246,188 and \$1,608,443, respectively. If the tribe pursues both coal and oil and gas development, total costs may exhibit economies of scale since office space and some of the personnel would be able to perform a dual role.

In addition, to obtain its own estimates of reserves before proceeding with any contractual arrangements, the tribe may wish to pay for petroleum exploration on the reservation. Often, an interested mineral company will pay for exploration but all of the findings may not be available to the tribe. Exploration of the entire reservation by aerial photography followed by seismic exploration might cost the tribe from \$150,000 to \$350,000,^{2/} depending on the detail required and topography.

^{1/} See Volume II for a more detailed discussion.

^{2/} Estimate by industry personnel interviewed confidentially by Ernst & Ernst.

Environmental Costs

The physical environmental impacts of oil and gas development are generally less significant than those of coal if proper control techniques are used. The greatest potential impact is contamination of surface and ground waters. Surface water pollution from casinghead or pipeline leakage and spillage could be carried by storm runoff into nearby surface water bodies. Contamination of underground aquifers may result from improperly designed or operated oil field injection wells. The chance of either of these impacts occurring is relatively low, because relatively strict control measures are specified in all well-drilling and operating permits issued by the USGS.^{1/} The cost of control measures is internalized in the unit production cost cited in Exhibit IV-9.

Other physical environmental impacts are generally minimal. These include:

- Noise. Some noise may result during drilling.
- Seepage into groundwater. Usually, excess drilling fluid is temporarily stored in portable tanks or earthen pits lined with plastic (polyurethane) to prevent seepage into groundwater. After well drilling, these pits (ranging in size from 1/4 to 1/2 acre) are pumped out by vacuum trucks or, with the landowner's permission, the fluid is allowed to remain until it evaporates and the remaining residue is scraped out of the pit to be plowed back into the ground (again only with the landowner's permission). The pit is fenced off during evaporation and filled in after residues are cleaned out.^{2/}

^{1/} The degree to which control measures are adequately monitored may vary from case to case. Refer to Volume II for a more extensive discussion of the issue.

^{2/} American Petroleum Institute, Production Department, Dallas, Texas.

- Air quality. Air quality and ecosystems will probably not be significantly affected, but the actual impacts that may occur depend on site-specific characteristics. There is a very remote possibility of a well blow-out such as occurred off the Gulf Coast near Brownsville, Texas, several years ago. If such an unusual event were to occur on the reservation, air pollution from the burning fuel and the increased fire danger to surrounding ecosystems would constitute significant environmental impacts with potentially high costs. More commonly, oil production impacts are limited to the disposal of sludge. Some states have outlawed the use of sludge pits, in which case sludge is pumped into portable tanks or vacuum trucks for removal. In states that permit sludge pits, the pits are only temporary: wastes are periodically pumped into vacuum trucks and after production ceases, residues are scraped from the pit, disposed along with the protective plastic lining, and the pit is filled with soil.^{1/}
- Service roads. Finally, roads servicing the well sites can be unsightly if they are not well planned.

Judging from the relatively small impact on reservation population that is expected to result from oil and gas development, there should be a relatively low level of adverse socio-cultural and environmental impacts on the tribe. There will, however, be some degree of aesthetic impact from the appearance of drilling rigs, oil wells, and storage tanks on the reservation.

SUMMARY OF INDIRECT BENEFITS AND COSTS AND FISCAL IMPACTS

As noted in the coal development discussion, large-scale development on the reservation may result in increased employment and income from expanding service industries and public services, improved

^{1/} Ibid.

communications and transportation, and an improved standard of living. However, indirect costs may also be incurred, including front-end and operating costs for expanded public services (e.g., transportation, fire, water and sewage, and law enforcement services), and an increased local cost of living. Some of these benefits and costs can be quantified; others cannot.

Considering the relatively low levels of oil-related employment that might occur on the reservation with either the current or additional development scenarios, the multiplier effect is not expected to be significant. Two types of indirect benefits might occur. One might be in the form of increased tribal business ventures funded by tribal oil-related general funds. The other might be a generally increased standard of living from oil-related per capita funds that may be reflected in a percent-per-capita income increase under a high-development situation.

Through multiplier effects, the tribe would receive 23 additional jobs (beyond new oil and gas jobs) and related income.

The level of indirect costs that may occur is also not expected to be significant. There will probably not be any significant population changes that might create a need for increased public facilities or services.

SUMMARY OF BENEFITS AND COSTS OF OIL AND GAS DEVELOPMENT

Taken together, direct tribal revenue benefits from oil and gas development range from \$14.7 million (low) to \$51.0 million (high). These benefits -- estimated at low and high levels -- from oil development and

gas development are summarized in Exhibits IV-15 and IV-16. The same comment pertains to these minimum and maximum estimates as was made in the coal section (pages III-40 to III-42).

EXHIBIT IV-15

SUMMARY OF REVENUE BENEFITS TO TRIBE FROM OIL UNDER VARIOUS DEVELOPMENT ARRANGEMENTS (PRESENT VALUE IN \$1,000's)

Development Arrangement	Discount Rate	
	10%	15%
Current Development		
12.5% royalty	\$ 515	\$ 384
16.7% royalty	686	511
20.0% royalty	823	614
Additional Development		
16.7% royalty	19,307	12,718
20.0% royalty	23,163	13,618
Carried interest-joint venture	42,738	27,294

Range of Benefits from Oil

Minimum: (15% discount) Current 12.5% plus additional 16.7% = \$384 + \$12,718 = \$13,102.

Maximum: (10% discount) Current 20.0% plus additional joint venture = \$823 + \$42,738 = \$43,561.

EXHIBIT IV-16

SUMMARY OF REVENUE BENEFITS TO TRIBE FROM GAS BY-PRODUCT UNDER VARIOUS DEVELOPMENT ARRANGEMENTS OVER 24 YEARS (PRESENT VALUE IN \$1,000's)

Development Arrangement	Discount Rate	
	10%	15%
Current Development		
12.5% royalty	\$ 137	\$ 102
16.7% royalty	184	137
20.0% royalty	217	163
Additional Development		
16.7% royalty	2,413	1,486
20.0% royalty	2,890	1,780
Carried interest-joint venture	7,227	4,374

Range of Benefits from Gas

Minimum: (15% discount) Current -12.5% plus additional -16.7% = \$102 + \$1,486
= \$1,588

Maximum: (10% discount) Current -20.0% plus additional joint venture
= \$217 + \$7,277 = \$7,444

As discussed on page IV-33, the environmental impacts of additional oil and gas development are not significant except for aesthetic impacts of oil wells.

Personal income from added direct employment would total from \$2.7 million to \$4.1 million. When the costs of a minerals office -- from \$.3 million to \$2.6 million -- are netted out of tribal revenue and employment income the remaining numbers represent the range of net benefits: \$14.8 million (low) to \$54.8 million (high). These estimates, derived from analyses earlier in this section, are summarized in Exhibit IV-17.

The benefits and costs of uranium, oil shale, and geothermal development are examined in Section V following the same overall approach used in Sections III and IV.

EXHIBIT IV-17

SUMMARY OF BENEFITS AND COSTS FROM
OIL AND GAS DEVELOPMENT
(PRESENT VALUE IN \$1,000's)

EFFECTS OF OIL & GAS DEVELOPMENT	Computation of Minimum Net Benefit <u>1/</u>	Computation of Maximum Net Benefit <u>2/</u>
BENEFITS		
Tribal Revenues	\$14,690	\$51,005
Personal Income from Employment	2,700	4,100
COSTS		
Administrative	(2,596)	(311)
Environmental & Socio-Cultural	Value to be determined by tribe	Value to be determined by tribe
TOTAL	\$14,794 Minus environ- mental and so- cio-cultural costs	\$54,794 Minus environmental and socio-cultural costs

1/ Smallest benefits less greatest costs.

2/ Greatest benefits less smallest costs.

V. APPLICATION OF THE BENEFIT-COST ANALYSIS FRAMEWORK: URANIUM, OIL SHALE, AND GEOTHERMAL DEVELOPMENT

In this section, the benefit-cost analysis framework developed in Section II is applied to the development of three other energy resources: uranium, oil shale, and geothermal. For three main reasons, the analysis presented herein is not as detailed as the examples presented in either of the two preceding sections. First, few tribes have these resources on the reservation. Second, reserve data are limited for these resources: Estimates of uranium reserves are limited because of the unpredictable patterns of widely varying grades of ore; geothermal reservoirs have been used commercially for many years, but reservoir data are limited in most areas. Third, information concerning future development costs and profitability of developing these resources is also limited. For example, only a few demonstration plants have been developed for oil shale, and the in-situ process, while promising, has not been widely applied. In the case of uranium, future development is uncertain because of the recent national emphasis on coal as a primary energy source and the increasing delays and costs involved

in nuclear plant construction.^{1/} This also makes it difficult to project future uranium prices.

With this background in mind, the following discussion presents estimates of the potential benefits and costs of development of each of these three resources based on the best information available from industry and public sources. We have tried to emphasize the key factors that should affect the tribe's decision on whether to develop one or more of these resources, given that the nature and extent of their occurrence are known.

The discussion follows the same format developed in Section II for a hypothetical tribe that has one or more of these resources on the reservation. Examples of the potential benefits discussed include tribal income from royalty leases and personal income from increased employment. Examples of direct costs to the tribe include opportunity costs of land conversion, quantifiable and unquantifiable environmental costs, and administrative costs to the tribe. Indirect benefits and costs and fiscal impacts are also covered in summary form. The order in which the resources are discussed in this section is: uranium, oil shale, and geothermal (hot dry rock) resources.

^{1/} The Carter Administration energy plan places significant emphasis on developing coal (while continuing to develop conventional nuclear fusion) as a primary energy source in a shift away from oil and gas. Increasingly important environmental concerns and licensing procedures continue to delay nuclear plant construction and increase costs to the point where many utilities may consider nuclear power plant construction economically unfeasible. Increasing emphasis on coal is a readily available and potentially cheaper energy source (because of lower plant construction costs) may further shift emphasis away from nuclear sources.

URANIUM DEVELOPMENT

Overview

Deposits of uranium ore are known to exist in several basins in Wyoming, Colorado, Utah, New Mexico and several other states, with ore grades ranging from less than 0.1 percent to over 0.5 percent uranium oxide (U_3O_8). Most of the known deposits occur at depths of less than 500 feet, allowing open-pit mining. However, at ore depths greater than 300 feet, underground mining is usually preferred.

Assumptions

The analyses that follow are based on the following assumptions for a hypothetical tribe:

- The tribe has over 5 million tons of high-grade (0.25 percent) U_3O_8 ore.
- An underground mine will be used to extract the ore over a period of 10 years, at a rate of 1,500 tons per day.^{1/}
- A mill will be constructed at the mine site to process the ore into U_3O_8 concentrate ("yellowcake").
- The project has a total life of 18 years: 8 years for development of the mining and milling facilities, and 10 years for actual production.^{2/}

^{1/} The assumption of a productive life of 10 years is taken from John Klemenic, "Examples of Overall Economics in a Future Cycle of Uranium Concentrate Production...", U.S. Atomic Energy Commission, 1972.

^{2/} For a typical facility, Klemenic assumes 10 years are required for development. For this example, we subtracted the 2 years he allows for acquisition of the property, assuming that the project is evaluated from the start of the lease agreement between the tribe and the operating company.

- The efficiency of the milling operation is 95 percent. That is, 5 percent of the U_3O_8 in the ore will be extracted as concentrate.^{1/} Therefore, the processing of 1,500 tons of ore per day will yield 3.56 tons (7,125 pounds) of U_3O_8 concentrate per day.
- The U_3O_8 concentrate is sold for \$40 per pound (in constant dollars) over the life of the project. It must be kept in mind that the future price of uranium is highly uncertain, having declined over the years 1955-1972 and then having risen sharply.

Estimate of the Direct Benefits of Uranium Development

Overview. In this subsection, we examine the potential tribal income that may be received from alternative contract arrangements--a lease with royalties versus a carried-interest joint venture--and individual jobs and income that will be associated with uranium mining and processing. The analytical models used are similar to those discussed in Section III. A detailed discussion of the estimation methods used is also provided in that section.

^{1/} The efficiency of milling is directly proportioned to the grade of ore. For a lower grade of ore--say, 0.05 percent--efficiency of 87.5 percent would be expected. (John Klemenic, personal communication.)

Royalty Lease Arrangement. Historically, royalties on uranium production have been paid to lessors based on the quantity of U_3O_8 present in the unprocessed ore, as determined by sampling and assay. The size of the royalty per pound of U_3O_8 increases with the grade of the ore, because a greater proportion of the U_3O_8 content can be recovered from higher-grade ore. Recently, however, the industry trend is toward so-called "yellowcake" royalties, which are computed on the value of the processed uranium concentrate.^{1/} These are generally perceived as advantageous to the lessor, since the price of U_3O_8 concentrate has risen faster than the price of unprocessed ore. Typically, royalties under such an arrangement are computed as 5 percent of the value of the U_3O_8 concentrate.^{2/}

Exhibit V-1 shows the revenue that the hypothetical tribe would receive under a lease arrangement, assuming a 5 percent royalty.

^{1/} Royal E. Peterson, "The Uranium Royalty Provision: Its Evolution, Present Complexity, and Uncertainty." Rocky Mountain Mineral Law Foundation, 1976.

^{2/} Royal E. Peterson, personal communication.

EXHIBIT V-1

CASH FLOW TO TRIBE FROM LEASE ARRANGEMENT WITH 5 PERCENT ROYALTY

Year	Tons of Ore Processed (Millions)	Pounds of U ₃ O ₈ Produced (Millions)	Price of U ₃ O ₈ (Constant \$/lb)	Value of U ₃ O ₈ Produced (Constant \$ Millions)	Cash Flow to Tribe from Royalties (Constant \$ Millions)
1	0	0	\$ 0	\$ 0	\$ 0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0.55	2.60	40	104.0	5.2
10	0.55	2.60	40	104.0	5.2
11	0.55	2.60	40	104.0	5.2
12	0.55	2.60	40	104.0	5.2
13	0.55	2.60	40	104.0	5.2
14	0.55	2.60	40	104.0	5.2
15	0.55	2.60	40	104.0	5.2
16	0.55	2.60	40	104.0	5.2
17	0.55	2.60	40	104.0	5.2
18	0.55	2.60	40	104.0	5.2
Total	5.48	26.0		\$1,040.0	\$52.0

Present Value of Cash Flow:

Discounted at 10%	\$14.91
Discounted at 15%	\$ 8.53

Carried-Interest, Joint-Venture Arrangement. In this subsection, we examine the potential revenues that may be received in a carried-interest joint venture. This arrangement is discussed in greater detail in Section III.

The analysis is based on the following additional assumptions:

- There is a 50 percent carried-interest agreement between the tribe and the operating company. That is, the tribe is responsible for half of the investment and half of the costs, and receives half of the revenues from the combined mining and milling operations. The entire initial investment is furnished by the operating company. The tribe repays the operating company for its half of the investment, plus interest, out of its share of revenues.
- The initial investment in the mine and mill totals \$70 million over the eight pre-production years. \$6 million is invested in each year for the first five years; \$10 million is invested in the sixth year; and \$15 million is invested in each of the next two years.^{1/}
- For purposes of computing the operating company's income tax, 75 percent of the initial investment is capitalized and 25 percent is expensed. The capitalized portion is depreciated using the straight-line method over the 10 years of production.
- Depletion is computed as 22 percent of gross income, up to a maximum of 50 percent of taxable income before depletion.
- The income tax level is 50 percent (48 percent federal and 2 percent state).
- A severance tax of \$2 per pound of concentrate is charged to the joint venture.^{2/}

^{1/} The \$70 million total investment is estimated from figures in Klemenic, op. cit., updated to 1976 dollars using the Marshall & Swift Mining and Milling Equipment Cost Index and the Chemical Engineering Plant Cost Index. The pattern of investment over the eight pre-production years approximates that described by Klemenic.

^{2/} This is the tax that would be charged in New Mexico, assuming a sales price of \$40 per pound.

- Operating costs of mining, hauling and milling total \$25.72 per ton of unprocessed ore.^{1/} Since 1 ton of ore yields 4.75 lbs. of concentrate, the cost per pound is \$5.41.

Exhibit V-2 shows the income and cash flow calculations for the carried-interest, joint-venture arrangement, based on the above assumptions.^{2/} For the tribe, the present value of the cash flows from the project, discounted at 10 percent, is \$49.022 million; discounted at 15 percent, the present value is 18.618 million. It must be kept in mind that these estimates will be sensitive to variations in the assumptions used to develop the example. In particular, the price of U_3O_8 concentrate, and the schedule of repayment of the carried interest, might well vary from the assumptions.

^{1/} Klemenic, *op. cit.*, updated using the Bureau of Labor Statistics Wholesale Price Index for Industrial Commodities.

^{2/} The procedure used to derive each column in Exhibit V-2 is the same as the procedure described in Exhibit III-4.

EXHIBIT V-2

CARRIED-INTEREST, JOINT-VENTURE ARRANGEMENT
(All Figures in Millions of Constant Dollars unless Otherwise Indicated)

	A	B	C	D	E	F	G	H	I	
	Quantity of U ₃ O ₈ Concentrate Produced (Millions of Pounds Per Year)	Price (\$/lb)	Gross Income (AxB)	Severance Tax (\$/x A)	Unit Production Cost (\$/lb)	Total Production Cost (Ax E)	Contribution to Income from Operations (C-D-F)	Contribution to Tribe (50% of G)	Contribution to Operating Company (50% of G)	
Year										Year
1										1
2										2
3										3
4										4
5										5
6										6
7										7
8										8
9	2.60	\$ 40.00	\$ 104.0	\$ 2.60	\$ 5.41	\$ 14.07	\$ 87.33	\$ 43.67	\$ 43.67	9
10	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	10
11	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	11
12	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	12
13	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	13
14	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	14
15	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	15
16	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	16
17	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	17
18	2.60	40.00	104.0	2.60	5.41	14.07	87.33	43.67	43.67	18

6-A

EXHIBIT V-2 (Cont.)

	J	K	L	M	N	
Year	Tribe's Share of Development Costs	Balance of Carried Interest	Interest Charges (10% of K)	Carried- Interest Repayments	Net Cash Flow to Tribe (H-M)	Year
1	\$ 3.0	\$ 3.0	\$ 0.30			1
2	3.0	6.3	0.63			2
3	3.0	9.93	0.99			3
4	3.0	13.92	1.39			4
5	3.0	18.32	1.83			5
6	5.0	25.15	2.52			6
7	7.5	35.16	3.52			7
8	7.5	46.18	4.52			8
9		50.80	5.08	\$ 43.67	\$ 0	9
10		12.20	1.22	13.42	30.25	10
11		0			43.67	11
12					43.67	12
13					43.67	13
14					43.67	14
15					43.67	15
16					43.67	16
17					43.67	17
18					43.67	18
Total Cash Flow					\$379.61	
Present Value of Cash Flow:						
Discounted at 10%					\$101.49	
Discounted at 15%					\$ 55.92	

EXHIBIT V-2 (Cont.)

Year	O Operating Company's Share of Development Costs	P Expensed Development Costs (25% of O)	Q Capitalized Development Costs (75% of O)	R Depreciation	S Taxable Income before Depletion (I-P-R)	T Depletion (5% of C, up to 50% of S)	U Taxable Income (S-T)	V Income Taxes (50% of U)	W Operating Company's Net Income (U-V)	X Net Cash Flow to Operating Company (M+R+T+N-J-O)	Year
1	\$3.0	\$ 0.750	\$ 2.250		\$(0.750)		\$(0.750)	\$ 0	\$(0.750)	\$(6.750)	1
2	3.0	0.750	2.250		(0.750)		(0.750)	0	(0.750)	(6.750)	2
3	3.0	0.750	2.250		(0.750)		(0.750)	0	(0.750)	(6.750)	3
4	3.0	0.750	2.250		(0.750)		(0.750)	0	(0.750)	(6.750)	4
5	3.0	0.750	2.250		(0.750)		(0.750)	0	(0.750)	(6.750)	5
6	5.0	1.250	3.750		(1.250)		(1.250)	0	(1.250)	(11.250)	6
7	7.5	1.875	5.625		(1.875)		(1.875)	0	(1.875)	(16.875)	7
8	7.5	1.875	5.625		(1.875)		(1.875)	0	(1.875)	(16.875)	8
9				\$ 2.625	41.045	\$5.2	35.845	17.92	17.920	69.415	9
10				2.625	41.045	5.2	35.845	17.92	17.920	39.165	10
11				2.625	41.045	5.2	35.845	17.92	17.920	25.745	11
12				2.625	41.045	5.2	35.845	17.92	17.920	25.745	12
13				2.625	41.045	5.2	35.845	17.92	17.920	25.745	13
14				2.625	41.045	5.2	35.845	17.92	17.920	25.745	14
15				2.625	41.045	5.2	35.845	17.92	17.920	25.745	15
16				2.625	41.045	5.2	35.845	17.92	17.920	25.745	16
17				2.625	41.045	5.2	35.845	17.92	17.920	25.745	17
18				2.625	41.045	5.2	35.845	17.92	17.92	25.745	18

Total Cash Flow

\$235.790

Present Value of Cash Flow:

Discounted at 10%
Discounted at 15%

\$ 49.022
\$ 18.618

Tribal Jobs and Income. For the level of development described above, estimates of the level of employment in the mining and milling operations are shown in Exhibit V-3.^{1/} Descriptions of the job qualifications and available training programs are provided in Volume III.

^{1/} Bureau of Indian Affairs, Navajo-Exxon Uranium Development, Final Environmental Impact Statement, 1976. The project to which these estimates apply includes a mill that processes, on the average, 2,500 tons per day, with an operating range of 1,500 to 3,500 tons per day. It is assumed that employment in the 2,500 tons-per-day plant is roughly comparable to employment in the 1,500 tons-per-day plant in our example.

EXHIBIT V-3

PHASING OF EMPLOYMENT

<u>Year</u>	<u>Exploration</u>	<u>Construction</u>		<u>Operation</u>		<u>Total</u>
		<u>Mine</u>	<u>Mill</u>	<u>Mine</u>	<u>Mill</u>	
1	32					32
2	32					32
3	32					32
4	32					32
5	32					32
6			75			75
7		76	151			227
8		76	151			227
9				248	77	325
10				248	77	325
11				248	77	325
12				248	77	325
13				248	77	325
14				248	77	325
15				248	77	325
16				248	77	325
17				248	77	325
18				248	77	325

As in the coal development example, we assume that half of the jobs created will be filled by tribal members, and that the average salary will be \$18,700 (constant dollars) per year. Exhibit V-4 summarizes the employment and income of tribal members, and shows that the present value of this income, discounted at 10 percent, is \$12.36 million; discounted at 15 percent, it is \$7.809 million.

EXHIBIT V-4

POTENTIAL INDIAN EMPLOYMENT AND INCOME

<u>Year</u>	<u>Number of Jobs Held by Tribal Members</u>	<u>Personal Income (\$ Millions)</u>
1	16	\$ 0.299
2	16	0.299
3	16	0.299
4	16	0.299
5	16	0.299
6	38	0.711
7	114	2.132
8	114	2.132
9	163	3.048
10	163	3.048
11	163	3.048
12	163	3.048
13	163	3.048
14	163	3.048
15	163	3.048
16	163	3.048
17	163	3.048
18	163	3.048
Total		\$ 36.950

Present Value of Income:

Discounted at 10%	\$ 12.360
Discounted at 15%	\$ 7.809

Estimate of Direct Costs to the Tribe

The types of costs associated with energy resource development were introduced in Section II. The costs that are specific to uranium development are summarized below in the same format.

Opportunity Costs of Land Conversion. The total land requirements that would be involved for an underground mining and surface milling operation are expected to be approximately 500 acres over the project life.^{1/} For the purposes of this analysis, we will consider the total land area lost from grazing or dry farming to be an insignificant amount. However, an actual dollar figure for the income foregone could be estimated using the procedure described in Section III. It should be noted, however, that for a surface mining operation, the total land area disturbed would be significantly greater than for an underground mine. And the costs to the tribe would be similar in magnitude to those calculated for the coal strip mining example if surface uranium mining technology were utilized.

Relocation Costs. Based on the estimates of acreage lost discussed above, the costs of relocation of displaced families or enterprises would not be significant for underground mining. In the case of surface mining, the estimates would closely resemble those for coal surface mining on a per-acre basis.

^{1/} Based on direct land requirements described in Navajo-Exxon Uranium Development, op. cit.

Administrative Costs to the Tribal Government. The major administrative costs to the tribe would be the costs of setting up and operating a tribal minerals office. The costs involved, including capital costs (office space, equipment, vehicles, etc.) and operating costs (salaries, supplies, fuel, etc.), would be similar to the costs for other development projects. They are discussed in more detail in Section III of this volume and in Volume II.

Summary of Environmental Costs. As discussed in previous subsections there will be direct environmental costs to the tribe that cannot be quantified, especially the loss of aesthetic quality of natural areas and the loss of wildlife habitat. However, the relative importance of these types of costs must still be considered by the tribe in making any sort of development decision. The long-range effect on health from radiation exposure during mining and milling activities is the most significant environmental cost that is particular to uranium mining, although a realistic method for projecting future costs has not been advanced. In Exhibit V-5, we have provided a summary of the types of direct environmental costs that can be expected to result from uranium development.

^{1/} A more detailed discussion of these types of impacts is presented in Volume IV.

EXHIBIT V-5

DIRECT ENVIRONMENTAL COSTS TO THE TRIBE
FROM URANIUM MINING AND MILLING

Environmental
Factor Affected

Description of Impact

Aesthetic Quality

Disruption of the landscape represents a cultural loss to the tribe. The land often has great spiritual and religious value. Disruption of the landscape may also decrease the number of tourists that frequent the area.

Air Quality

Dust, radioactivity, smoke, and other emissions that originate primarily from the milling process will represent some long-term health and aesthetic costs to the tribe over the long run. Appropriate emissions control measures will minimize these effects.

Noise

Noise from exploratory drilling, mining, and milling will represent some long-term health costs to those employees working in the immediate area.

Water Quality

Discharges of radioactive water from mining operations may have some impact on health costs, although the critical level of exposure from this source is not known as yet. Also, it is possible that the quality of drinking water from artesian wells could deteriorate from contamination due to exploratory drilling. Seepage from mine tailings ponds into water supplies is expected to be minimal, assuming proper control measures are used. Pumping from the mines could also cause long-term drawdown of local groundwater aquifers.

Ecological

Some losses to the tribe will result in the form of decreased hunting and fishing from the disruption of land and aquatic feeding patterns and habitats.

Note: This list is not all-inclusive but is intended to summarize the major environmental costs of uranium development. The actual types and magnitudes of impacts depend on site-specific characteristics and should be assessed on a project-by-project basis.

The health risks to uranium miners are well established. Excerpts from a recent National Institute for Occupational Safety and Health study indicate the severity of these risks.

Because radon^{1/} diffuses from the rock into open areas of mines, most underground miners are exposed to radon concentrations in excess of those above ground.... An intensive follow-up was done on 3,366 white and 780 non-white workers who had been examined by our traveling medical teams between 1950 and 1960.... The follow-up cut-off date was January 1, 1974, for Indians, and September 30, 1974 for whites.... Follow-up was 100% among Indians.... Respiratory cancer was the only death cause which was significantly higher than expected.... There was a trend toward excess deaths from tuberculosis [and] other non-malignant respiratory disease.... Respiratory disease (both malignant and non-malignant) is not elevated among workers with less than five years exposure, begins to rise during the five-to-ten year period, and rises rapidly with longer time intervals after the start of mining. The time from start of mining to cancer...range [sic] from 11 to 24 years with a mean of 17.1 years. The excess respiratory cancer among Indians...shows that Indians are not immune to radiation-induced cancer....^{2/} [W]ith use of a computer model it was calculated that for 30 years' exposure at 4WLM/year^{3/} a group of 20-year-olds, by age 80, would have a 45% increase of respiratory cancer over expected numbers.^{4/}

The risks to uranium mill workers are "very similar to those faced by miners."^{5/} The dangers to mill workers are from radioactive dust and gases released during uranium ore crushing and stamping and from toxic ion exchange and extraction reagents (mainly ammonia derivatives) used during the yellowcake production process.

^{1/} A radioactive gas that is a uranium decay product.

^{2/} As had previously been suggested in the public health literature.

^{3/} The current safety standard for uranium mines.

^{4/} Excerpt from: Archer, V. E., J. D. Gillam, and J. K. Wagoner, "Respiratory Disease Mortality Among Uranium Miners," Annals N.Y. Acad. Sci. 271: 280-293, 1976.

^{5/} Dr. Frank Collins, Legislative Department, Oil Chemical and Atomic Workers International Union.

Summary of the Indirect Benefits and Costs and Fiscal Impacts

Based on the level of development discussed thus far, it is likely that the indirect benefits and costs described in Section II may be significant for uranium development. Assuming an employment and income multiplier of 2.0, a total of 650 direct and indirect jobs will be created in the area during the years of mine and mill operation (assuming about 325 jobs are filled by tribal members already on the reservation). Not all of these will necessarily be in the immediate vicinity of the uranium development because it is assumed there will be some dispersion of families attracted to the area. However, in situations where the potential population increase in a single community is significant (the "boom town" effect), an estimate of the fiscal impacts that will be experienced by the tribal or municipal governments can be made using the planning factors provided in Section III. The uncertainty concerning future uranium prices will also have a significant effect on uranium development and boom-town development. A drop in uranium prices could create a slow-down in current producing areas and preclude development in other areas.

Summary of Uranium Development

In this section we have examined the benefits and costs of uranium development on an Indian reservation. For the level of production examined (2.6 million pounds of uranium concentrate per year), the major potential benefits to the tribe include up to \$49 million in tribal income (in present-value terms) under 50 percent carried-interest joint venture, and employment of 325 tribal members in new mines and mills. However, there may be significant costs to the tribe, including the opportunity costs of converting

agricultural and grazing land to mining. The tribe may also experience costs for relocating displaced families, and setting up and maintaining a contract monitoring program (e.g., a tribal minerals office). Fiscal impacts of financing additional public services will also result from significant population increases. Unquantifiable environmental costs include long-term health costs from radiation and air and water quality deterioration, as well as potential cultural and aesthetic losses.

OIL SHALE DEVELOPMENT

Overview

A significant amount of oil shale is known to underlie much land area in Colorado, Wyoming, and Utah. At present, three processes are possible for recovery of oil from oil shale: surface retorting, in situ ("in place") retorting, and modified in situ retorting. The cost per barrel of oil differs for each of these technologies, as shown below:

<u>Retorting Process</u>	<u>Cost per Barrel (1976 dollars)</u> ^{1/}
Surface	\$15 - \$25
<u>In Situ</u>	\$ 8 - \$15
Modified <u>In Situ</u>	\$12.50 - \$14.50

In light of current world oil prices (about \$14.00 per barrel) the price estimates listed above indicate two things. First, at a \$15 per barrel price, the surface retorting process is not economically competitive, but may become competitive if world oil prices exceed \$15 per barrel in the near future (or if processing costs decline). Second, the estimated prices for in situ and modified in situ processing appear to be economically competitive; however, many technological aspects of these processes have not been sufficiently developed for commercial use. Therefore, the tribe is faced with the decision whether to pursue a developed technology (that is, surface retorting) that may be only marginally competitive or to wait to pursue a more competitive process with great technical uncertainties.

^{1/} Estimates from an Oil Shale Program presentation, Energy Research and Development Administration, 1977.

For illustrative purposes, it is assumed that the oil shale resources of a hypothetical tribe are sufficient to undertake development using a surface retorting process. The analysis that follows is based on the following additional assumptions:

- Approximately 375 million barrels of oil are recoverable from shale that contains an average of 28 gallons per ton.^{1/}
- The oil shale will be mined underground at a rate of 75,000 tons per day.
- Surface facilities will include a crushing plant (to crush and store the mined oil shale), a briquetting plant (to press the crushed oil shale into uniform pieces), a retort mill (to heat the oil shale to temperatures that release the oil), and an upgrading plant (to upgrade the shale oil to a synthetic crude suitable as input to a conventional refinery).
- The surface facilities will process the oil shale at a rate of 75,000 tons per day, yielding 50,000 barrels of synthetic crude oil per day.^{2/} At this rate, the mine will be productive for at least 20 years.

Estimation of the Direct Benefits of Oil Shale Development

Tribal Revenues. For the purpose of this analysis, we will consider only the lease arrangement, under which the tribe receives royalties based on production.

^{1/} These figures are comparable to those estimated for Federal Prototype Oil Shale Lease Tract U-a. Phillips Petroleum Co. and Sunoco Energy Development Co., Application for Suspension of Operations and Production Under Oil Shale Lease Serial U-26194. One barrel of oil equals 42 gallons.

^{2/} Several by-products will also result (e.g., ammonia, coke, and sulfur).

Tribal revenues are estimated by applying hypothetical royalty rates to the current estimated minimum selling price (\$15) for the surface retorting process, which is the most commercially advanced process. Exhibit V-6 shows estimates for tribal income when royalty rates of 12.5 and 25 percent are applied.

EXHIBIT V-6

TRIBAL REVENUES FROM OIL SHALE ROYALTIES

Year	Price/Barrel (Constant \$)	Barrels/Year (Millions)	Total Value of Production/ Year (Constant \$ Millions) ^{1/}	Tribal Royalty Revenue/Year (Constant \$ Millions)	
				12.5%	25%
1-8	--	\$ 0 ^{2/}	\$ 0	\$ 0	\$ 0
9-28	\$15	\$18.25	273.75	34.22	68.44
Total				\$684.38	\$136.88
Present Value of Revenue:					
Discounted at 10%				\$135.91	\$271.82
Discounted at 15%				\$ 70.02	\$140.04

^{1/} Potential revenue from the sale of by-products is not included.

^{2/} Allowing 8 pre-production years.

Tribal Jobs and Income

A significant number of jobs would be generated from an oil shale project producing 50,000 barrels per day. An estimated 592 persons would be required to operate the underground mine; an additional 375 would be employed in surface retorting and upgrading facilities.^{1/} Assuming that half of these jobs are filled by tribal members at an average salary of \$18,700 (in constant dollars), an estimated \$9.05 million income would accrue to tribal members in each year of production. The present value of this stream of income, discounted at 10 percent, is \$35.95 million (discounted at 15 percent, \$18.52 million).^{2/}

Estimation of Direct Costs of Oil Shale Development

Opportunity Costs of Land Conversion. As oil shale is mined, land must be diverted from agricultural, grazing, or forestry applications. For underground mining, it is estimated that 800 acres would be diverted over 20 years of operation. If surface mining were employed, a total of 8,000 acres would be diverted.^{3/} The opportunity cost of diverting this land could be computed using the same procedure applied in Section III, based upon the distribution of land among the three basic uses.

^{1/} Bechtel Corporation, Manpower, Materials, Equipment and Utilities Required to Operate and Maintain Energy Facilities, 1975.

^{2/} Not included in this estimate is income that would accrue to tribal members who were employed during the eight pre-production years.

^{3/} Battelle Columbus Laboratories, Environmental Considerations for Oil Shale Development, 1974.

Relocation Costs. Based on the data used in Section III, it is assumed that for each 2,200 acres of grazing and agricultural land disturbed, one family would be displaced; therefore, it can be estimated that up to three families might be displaced depending on the mining method used. The direct cost of relocating families could either be written into the contract agreement as a charge to the developing company or be borne by the tribe (paid for eventually from the tribe's royalties). However, there will be some hardships borne by individual families forced to relocate that are not readily quantifiable (e.g., social readjustment).

Administrative Costs to the Tribe. It is assumed that administrative costs to the tribe for setting up a minerals office will be similar to those for coal development. Volume II and Section III of this volume provide a more detailed discussion of these costs.

Environmental Costs. The range and extent of environmental impacts that may result from oil shale mining and processing are broad. The most important impacts are the effects of air pollution and solid waste. It is assumed that most of the direct environmental costs (e.g., the reclamation and shale disposal costs) will be paid by the developing company as part of its operating costs. However, there are other environmental costs that will be experienced by the tribe but that are not readily quantifiable in monetary terms. Most notable are the aesthetic effects of spent shale disposal areas, the potential impacts on ground and surface water quality from the seepage of spent shale wastes and oil shale mining areas, and the costs to health from air quality impacts resulting from mining and upgrading

processes. The main danger from water seepage is increased salinity in ground and surface water. Saline water can upset soil chemistry over long periods of time, thus reducing agricultural productivity. If ingested, saline water can be injurious to people and livestock. Salinity problems can be controlled by proper drainage and catchments at the pollution source, but are difficult to correct once water has been contaminated. Therefore, tribes should insist on adequate preventive measures before, during, and after oil shale mining and milling. Another significant impact of oil shale is the potential health problem posed by toxic metals in the shale. Exhibit V-7 summarizes the types of environmental costs that should be considered by the tribe in making a development decision. The summary is not all-inclusive, but represents a sample of the types of costs that may result from oil shale development.

ENVIRONMENTAL IMPACTS TO THE TRIBE FROM SHALE OIL DEVELOPMENT

<u>Environmental Factor Affected</u>	<u>Description of Impact</u>
Solid Waste	A significant amount (up to 5,000 acres) of tribal land area will be disturbed using surface disposal techniques that affect both aesthetic and land productivity. Impacts result from the disposal of unused crushed shale oil and spent shale from retorting and may be long-lasting because reclamation is costly and not always successful.
Air Quality	Dust from spent shale disposal areas, and sulfur dioxide from processing affect respiration. Both can be controlled using proper control measures. ^{1/}
Water Quality	Leachates from spent shale areas can infiltrate ground and surface waters. Health risks and reduced livestock and crop productivity are likely unless proper control measures or water treatment are used.
Ecological Disturbance	Wildlife migrating and feeding patterns will be disturbed during construction and operation of the facility, and will affect tribal hunting. Water quality impacts on aquatic life will affect tribal fishing.
Aesthetics	Mines and facilities will affect the aesthetic value of the landscape for the tribe and tourists.
Health Effects	For oil shale facility workers, skin contact exposure to oil shale, solid residues and process gases may present certain health risks. Oil shale contains trace amounts of toxic metals which over the long run may generate occupational health problems for mine and mill workers. Toxic metal-induced disorders include liver and kidney dysfunction, blindness, lack of motor coordination, and brain damage.

^{1/} Without control measures, hydrocarbon and sulfur dioxide levels would greatly exceed EPA Non-Significant Degradation 3-hour exposure standards. Source: Energy from the West: A Progress Report of Technology Assessment of Western Energy Resource Development, Vol. I. ERDA, July 1977.

Note: This list is not all-inclusive but is intended to summarize the major environmental costs of oil shale development. The actual types and magnitudes of impacts depend on site-specific characteristics and should be assessed on a project-by-project basis.

Summary of Indirect Benefits and Costs and Fiscal Impacts

The major indirect benefits that will result from oil shale development are the indirect jobs and incomes created. A general procedure to estimate these impacts is provided in Section III.

The major indirect costs of oil shale development will be the fiscal impact of providing additional public services to meet an expanding population. Under the level of development described in this section, it is not likely that a significant number of employees will be attracted to the area to classify tribal communities as "boom towns." However, it is possible that some towns in the area will experience increases in population of up to several hundred people as a result of direct and indirect employment opportunities resulting from development. Where larger scale development is expected to occur, fiscal impacts required to supply additional services will be greater and can be estimated from the "boom town" planning factors provided in Section III. Reduced water availability for other uses may result from oil shale development, since up to 9,000 acre-feet per year may be required for mining and processing. This effect creates an opportunity cost of foregone future development.

Summary of Oil Shale Development

The preceding pages have presented the most significant aspects of oil shale development. However, the uncertain status of oil shale technology, combined with potentially significant environmental effects, makes it difficult to reasonably assess other future benefits and costs of oil shale development. At the present time this uncertainty factor would appear to greatly diminish potential benefits and add to the potential costs of development.

GEOHERMAL RESOURCES DEVELOPMENT

Overview

In the most general sense, geothermal energy is heat that occurs naturally in the earth's crust. Geothermal resources can exist in several forms: the element common to them is that each contains useful energy in the form of heat.

At present, there are three types of geothermal resources that can be exploited with existing technologies:

- Vapor-dominated: naturally occurring reservoirs of super-heated steam. Only a few major reservoirs of this type are known to exist; these have been developed for electrical generation.
- Liquid-dominated: naturally occurring mixtures of liquid water (or brine) and steam, at high pressure and temperature. There are many such reservoirs throughout the world, a few of which have been developed.
- Hot dry rock: geologic formations that have an abnormally high heat content, without naturally occurring water. The heat energy is tapped by circulating water through man-made fractures in the rock. This technique is under development at present, and has not been used for commercial power production. It is believed that numerous sites in the western United States have sufficient hot dry rock deposits to justify development.^{1/}

^{1/} The Futures Group, A Technology Assessment of Geothermal Energy Resource Development, 1975.

The temperature, depth, rate of flow, and proximity of geothermal resources to potential users determine their economic utility. The use of geothermal reservoirs as a direct heat source for industrial, agricultural, or residential uses can be economical for fairly low water temperatures and rates of flow, but this heat cannot be transported great distances.

The federally sponsored Los Alamos Scientific Laboratory (LASL) Hot Dry Rock Geothermal Project has evaluated the development of relatively small-scale (100-MW or less) electrical generation facilities using hot dry rock.^{1/} LASL estimates that such plants would be competitive with similarly sized oil-fired plants, and thus should be attractive to small utilities seeking to fill localized needs.

Although hot dry rock geothermal resources are seen as having great potential, it is uncertain at what point commercial development will become technologically and economically feasible. LASL hopes to have a prototype 10-MW plant in operation by 1981, according to current plans.^{2/} How quickly this technology will be made available for use at other sites is unknown.

For the purposes of this analysis, it is assumed that a hypothetical tribe has sufficient geothermal resources of the hot dry rock type to develop an electric power plant or to use directly for heating or other on-site uses. In the discussion that follows, the potential benefits and costs of geothermal resource development to the tribe are presented using the benefit-cost framework developed in Section II. The discussion is less detailed than other

^{1/} Los Alamos Scientific Laboratories, "Statement on Hot Dry Rock Geothermal Energy Development," 1977.

^{2/} Ibid.

energy resource sections, since less information is available on market conditions, development costs, employment, and other factors that would directly affect benefits and costs to the tribe.

Estimation of Direct Benefits to the Tribe

Overview. In this subsection we examine the production-related tribal income and job-related personal income as the major benefits of geothermal resource development. We assume that in considering future revenues in making a development decision, a tribe is faced with the basic contract alternatives discussed in the preceding energy resource sections: royalty leases, and joint ventures. In this example, we discuss potential royalty revenues from a geothermal hot water and electrical power system as a source of tribal revenues. Other uses of geothermal resources are also described.

Specific assumptions used in this analysis are:

- The tribe's hot dry rock deposits are similar to those found at the LASL prototype site. Under these conditions, a 100-MW power station would be feasible.
- A 100-MW facility will be developed, including 11 pairs of wells, and a generating station with an 85% plant availability factor. A 20-year project life is assumed.^{1/}
- The cost of electricity (including capital, maintenance, operating costs, and a reasonable rate of return on investment, but not including royalties) is 2.5¢/KWH.^{2/}

^{1/} Ibid.

^{2/} Ibid.

Tribal Revenues--Lease Arrangement. In the past, lease arrangements for development of vapor- and liquid-dominated geothermal reservoirs on federal lands have included royalties ranging from 10 to 15 percent of the value of production. Some additional royalties may be received from the sale of by-products (such as extracted minerals or natural gas).

Given the assumption outlined above, a 10 percent royalty rate will yield the tribe \$2.07 million per year if the operating company exactly recovers its costs, plus a reasonable rate of return on its investment. The present value of this amount received annually for 20 years, discounted at 10 percent, is \$17.6 million; discounted at 15 percent, \$12.9 million.^{1/}

As mentioned above, the tribe could conceivably become involved in a joint-venture or other contractual arrangement. The revenue benefits to the tribe from either of these arrangements could be significant but are not estimated here because of the uncertainties associated with financing, facility costs, development time, etc.

Tribal Jobs and Income. Because there are no hot dry rock facilities in operation at present, estimates of potential employment are purely speculative. If we assume that the number of personnel required to operate such a facility is comparable to that for a similar-sized coal-fired power plant, then a total of 40 employees may be estimated for the 100-MW facility.^{2/}

^{1/} However, this calculation does not take into account the time that would elapse between the signing of the lease and the actual generation and sale of power. Since no such commercial facilities have been constructed to date, this time period cannot be reasonably estimated.

^{2/} Bechtel Corporation, Manpower, Materials, Equipment, and Utilities Required to Operate and Maintain Energy Facilities, 1975.

Assuming an average salary of \$13,500 (comparable to that for oil and gas workers), and a 50 percent hiring rate for Indians, approximately \$270,000 in personal income would accrue to 20 Indians during each year of operation. In present value terms, this amount received over 20 years, discounted at 10 percent, is \$2.3 million; discounted at 15 percent, \$1.69 million. This does not include manpower requirements for exploration and construction; however, it is likely that many of these jobs would be filled by transient workers.

Additional Benefits from Geothermal Development. In addition to direct income from royalties, joint-venture profits, and jobs, the tribe may benefit by using its geothermal resources for other uses. Several of these uses are described below, although dollar amounts for the actual benefits have not been estimated.

Low-temperature geothermal water can be used directly for residential or commercial space heating if it need not be transported over great distances. After construction of a distribution system, benefits would accrue to the tribe in the form of cost savings from using an energy source that is cheaper than fuel oil, natural gas, coal, etc. In a typical commercial application, low-temperature water (60°C) is used to heat greenhouses.

Other industrial and agricultural applications are potentially numerous; however, they would require additional capital investments by the tribe. For low-temperature output, some examples are: simple industrial process heating, refrigeration, and fish farming. High-temperature output may be used directly in distillation, desalinization, and as process steam in such industries as paper manufacturing.

Estimation of Direct Costs to the Tribe

Overview. As discussed in Section II, some of the direct costs of energy resource development to the tribe can be quantified, while others cannot. For geothermal development, both types of direct costs are identified and discussed below, including opportunity costs of land conversion, relocation costs, administrative costs to the tribal government, and direct environmental costs. Similarities to other energy resource development situations are identified where appropriate.

Opportunity Costs of Land Conversion. Based on available information, the land requirements for geothermal development would be similar to those for oil and gas development. Geothermal wells are generally spaced at about one well per 11 acres (compared with a maximum density of one well per 40 acres for oil development); perhaps 11 pairs of wells must be drilled to develop a 100-MW facility. The total land area actually disturbed by drilling and power plant operations would probably be an insignificant number in terms of lost land productivity--a total of perhaps several hundred acres might be diverted.

Relocation Costs. Based on the land requirement information presented above, it is also assumed that relocation costs will be negligible. In fact, if the tribe uses geothermal energy for residential heating, it may wish to pay for relocation of families to new housing in the geothermal development area.

Administrative Costs to the Tribal Government. As discussed in Section III of this volume and in Volume II, the tribe may incur the cost of setting up and operating a minerals office as an integral part of its energy

resource development activities. Depending on the level of development pursued and the type of contractual arrangement into which the tribe enters, the annual costs incurred may range between \$25,000 and \$250,000. The costs of a geologic and seismic survey would range from \$150,000 to \$350,000. As mentioned previously, a more detailed discussion of these costs is provided in Volume II.

Summary of Environmental Costs. In general, the environmental impacts of geothermal development and the resultant environmental costs to the tribe are expected to be minimal. Geothermal energy is considered a relatively "clean" energy source. Exhibit V-8 summarizes the most significant environmental costs that are common among geothermal recovery systems, with emphasis on hot dry rock resources.

EXHIBIT V-8

SUMMARY OF ENVIRONMENTAL
COSTS OF GEOTHERMAL DEVELOPMENT

Environmental
Factor Affected

Description of Impact

Air Quality

The only potentially significant air quality impact is the small release of radioactive gases from the fracture of hot dry rock masses; however, the magnitude of the impact on health costs is expected to be very small. Toxic gases released from vapor-dominated and hot-water-dominated systems may have an impact on health costs to workers in the immediate area.

Water Quality

No significant cost is expected to result concerning surface or ground water quality if proper maintenance and control measures are used.

Seismic and Topographical
Characteristics

The possibility of triggering seismic activity at minor fault lines at great well depths may result in surface damages to buildings and other facilities. The extent of impact seismic reaction and resultant costs is currently unpredictable. In steep terrain, land slide and erosion are also likely.

Ecological Characteristics

Tribal hunting and fishing will be affected to the extent that land is disturbed for development. It is expected that land requirements will be low enough (less than 500 acres) that the overall cost to the tribe will be minimal.

Aesthetic Quality

Depending on where a facility is located, the heat recovery and power generation facilities for geothermal development may represent an aesthetic cost to the tribe.

Noise

Noise levels from drilling geothermal wells, turbines, and cooling towers may result in unquantifiable cost to Indian cultural values.

Note: This list is intended to represent a cross-cut of environmental costs that may result from geothermal development, and is not exhaustive.

Summary of Indirect Benefits and Costs and Fiscal Impacts. Based on the level of development described in previous sections, it does not seem likely that the reservation will experience significant short- or long-term employment and population increases. Temporary population increases during construction may range as high as several hundred people.

Over the long term, during project operation, approximately half of the long-term jobs created may be filled by non-Indians attracted from other areas to the project. Unless large-scale geothermal development attracts commerce and industry to newly available and possibly less-expensive energy sources, the net population increase, in non-reservation towns, may be about 100-150 over present levels, assuming 40 workers (20 direct plus 20 indirect jobs) are attracted to the area. If these population increases concentrate near a single community, the increases may result in the fiscal burden of supplying additional public services to meet minimum health and public safety needs. Either the tribe, the local municipal government, or the developer may be assigned these costs, depending on the characteristics of project development and the terms of the contract agreement. A discussion of planning factors, which can be used to estimate the fiscal impacts of population changes, was provided in Section III.

Summary of Geothermal Resources Development

With the development of geothermal resources to generate electric power, potential benefits to the tribe appear to be significant. Tribal income may be as high as \$2 million annually, but only about 20 long-term tribal jobs may be created. Innovative commercial uses of geothermal energy (e.g., for greenhousing) may provide additional benefits to the tribe.

Costs to the tribe include: opportunity costs of converting limited amounts of currently utilized land to geothermal development; potential relocation costs for displaced families; administrative costs; and fiscal impacts in cases where additional public services must be supplied for increases in population. The potential environmental costs for geothermal development are not expected to be significant compared with other energy resources.