DRAFT

ENVIRONMENTAL STATEMENT FOR THE PROPOSED PROTOTYPE OIL SHALE LEASING PROGRAM

DES-72-89

Volume III of III

Description of Selected Tracts and Potential Environmental Impacts

U.S. DEPARTMENT OF THE INTERIOR
SEPTEMBER 1972

DRAFT

ENVIRONMENTAL STATEMENT

FOR THE

PROPOSED PROTOTYPE OIL-SHALE LEASING PROGRAM

Volume III of III

Description of Proposed Prototype Leases
and
Potential Environmental Impacts

Prepared in Compliance with

Section 102 (2) (c) of the National Environmental

Policy Act of 1969

Prepared by

UNITED STATES DEPARTMENT OF THE INTERIOR

September 1972

SUMMARY

Draft Environmental Impact Statement
Department of the Interior, Office of the Secretary

1. Type of action: Administrative

2. Brief description of action:

   This proposed action would make available for private development up to six leases of not more than 5,120 acres each. Two tracts are located in each of the states of Colorado, Utah, and Wyoming.

   Such leases would be sold by competitive bonus bidding and would require the payment to the United States of royalty on production. Additional oil shale leasing would not be considered until development under the proposed program had been satisfactorily evaluated.

3. Summary of environmental impact and adverse environmental effects:

   Oil shale development would produce both direct and indirect changes in the environment of the oil shale region in each of the three states where commercial quantities of oil shale resources exist. Many of the environmental changes would be of local significance while others would be of an expanding nature and have cumulative impact. These major regional changes will conflict with other physical resources and uses of the land and water involved. Impacts would include those on the land itself, the water resources and air quality, on fish and wildlife habitat, on grazing and agricultural activities, on recreation and aesthetic values, and on the existing social and economic patterns as well as others. The environmental impacts from both prototype development and a mature industry are assessed for their anticipated direct, indirect, and cumulative effects.

4. Alternatives considered:

   A. Alternative Leasing Tracts.
   B. Alternative Oil Shale Leasing Policies.
   C. Alternative Energy Policies.
   D. Alternative Energy Sources.

5. Comments have been requested from the following: (see attached sheet).

6. Date made available to CEQ and the public:

   Draft Statement:

Comments Requested

Federal Agencies

Environmental Protection Agency
Department of Commerce
Department of Transportation
Atomic Energy Commission
Federal Power Commission
Office of Emergency Preparedness
Department of Defense - Office of Naval Petroleum and Oil Shale Reserves
Department of Agriculture
Bureau of Sport Fisheries and Wildlife, Department of the Interior
National Park Service, Department of the Interior
Bureau of Recreation, Department of the Interior
Geological Survey, Department of the Interior
Bureau of Mines, Department of the Interior
Office of Coal Research. Department of the Interior
Office of Oil and Gas, Department of the Interior
Bureau of Land Management, Department of the Interior
Bureau of Indian Affairs, Department of the Interior
Bureau of Reclamation, Department of the Interior

State House Agencies

Colorado Department of Local Affairs
Utah State Planning Coordinator
Wyoming State Planning Coordinator
Oil Shale Regional Planning Commission (of Garfield, Mesa and Rio Blanco Counties, Colorado)
County Commissioners of Utah County and Wyoming County

Private Organizations

Natural Resources Defense Council
Rocky Mountain Center on Environment
University of Wisconsin, Glen D. Weaver
Colorado Open Space Council
Sierra Club
Wilderness Society
National Audubon Society
National Recreation and Park Association
Wildlife Management Institute
National Wildlife Federation
Issac Walton League
Environmental Action
Friends of the Earth
Environmental Policy Center
Conservation Foundation
Nature Conservancy
American Forest Association
Center for Law and Social Policy
Environmental Defense Fund
Colorado Sportsmen's Association
Rocky Mountain Sportsmen's Federation
National Council of Public Land Users
Utah Wildlife Federation

Wyoming Open Space Council
American Petrofina of Texas
Ashland Oil, Inc.
Barodynamics, Inc.
Occidental Petroleum Corporation
Garrett Research (Occidental Petroleum Corporation)
Ceokinetics, Inc.
Gulf Minerals Resources Company
Marathon Oil Company
The Oil Shale Corporation
Phelps Dodge Corporation
Shell Oil Company
SOHIO Petroleum Company
The Superior Oil Company
Cameron Engineers
Sun Oil Company
Western Oil Shale Corporation
Mobil Oil Company
Chevron Oil Company
Equity Oil Company
Cities Service Oil Company
Carter Oil Company
Union Oil Company
Getty Oil Company
Development Engineering
Denver Audubon Society
Thorn Ecological Institute
Colorado State Rehabilitation Sub-Committee
Denver Research Institute
Humble Oil and Refining Company
AMOCO Production Company
Bell Petroleum Company

INTRODUCTORY NOTE

THIS DRAFT ENVIRONMENTAL STATEMENT HAS BEEN PREPARED PURSUANT TO SECTION 102 (2) (C) OF THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 (42 U.S.C. SECS. 4321-4347). ITS GENERAL PURPOSE IS A STUDY OF THE ENVIRONMENTAL IMPACTS OF OIL SHALE DEVELOPMENT.

THE SECRETARY OF THE INTERIOR ANNOUNCED PLANS ON JUNE 29, 1971, FOR THIS PROPOSED PROGRAM AND RELEASED A PRELIMINARY ENVIRONMENTAL STATEMENT, A PROGRAM STATEMENT, AND REPORTS PREPARED BY THE STATES OF COLORADO, UTAH, AND WYOMING ON THE ENVIRONMENTAL COSTS AND PROBLEMS OF OIL SHALE DEVELOPMENT.

THE PROPOSED PROGRAM IS IN CONCERT WITH THE PRESIDENT'S ENERGY MESSAGE OF JUNE 4, 1971, IN WHICH HE REQUESTED THAT THE SECRETARY OF THE INTERIOR INITIATE "A LEASING PROGRAM TO DEVELOP OUR VAST OIL SHALE RESOURCES, PROVIDED THAT ENVIRONMENTAL QUESTIONS CAN BE SATISFACTORILY RESOLVED."

AS PART OF THE PROGRAM, THE DEPARTMENT AUTHORIZED INFORMATIONAL CORE DRILLING AT VARIOUS SITES IN COLORADO AND UTAH AND 16 CORE HOLES WERE COMPLETED. THE DEPARTMENT REQUESTED NOMINATIONS OF PROPOSED LEASING TRACTS ON NOVEMBER 2, 1971, AND A TOTAL OF 20 INDIVIDUAL TRACTS OF OIL SHALE LAND WERE NOMINATED. WITH THE CONCURRENCE OF THE CONCERNED STATES, THE DEPARTMENT OF THE INTERIOR ANNOUNCED ON APRIL 25, 1972, THE SELECTION OF 6 OF THESE TRACTS, 2 EACH IN COLORADO, UTAH, AND WYOMING.

THE PROPOSED PROGRAM IS ESSENTIALLY UNCHANGED FROM THAT ANNOUNCED ON JUNE 29, 1971, BUT THE PRELIMINARY STATEMENT ISSUED AT THAT TIME HAS BEEN EXPANDED TO CONSIDER THE IMPACT OF A FULL-SCALE OIL SHALE INDUSTRY, THE IMPACT OF DEVELOPMENT OF THE SIX SPECIFIC TRACTS, AND A COMPREHENSIVE ANALYSIS OF OTHER ENERGY ALTERNATIVES. THIS INFORMATION IS NOW CONTAINED IN THREE VOLUMES.

THE FIRST VOLUME PROVIDES AN ASSESSMENT OF THE CURRENT STATE OF OIL SHALE TECHNOLOGY. VOLUME I ALSO DESCRIBES THE REGIONAL ENVIRONMENTAL IMPACT OF OIL SHALE DEVELOPMENT IN THE FORM OF PRODUCTION FROM PUBLIC AND PRIVATE LANDS, THE DEVELOPMENT OF WHICH MAY BE STIMULATED BY THE DEPARTMENT'S PROPOSED ACTION. VOLUME II EXTENDS THIS STUDY WITH AN EXAMINATION OF ALTERNATIVES TO SHALE OIL PRODUCTION AT THE RATE OF 1-MILLION BARRELS PER DAY BY 1985. VOLUMES I AND II THUS CONSIDER THE BROAD GENERAL AND CUMULATIVE ASPECTS OF OIL SHALE DEVELOPMENT.

VOLUME III EXAMINES THE SPECIFIC PROPOSED ACTION UNDER CONSIDERATION, WHICH IS THE ISSUANCE OF NOT MORE THAN TWO PROTOTYPE OIL SHALE LEASES IN EACH OF THE THREE STATES OF COLORADO, UTAH, AND WYOMING.

THIS DOCUMENT IS BASED ON MANY SOURCES OF INFORMATION, INCLUDING RESEARCH DATA AND PILOT PROGRAMS DEVELOPED BY BOTH THE GOVERNMENT AND PRIVATE INDUSTRY OVER THE PAST THIRTY YEARS. MANY FACTORS SUCH AS CHANGING TECHNOLOGY, EVENTUAL OIL PRODUCTION LEVELS, AND

ATTENDANT REGIONAL POPULATION INCREASES ARE NOT PRECISELY PREDICTABLE. THE IMPACT ANALYSIS INCLUDED HEREIN IS CONSIDERED TO CONSTITUTE A REASONABLE TREATMENT OF THE POTENTIAL ENVIRONMENTAL EFFECTS WHICH WOULD BE ASSOCIATED WITH OIL SHALE DEVELOPMENT. DEPARTMENTAL EXPERTS, IN THE MANY AREAS WHICH ARE DISCUSSED, HAVE USED THEIR BEST JUDGMENT TO FORECAST THESE ENVIRONMENTAL EFFECTS.

ANY WRITTEN COMMENTS ON THIS DRAFT STATEMENT RECEIVED WITHIN 45 DAYS OF THE ISSUANCE OF THIS STATEMENT WILL BE GIVEN CAREFUL CONSIDERATION. PUBLIC HEARINGS WILL BE SCHEDULED WITHIN THE SAME 45-DAY REVIEW PERIOD. UPON COMPLETION OF THE REVIEW PERIOD, THE DEPARTMENT WILL WEIGH ALL INFORMATION AND COMMENTS RECEIVED AND, IF THE DECISION IS TO PROCEED FURTHER, WILL PREPARE A FINAL ENVIRONMENTAL STATEMENT. ONLY AFTER COMPLETION OF THE FINAL ENVIRONMENTAL STATEMENT AND COMPLIANCE WITH ALL THE REQUIREMENTS OF NEPA AND THE COUNCIL ON ENVIRONMENTAL QUALITY GUIDLINES ISSUED PURSUANT TO IT, WILL A FINAL DECISION BE MADE WHETHER TO PROCEED WITH AN OIL SHALE LEASING PROGRAM.

AVAILABILITY OF DRAFT ENVIRONMENTAL STATEMENT

The three-volume set may be purchased by mail or in person from the Map Information Office, Geological Survey, U. S. Department of the Interior, Washington, D. C. 20240. The set is priced at $7.00. Individual volumes are $3.00 for Volume I, $1.00 for Volume II, and $3.00 for Volume III.

Copies may also be purchased from Bureau of Land Management State Offices in the following cities: Denver, Colo. (Colorado State Bank Building, 1600 Broadway, Denver, Colorado, 80202); Salt Lake City, Utah (Federal Building, 124 South State, Salt Lake City, Utah, 84111); and Cheyenne, Wyo. (Joseph C. O'Mahoney, Federal Center, 2120 Capital Avenue, Cheyenne, Wyoming, 82001). Inspection copies are available in the following Bureau of Land Management district offices: Colorado: Canon City, Craig, Glenwood Springs, Grand Junction, Montrose; Utah: Vernal, Price, Monticello, Kanab, Richfield; Wyoming: Rock Springs, Rawlins, Casper, Lander, Pinedale, Worland.

TABLE OF CONTENTS

Page

Page

Page

Page

Page

Page

LIST OF ILLUSTRATIONS

Figure | Page

III. Mining and Processing Options on Selected Tracts

Figure | Page

Figure		Page

LIST OF TABLES

II. Prototype Tracts and Existing Environment

III. Mining and Processing Options on Selected Tracts

I. DESCRIPTION OF THE PROPOSED ACTION

A. Introduction

Volume I of this review of the environmental consequences of oil shale development has detailed the nature of the resource and the potential impact from an oil shale industry that may develop on both private and public lands (1). This document details the specific impacts associated with the development of up to six tracts which, if implemented, would be offered for development under the Department of the Interior's proposed prototype oil shale leasing program (2).

Oil shale is a leasable mineral, subject to the provisions of the mineral leasing laws (3). Under the authority and guidance provided by these laws, the responsibility for managing and leasing public oil shale lands is vested in the Secretary of the Interior.

No oil shale leases have been issued since 1925.[1/] A previous attempt to lease public lands (1968) was unsuccessful due to a number of interrelated problems stemming from the legal, environmental, and economic constraints of that leasing plan. Resolution of these problems will require effective coordination between the public and private sectors, since neither by itself has the full

1/ Should the program be implemented, Executive Order 5327 would be further modified to the extent necessary to allow the issuance of oil shale leases for the specific tracts selected.

range of competence and/or responsibility to carry forth the proposed prototype program described in this document.

This proposed prototype program has been formulated, in part, to resolve past difficulties by making available for private development under carefully controlled conditions, a limited number of leases (six at most) of not more than 5,120 acres each. Specifically, the objectives of the program are to -

(1) Provide a new source of energy to the Nation by stimulating the development of commercial oil shale technology by private industry;

(2) Insure the environmental integrity of the affected areas, and concurrently, define, describe, and develop a full range of environmental safeguards and restoration techniques that can be reasonably incorporated into the planning of a mature oil shale industry;

(3) Permit an equitable return to all parties in the development of this public resource; and

(4) Develop management expertise in the leasing and supervision of oil shale resource development in order to provide the basis for future administrative procedures.

The proposed program would make available to private enterprise, for development under lease, a limited amount of public oil shale resources. Such leases would be sold by competitive bonus bidding and would include assumption of certain royalty obligations to the United States. Additional oil shale leasing would not be considered until development under the proposed program had been satisfactorily evaluated.

The goal and scope of the proposed program are as follows:

GOAL

The goal of the Department of the Interior's proposed prototype leasing program is to provide a new source of energy for the Nation by stimulating the timely development of commercial oil shale technology by private enterprise, and to do so in a manner that will assure the minimum possible impact on the present environment while providing for the future restoration of the immediate and surrounding area.

SCOPE

The primary oil-shale resources of Colorado, Utah, and Wyoming cover an 11 million-acre area. The leases to be offered under this program can, by law, include no more than 5,120 acres for each lease, or a total of 30,720 acres for the combined six leases.

This proposed program would therefore, affect only a small portion of the Nation's oil shale resource. The results of prototype development would provide the background information needed to formulate comprehensive resource utilization programs and regional land use plans. Additional leases of public oil shale lands would not be considered until the prototype development permitted under this program has been satisfactorilly evaluated.

B. Environmental Impact Studies

The assessment of the environmental consequences of oil shale development has been an evolving process over nearly a 3-year period, continuously becoming more specific about the nature and magnitude of potential impacts. Following a review of available data in early 1970, detailed studies were initiated in May 1970, when the Department of the Interior requested the Governors of Colorado, Utah, and Wyoming to form a Panel to study the impact upon the environment if oil shale leases were to be developed in their States and to determine the costs of appropriate environmental controls. Each of the Governors commissioned a study in accordance with the following suggested guidelines:

> Specifically, the environmental requirements of returning the residues from mining and refining to the earth for further use, and those costs involved will be developed between the Department and the States. - - -
>
> It is suggested that proposed methods of development for typical areas in each State be outlined and selected methods for mining and processing be studied. Each outline should include the current applicable regulations for each phase of the operation, or the proposed regulations to be adopted where the current standards have not been developed, in order that the resulting economic cost may be evaluated.

Proposed methods of development should include:

(1) underground mining, with underground disposal,

(2) underground mining with surface disposal,

(3) strip mining with backfill, and

(4) in-situ operations.

Particular care shall be taken to assure that the following provisions are included:

(1) air quality standards are maintained,

(2) surface and ground water quality is maintained,

(3) restoration of the lands is commensurate with future land use plans,

(4) wildlife habitat is protected and restored for future use, and

(5) scenic and aesthetic values are to be maintained.

The resulting studies should provide that future land use requirements will be in accordance with State and local plans for development.

Specific requirements as to soil compaction, drainage, revegetation, and community development plans should be included in each summary in order that a complete economic evaluation of the total environmental costs may be made by the Department and by prospective lessees.

The basis for preparing the Preliminary Draft Environmental Impact Statement which was issued in June 1971, was provided by these Departmental and Inter-agency studies, and by the States of Colorado, Utah, and Wyoming. This detailed 7-month study of lease sites, typical of those that are expected to be nominated for development under the proposed program, involved more than 150 professionals with diverse backgrounds, including representatives from various Federal and State agencies, research foundations, universities, independent conservation groups, and industrial firms. The State documents are available 1/ and contain extensive information on the expected environmental impact and controls that could be applied if oil shale operations were initiated.

At that time, however, it was apparent that specific information was not available on which to base an evaluation of the impact of development of a particular tract. Informational core drilling on certain of the public lands was authorized in June 1971. This phase of the program development proceeded under strict environmental standards and no significant impact on the land use resulted from these coring activities.

Informational core drilling operations and lease nominations have identified the areas of greatest commercial interest and aided in focusing efforts aimed at assessing environmental impacts.

1/ Individual reports (without appendices) prepared by the States of Colorado, Utah, Wyoming may be purchased through the U. S. Geological Survey, Map Information Office, Room 1038, General Services Building, Washington, D. C. 20242, at $2.00 per copy.

The type of mining-waste disposal system(s) most likely to be used if the proposed site were developed was then evaluated in relation to the actual characteristics of the area.

These detailed environmental studies containing the known prevailing conditions against which the estimated environmental impact can be measured. Moresstudies are being conducted by the Department of the Interior in consultation with the Governors' panels of the States of Colorado, Utah, and Wyoming.

C. Program Implementation

If the program is implemented and lease are accepted by private enterprise, operations would proceed under the terms of a lease specifically designed to achieve the stated program goal to stimulate ". . .the timely development of commercial oil shale technology by private enterprise, and to do so in a manner that will assure the minimum possible impact on the present environment while providing for the future restoration of the immediate and surrounding area." To achieve these goals we have provided an interlocking set of bonus, royalty, bonding, and performance provisions to be incorporated into the leasing provisions. Highlights of our current views of this leasing method are set forth below. The complete lease, stipulations, and mining regulations designed to protect the environment are contained in Chapter V of this Volume.

1. Bonus Bids

Sealed competitive bonus bids received from qualified applicants would determine who would be granted the right to develop the resource. Sealed bidding is an established market tested method for obtaining an equitable return for the resource when potential competition for the leases cannot be readily pre-determined. This method is currently being used by the Department of the Interior in competitive leasing of the mineral resources on the Outer Continental Shelf. In the early years of an oil shale industry, the number of bidders may be limited by (1) lack of an economically proven technology, (2) large investment commitments that may exceed $200 million or more for each lease to be developed, and (3) energy market uncertainties.

The coring and evaluation program has shown that minimal amounts of sodium or other leasableminerals are intermingled with oil shale on nominated tracts. It is anticipated that if the tracts containing those minerals are leased, the intermingled minerals would be included under a single lease offering for efficient development of all those resources.

The initial bonus payment to acquire these first leases could create an undesirable economic burden on development because of: (1) other large investment requirements in the early years of a lease operation, and (2) the lack of an established technology with accurately predictable capital and operating costs. To reduce this economic burden, the bonus would be paid in five equal annual installments.

2. Term, Rental, and Royalty

The lease would extend for a term of 20 years, and so long thereafter as there is production in paying quantities. Readjustment of royalty and operating terms may be made at the end of each 20-year period. Annual rental of 50 cents per acre per year for the use of the land would be charged, as required by the Mineral Leasing Act of 1920, as amended, and would be creditable against royalties.

Royalty is money due and payable to the lessor for the removal of the resource from the leased lands by the lessee. The royalty rate for this prototype program would be 12 cents for each ton of oil shale mined for processing that contains 30 gallons of shale oil per ton of material. Under the proposed lease, this rate would be adjusted, depending on the actual oil content of the mined material and the market value of the products.[1/]

1/ The proposed royalty rate is comparable to other mined minerals under the Mineral Leasing Act of 1920, as amended.

To spur development and to avoid long delays before development, a minimum royalty payment would be required. This payment is charged in lieu of actual royalty when production rates have not been achieved. Beginning in the sixth year, this minimum royalty would be $1 per acre and would increase at the rate of $1 per acre each year to and including the 10th year. During the 10th year, therefore, the minimum rate would be $5 per acre.

Beginning in the 11th year, the minimum royalty would be transferred from an acreage to a production basis established by estimating recoverable reserves. For example, assuming a recoverable reserve of 2.1 billion tons of oil shale (1.5 billion barrels of shale oil) that averages 30 gallons of oil per ton, the calculated minimum production rate during the 11th year would be 3,500 tons per day of shale. Each year the calculated minimum production would increase a like amount to and including the 20th year (i.e. in the foregoing example, to 35,000 tons per day. During the 20th year and thereafter, unless readjusted, the minimum royalty would be determined on the basis of a calculated production rate of 35,000 tons per day of the proportion of recoverable reserves under lease, to the base evaluation stated above.

3. Performance Requirements

Lease operations would require approved development plans and continued acceptable performance by the lessee. A preliminary plan for lease development by a prospective lessee would be incorporated in the terms of any lease offer submitted to the

Department of the Interior. After lease issuance, but prior to actual operations, a detailed plan that includes all proposed development and production operations would have to be prepared, on or before the third anniversary of the lease. This plan would have to meet all of the established environmental criteria and be approved by the Department prior to the start of operations. It would include a detailed projected analysis of the amount and types of expected waste materials, the location and extent of the residue disposal areas, the types and amount of vegetation that will be used in land restoration, a time schedule for the restoration process, and justification that would assure this Department that the operator has designed his disposal-restoration system to protect the long-run productivity of the affected area. Annual progress reports would be required, and all physical facilities and records pertaining to the operations could be inspected by the Department, concurrently with continuous monitoring of the operation.

The operator would be expected to plan construction and other developmental activities, to the extent consistent with Federal law, in full coordination with the land use, transportation, and other plans of the county or other local public agency.

4. Bonding

A bond would be required as security to ensure that the approved development-restoration plan would be conducted in a manner designed to avoid degradation of the environment and that all other related lease terms would be met. The bond would be for not less than $500 per acre of the land that is estimated to be affected during the first 3-year period of operation, and would in no event, be less than a total amount of $2,000. A similar bond would be filed and maintained for each succeeding 3-year period of development. Provision could be made to credit extra-ordinary environmental costs, that may develop after the lease issuance, against the royalties otherwise due the Government. This provision has been considered only for this prototype program so that unanticipated environmental expenditures involved in the development of this resource would not be placed inequitably on the lessee.

Subsequent sections of this volume document on the nature of the existing environment and the expected environmental impact of the proposed prototype leasing program.

D. References

1. Draft Environmental Impact Statement for the Proposed Oil Shale Leasing Program, Vol. I, Description of Regions and Potential Environmental Impacts, U.S. Department of the Interior, August 1972.

2. Program Statement for the Proposed Prototype Oil Shale Leasing Program, U.S. Department of the Interior, June 1971.

3. See 30 U.S.C. § § 241(a) and 352.

4. Same as ref. 3, Chapter IV.

II. DESCRIPTION OF THE ENVIRONMENT OF THE SELECTED TRACTS

A. Description of Prototype Tracts

In response to a call for nominations of potential lease sites dated November 2, 1971, 15 companies sub mitted 23 tracts for consideration. These nominations were received by the end of the nomination period (January 31, 1972). Two additional tracts were also nominated by the State of Wyoming, thus bringing the total number of nominated sites to 25. After elimination of duplicate sites, 20 individual nominated tracts remained.

The nominated tracts were reviewed by a selection committee of Federal and some State experts. A total of six tracts, two in each State, were recommended for the prototype program. That chapter also contains the basic information on the 14 tracts not selected. Following further review by the Department of the Interior and representatives of the Governor's Advisory Task Force in each of the three States, the final tract selections for the proposed program were announced on April 25, 1972.

The general geographic location of the six tracts is shown in Figure II-1. These six tracts have been designated as Colorado C-a and C-b, Utah U-a and U-b, and Wyoming W-a and W-b. The section below details the legal description of the six tracts; maps of the topography, and typical aerial views of them. Subsequent sections of this chapter contain detailed descriptions of the existing environment.

1. Selected Colorado Tracts

a. Description

Two sites, both in Rio Blanco County, Colorado have been selected from the nominations and are designated as tracts C-a and C-b. The legal descriptions of these tracts are given in Table II-1. Topographic plats are shown in Figures II-2 and II-3, and typical aerial views of the two sites in Figures II-4 and II-5.

b. Land Status, Tract C-a

Surface and Mineral rights on this tract are owned by the United States, except for the following portions of T.1. South, Range 99W: (See Figure II-2)

Section 33, NE1/4SE1/4, S1/2SE1/4, SE1/4SW1/4: The surface and the unreserved minerals are owned by the "Shields and Caldwell Hunting Camp, "c/o Charles F. Shields, Box 188, Murietta, CA 92362. Oil and gas and oil shale or other rock valuable as a source of petroleum and nitrogen in the lands so patented are reserved to the United States (Patent 871543, Act of July 17, 1914).

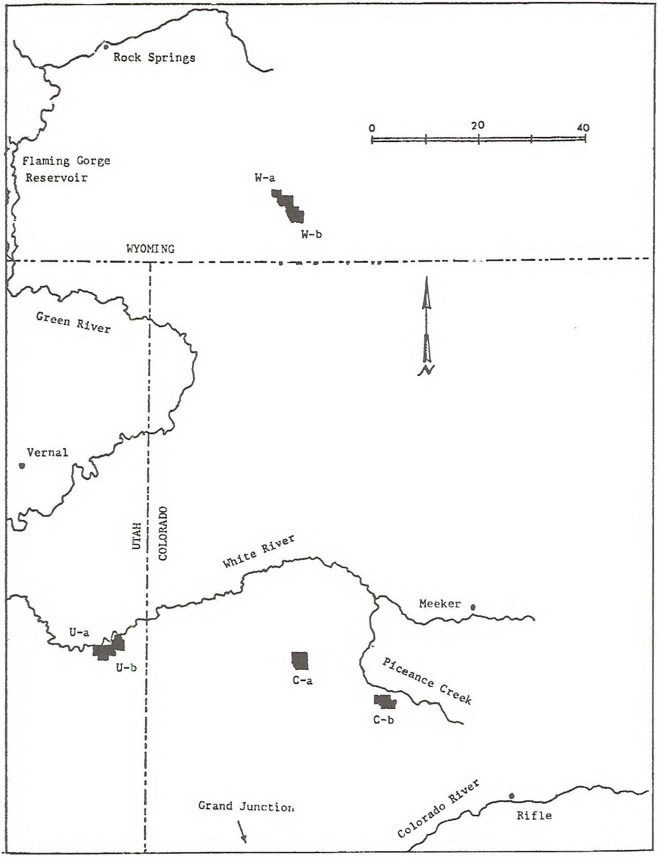

Figure II-1.--Map Showing General Geographic Location of the Six Oil Shale Tracts.

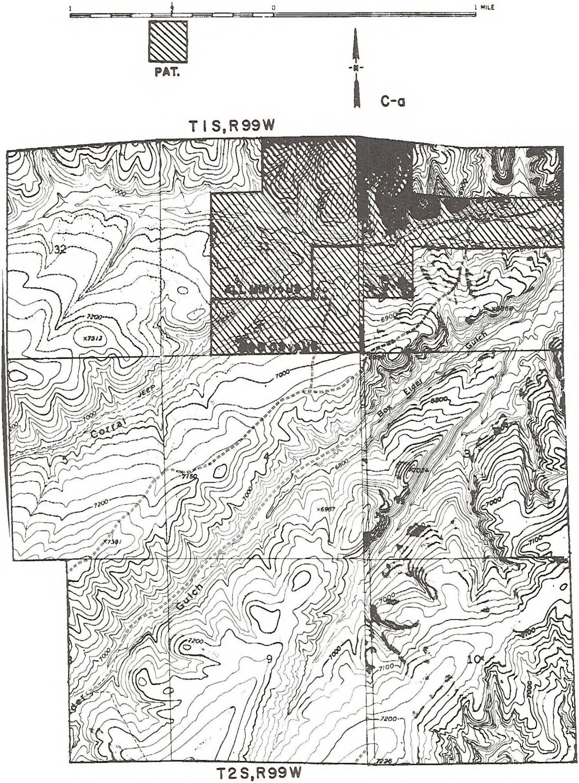

Figure II-2. Topographic Plat of Colorado Tract C-a.

Table II-1. - Legal Description of the two Colorado Oil Shale Tracts

Tract C-a

The lands described below are all within Rio Blanco County, Colo.

<u>T.1 S., R. 99 W., 6th PM</u>		
Sec. 32:	E½, E½W½	480.00 Acres
Sec. 33:	All	650.40 "
Sec. 34:	All	640.00 "
<u>T. 2 S., R. 99 W., 6th P.M.</u>		
Sec. 3:	All	640.00 "
Sec. 4:	All	640.00 "
Sec. 5:	E½, E½W½ (Incl. lots 1, 2, & 3)	480.00 "
Sec. 8:	E½	320.00 "
Sec. 9:	All	640.00 "
Sec. 10:	All	640.00 "
	Total	5,130.40 Acres

Tract C-b

The lands described below are all within Rio Blanco County, Colo.

<u>T. 3 S., R. 96 W., 6th P.M.</u>		
Sec. 5:	W½SE¼, SW¼	240.00 "
Sec. 6:	Lot 6 (21.51), Lot 7 (21.43), E½SW¼, SE¼	282.94 "
Sec. 7:	Lot 1 (21.39), Lot 2 (21.37), Lot 3 (21.35), Lot 4 (21.33), E½W½, E½	565.44 "
Sec. 8:	W½NE¼, NW¼, S½	560.00 "
Sec. 9:	SW¼	160.00 "
Sec. 16:	NW¼, W½SW¼	240.00 "
Sec. 17:	All	640.00 "
Sec. 18:	Lot 1 (21.34), Lot 2(21.36), Lot 3 (21.40), Lot 4 (21.42), E½W½, E½	565.52 "
<u>T. 3 S., R. 97 W., 6th P.M.</u>		
Sec. 1:	S½	320.00 "
Sec. 2:	SE¼	160.00 "
Sec. 11:	E½	320.00 "
Sec. 12:	All	640.00 "
Sec. 13:	N½	320.00 "
Sec. 14:	N'NE¼, N½N½S½NE¼	100.00 "
	Total	5,113.90 Acres

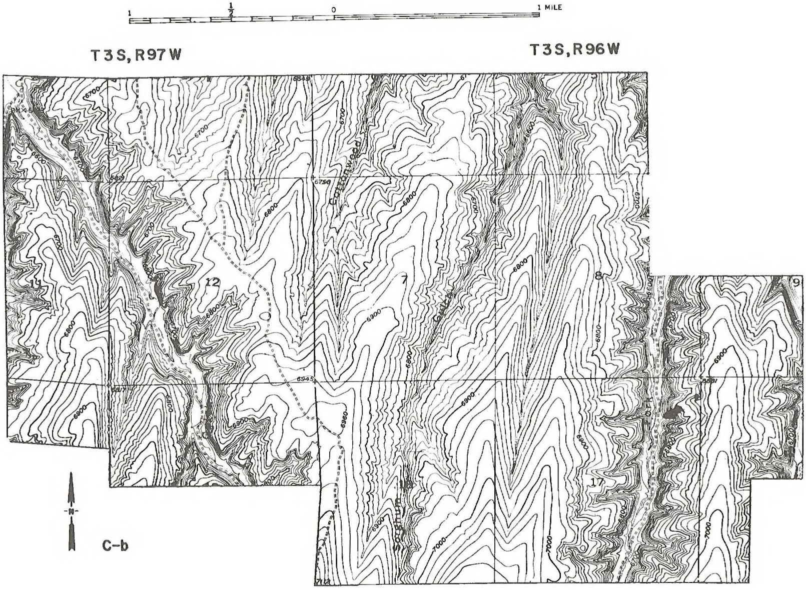

Figure II-3.-Topographic Plat of Colorado Tract C-b.

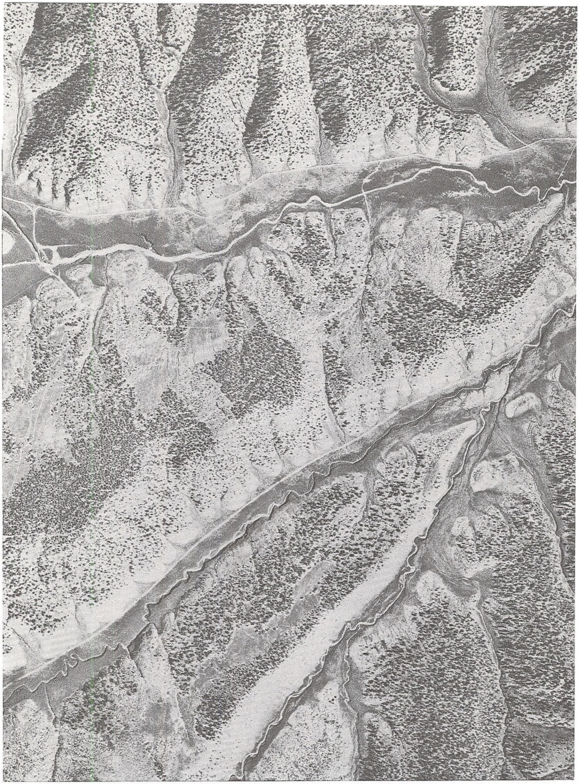

Figure II-4.--Typical Aerial View of Colorado Tract C-a.

Figure II-5.--Typical Aerial View of Colorado Tract C-b.

Section 33, NE1/4, SE1/4NW1/4, NWL/4SE1/4, NE1/4SW1/4: The surface is owned by the Colorado Game, Fish and Parks Department. All minerals are reserved to the United States (Patent 1031800, Act of December 29, 1916.

Section 34 NW1/4NW1/4, S1/2N1/2, NW1/4SW1/4: The surface is owned by the Colorado Game, Fish and Parks Department. The minerals reserved to the United States are oil and gas and oil shale or other rock valuable as a source of petroleum and nitrogen in the lands so patented. (Patent 990142; Act of July 17, 1914). Fifty percent of the unreserved minerals are owned by the Colorado Game, Fish and Parks Department, and 50% are owned by Bell Petroleum Co.

c. Land Status, Tract C-b

There is no patented land on this site, but access is currently through private lands along Piceance Creek.

2. Selected Utah Tracts

a. Description

Two sites, both in Uintah County, Utah and adjacent to one another, have been selected from the nominations and are hereinafter designated as Tracts U-a and U-b. The legal descriptions of the tracts are given in Table II-2. Topographic plats are shown in Figures II-6 and II-7, and typical aerial views of the two sites in Figures II-8 and II-9.

b. Land Status, Tracts U-a and U-b

Surface and mineral rights on both of these tracts are owned by the United States, except for a portion of Tract U-b, as follows: Township 10 South, Range 24E, Section 14, NW1/4NW1/4 (See Figure II-7), surface is owned by LaRue Pickup and others; oil and gas and oil shale are reserved to the United States.

An improved, unsurfaced county road passes through the northeast corner of Site U-b. An unimproved truck trail passes through both tracts, connecting the county road in the northeast corner of site U-b with an unimproved road running along West Fork Asphalt Wash.

A Gilsonite slurry pipeline and an electric powerline run through sections 12, 18, and 19 of Site U-b in a northwest to southeast direction, from Bonanza, Utah to Fruita, Colorado, and Grand Junction, Colorado, respectively. Two small collection gas pipelines are located in Southam Canyon in Site U-a. A woven wire sheep holding corral is situated near the northwest corner of section 25 in Site U-b and a small cattle handling corral is located in the southwest quarter, section 21 of Site U-a, in Southam Canyon.

Table II-2.--Legal Description of the two Utah Oil Shale Tracts.

Tract U-a

The lands described below are all within Uintah County, Utah

T. 10 S., R. 24 E., S.L.M.

Sections:	19:	E1/2
	20:	All
	21:	All
	22:	All
	27:	All
	28:	All
	29:	All
	30:	E1/2
	33:	N1/2
	34:	N1/2

total-5120 acres, more or less

Tract U-b

The lands described below are all within Uintah County, Utah

T. 10 S., R. 24 E., S.L.M.

Sections:	12:	S1/2, S1/2N1/2	480 acres
	13:	All	640
	14:	All	640
	23:	All	640
	24:	All	640
	25:	W1/2W1/2	160
	26:	All	640

T.10 S., R. 25 E., S.L.M.

Sections	18:	All	640 "
	19:	All	640 "

Total 5120 acres

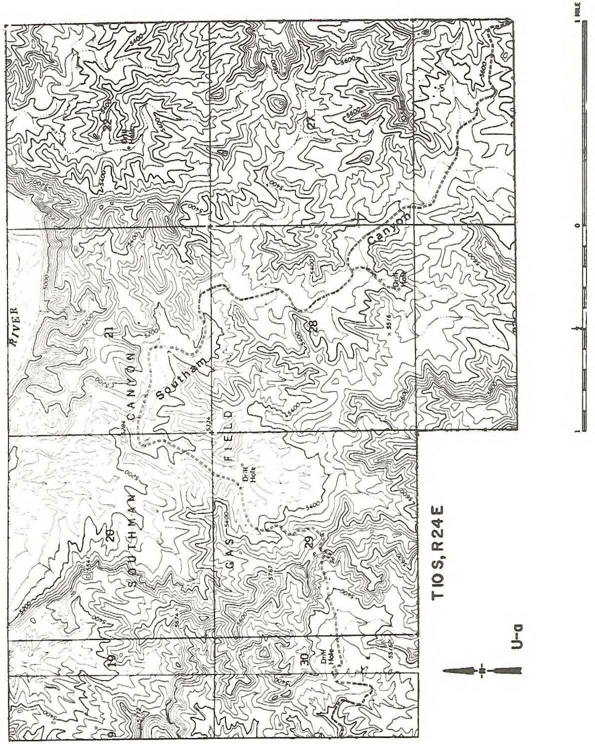

Figure II-6.--Topographic Plat of Utah Tract, U-a.

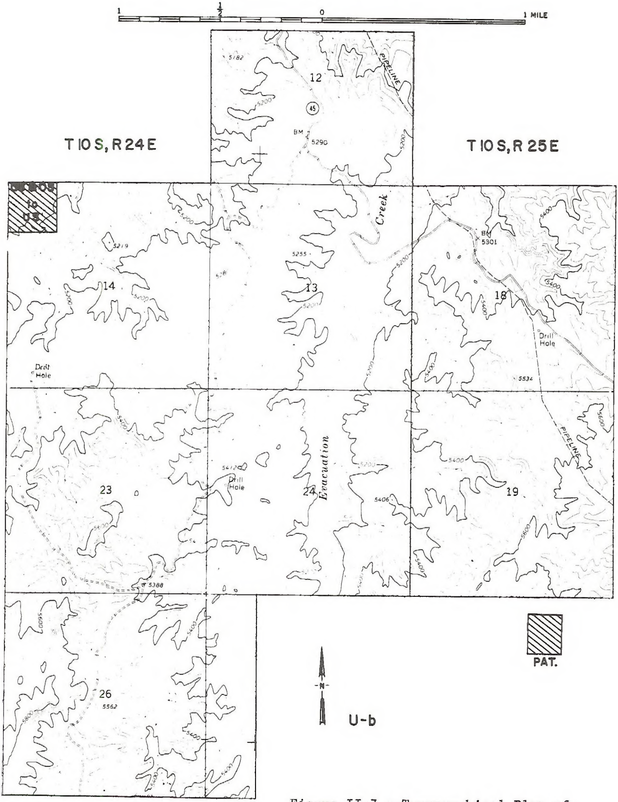

Figure II-7.--Topographical Plat of
Utah Tract U-b.

Figure II-8.--Typical Aerial View of Utah Tract U-a.

Figure II-9.--Typical Aerial View of Utah Tract U-b.

3. Selected Wyoming Tracts

a. Description

Two adjacent sites, both in Sweetwater County, Wyoming, have been selected from the nominations, and are designated hereinafter as Tracts W-a and W-b. The legal descriptions of the tracts are given in Table II-3. Topographic plats are shown in Figures II-10 and II-11, and typical aerial views of the two tracts in Figures II-12 and II-13.

b. Land Status, Tracts W-a and W-b

All surface and mineral rights on both of these tracts are owned by the United States.

An unimproved road passes through the northern end of Site W-a, in a southwest to northeast direction. There are no other man-made improvements on either Site W-a or W-b. Carson Spring, a developed livestock watering facility is situated near this road, approximately 3/4 mile northeast from Site W-a.

Table II-3.--Legal Description of the Two Wyoming Oil Shale Tracts.

Tract W-a

The lands described below are all within Sweetwater County, Wyoming

T. 14 N., R. 99 W., 6th P.M.

Sections	17:	ALL	
	18:	ALL	
	19:	NE$\frac{1}{4}$	
	20:	ALL	
	21:	ALL	
	22:	ALL	
	27:	ALL	
	28:	ALL	
	29:	N$\frac{1}{2}$, SE$\frac{1}{4}$	total 5120 acres, more or less

Tract W-b

The lands described below are all within Sweetwater County, Wyoming

T. 13 N., R. 99 W., 6th P.M.				
Sections	1:	S$\frac{1}{2}$, S$\frac{1}{2}$N$\frac{1}{2}$, N$\frac{1}{2}$ NW$\frac{1}{4}$, NE$\frac{1}{4}$NE$\frac{1}{4}$	601.26	Acres
	2:	ALL	642.15	"
	3:	ALL	640.36	"
	4:	Lot 1, SE$\frac{1}{4}$NE$\frac{1}{4}$	79.70	"
	10:	E$\frac{1}{2}$, E$\frac{1}{2}$NW$\frac{1}{4}$	400.00	"
	11:	ALL	640.00	"
	12:	ALL	640.00	"
T. 14 N., R. 99 W., 6th P.M.				
Sections	33:	E$\frac{1}{2}$E$\frac{1}{2}$	160.00	"
	34:	ALL	640.00	"
	35:	ALL	640.00	"
		Total	5083.47	

Figure II-10.--Topographic Plat of Wyoming Tract W-a.

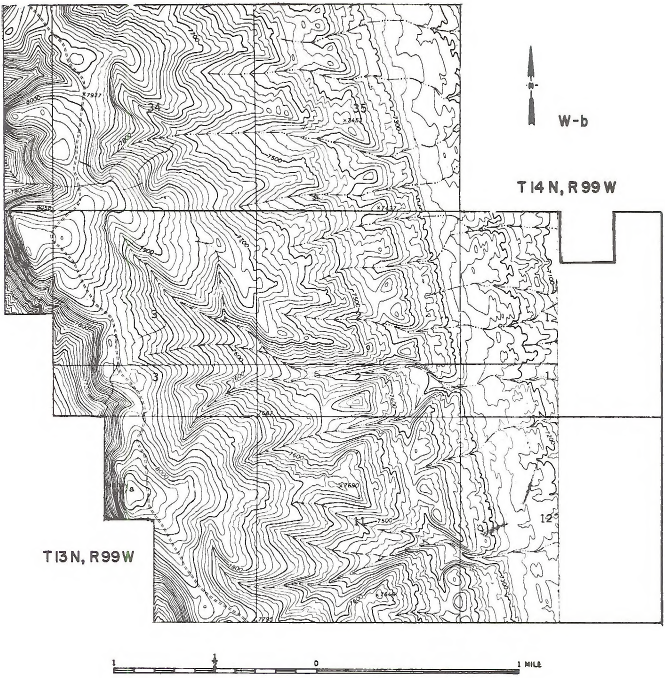

Figure II-11.--Topographic Plat of Wyoming Tract W-b.

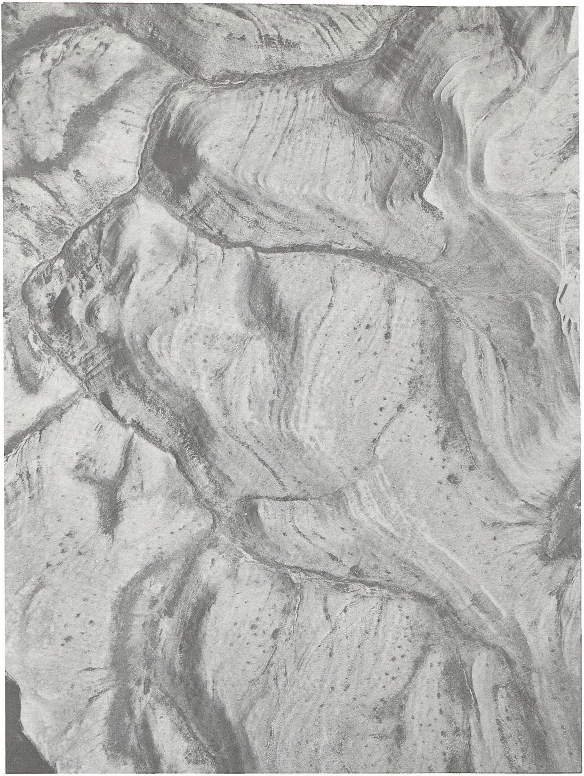

Figure II-12.--Typical Aerial View of Wyoming Tract W-a.

Figure II-13.--Typical Aerial View of Wyoming Tract W-b.

B. Description of the Environment

1. Colorado Tract C-a (Piceance Creek Basin)

a. Physiography

Tract C-a is located on the west flank of the Piceance Creek Basin. The topography of the area (see Figure II-2) is characterized by northeast-trending subparallel canyons and ridges. The slopes of the canyon walls are steep with a few ledges of oil shale breaking the slopes. The valley floors are narrow and the ridges are broad and rounded and both slope gently northeastward. Altitudes within the tract range from about 6,600 feet on Corral Creek near the northeast corner to about 7,400 feet on a ridge in the southwestern part. Greatest relief between valley bottom and nearby ridgetop is about 300 feet. Photographs of the area are shown in Figures II-14, II-15, and II-16.

Figure II-14.--Oblique Aerial view Tract C-a, Colorado. A general vision looking northeast down Box Elder Gulch in the eastern half of the Tract.

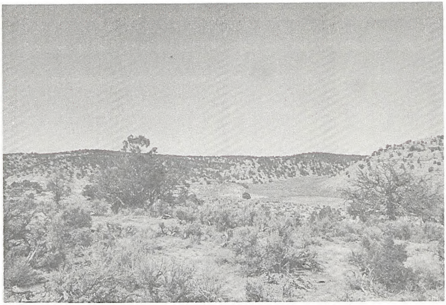

Figure II-15. Ground view, Tract C-a, Colorado, showing characteristic land surface and vegetation.

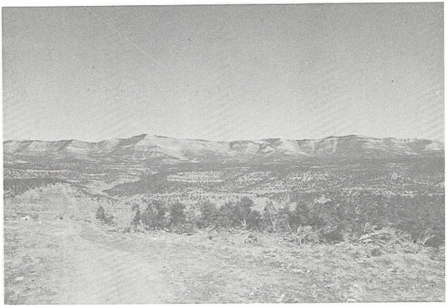

Figure II-16. Ground view, Tract C-a, Colorado, looking eastward toward the proposed spent shale disposal area on east Douglas Creek.

b. Climate

Tract C-a is located in an area in which the climate is classified as semi-arid with annual average precipitation amounts ranging from about 10 inches to a maximum of 18 inches, depending on altitude. The total number of days with precipitation amounts greater than 0.1 inches is about 40. Approximately half of the annual precipitation occurs as snow. Accumulated snow depth on higher terrain may exceed three feet for short time periods. Precipitation during the warmer months occurs mainly with local thunderstorms which are more frequent over higher terrain. Thunderstorms are often severe with strong local gusty winds and high precipitation rates causing local flash flooding.

The mean maximum temperature in January is about 38°F and the mean minimum about 5°F. The highest recorded in January is 60°F and the lowest is -35°F. The mean maximum temperature in July is about 86°F and the mean minimum about 45°F. The highest recorded in July is 98°F and the lowest is 30°F. The frost free period is approximately 90 days.

Prevailing winds are from a southwesterly direction, but gusty winds may occur from other directions depending on large-scale atmospheric circulation. Local topographic features have a strong influence on wind flow and create well organized mountain and valley wind flow patterns. In all seasons when local flow regimes predominate the most frequent wind direction is from the northeast (upslope) during the warmer part of the day; and the most frequent direction during the colder part of the day is from the southwest.

Night-time temperature inversions occur with high frequency over the Piceance Creek Basin in the lower few hundred meters above the terrain because of strong radiative cooling in a rather dry atmospheres.

c. Geology and Mineral Resources

Tract C-a is located on surface rocks that are entirely in the Green River Formation. The general geology of the Green River Formation is described in section II of Volume I the Environmental Statement. Details for the tract are given below and a section across the tract is shown on Figure II-17.

The strike of the beds in Tract C-a is in general to the north and the dip is generally to the east and ranges from 400 feet per mile in the western part of the tract to 300 feet per mile in the eastern part. A northwest-trending graben bisects the area. Maximum measured fault displacement is 175 feet.

The tract contains about 50 feet of shale, in the Mahogany zone, that averages 30 gallons of oil per ton. About 450 feet of shale, in the lower oil-shale zone, averages 30 gallons of oil per ton. The total in-place shale-oil resource in the two zones averages about 930,000 barrels per acre. Overburden on the Mahogany zone in the tract ranges from as little as 100 feet to

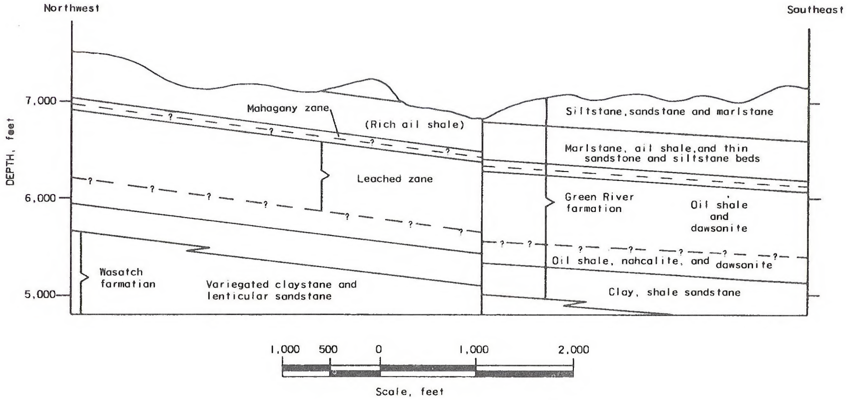

FIGURE II-17. Generalized Crass Section far Tract C-a, Calarada as much as 850 feet and averages about 450 feet. Nahcolite that is present probably does not occur in beds but in pods. Dawsonite probably is present in varying amounts in about 500 feet of section in the lower oil-shale zone. No oil or gas has been found on Tract C-a; however, commercially significant amounts of gas and small amounts of oil have been produced from the Douglas Creek Member of Green River Formation, and the Wasatch, Fort Union, Mesaverde Formations elsewhere in the Piceance Creek Basin. The Fort Union and Mesaverde Formations being considered in the Rio Blanco gas stimulation proposal underlie the entire tract at a depth of 2,000 or more feet below the base of the oil shale.

d. Water Resources

Tract C-a is drained by tributaries of Yellow Creek. Corral Gulch and Box Elder Gulch cut diagonally through the tract from southwest to northeast. They do not sustain streamflow except during periods of snowmelt and runoff from thunderstorms.

Small to moderate quantities of ground water, perhaps as much as 100 gallons per minute (about 0.2 cfs) can be pumped for a few days or a few weeks from the alluvium along the creeks. A water supply of several hundred gallons per minute can be developed from the leached zone. In the vicinity of the tract, water in this zone is fresh to slightly saline--the dissolved-solids concentration ranges from less than 500 to more than 2,000 mg/l. Data suggest that water in the lower part of the leached zone is more saline than the water above, and that permeability of the lower part generally is greater than that of the upper part of the leached zone. The potentiometric surface, and a possibility of flowing wells exists near the northeast corner of the tract.

Data from core holes drilled on and near tract C-a suggest that the transmissivity of the leached zone is about 10,000 gallons per day per foot. The transmissivity of the zone between the surface and the base of the Mahogany zone is about one-tenth of that of the leached zone. The amount of water required for dust control and compaction of the overburden probably can be picked up from the overburden excavation. If necessary, additional water may be obtained from wells in the leached zone.

After sufficient overburden is removed to begin mining oil shale, additional water that will be required to mine, retort, and refine shale at the rate necessary to produce 100,000 bbl/day of shale oil, could be obtained from wells penetrating the leached zone. Fortunately, pumping water for consumption will lower the water level initially at a rate faster than the rate of increased depth of excavation. Depending on the real value of transmissivity, the storage coefficient, the effects of hydraulic boundaries, and on the consumptive use that will be determined by final plant efficiency, the amount of water available from wells and the altitude of the saturated zone can be either favorable or unfavorable to mining operations.

After a few years, the rate of withdrawal may need to be increased and water pumped to waste in order to maintain a dry pit, if the transmissivity and storage coefficients are about the same or larger than have been estimated or, conversely, if aquifer characteristics are smaller than estimated, then yields may decline so that adequate ground water for consumptive use would not be available without drilling additional wells further from the pit and conveying the water to the site by pipeline. Chemical quality of the pumped water probably will deteriorate at some unknown rate as water is induced into the cone of depression from areas containing poorer quality.

In the event that sufficient ground water is not available for the life of the lease, then surface water can be imported from either the White River or Colorado River by pipeline. The White River (about 18 miles from Tract C-a) is closer but would require the construction of reservoirs to assure a firm supply. Water is available for purchase from the existing Green Mountain and RUCHI reservoirs and a possible future source of water is from the authorized West Divide Reclamation Project. A pipeline about 45 miles long would be required to convey water from these sources on the Colorado River.

e. Fish and Wildlife

Tract C-a is inhabited on a seasonal or yearlong basis by a wide variety of wildlife species including mule deer, wild horses, mountain lion, coyote, bobcat, rabbits, hawks, eagles, sage grouse and doves, plus numerous small bird and mammal species of aesthetic and ecological value. The area has very significant value for winter, as well as spring and fall deer range, and constitutes a wild horse use area (possibly 10 to 20 horses).

Tract C-a is served by a series of undeveloped roads and trails, situated approximately 16 miles from a surfaced highway system on Piceance Creek. The tract lies on the edge of a relatively remote, undistrubed habitat area managed by the Colorado Division of Game, Fish and Parks for the primary benefit of wildlife species and a broad spectrum of recreational users. In addition, the Shields Caldwell Hunting Camp, a private establishment headquartered within the tract boundaries, provides recreational access and services to members and guests annually.

A large portion of the mule deer population utilizing high elevation summer range on the Cathedral Bluffs-Roan Divide area, moves to historic winter range at lower elevation within the Piceance Creek basin. Tract C-a lies within the intermediate winter range zone, and bisects important deer migration routes used in their seasonal movements.

Existing land-use programs on Tract C-a, involve the coordinated management of domestic livestock and wildlife resources on a continuing, sustained production basis. No fishing habitat exists on the Tract.

f. Soils and Vegetation

The lack of detailed soil-survey information for the Piceance

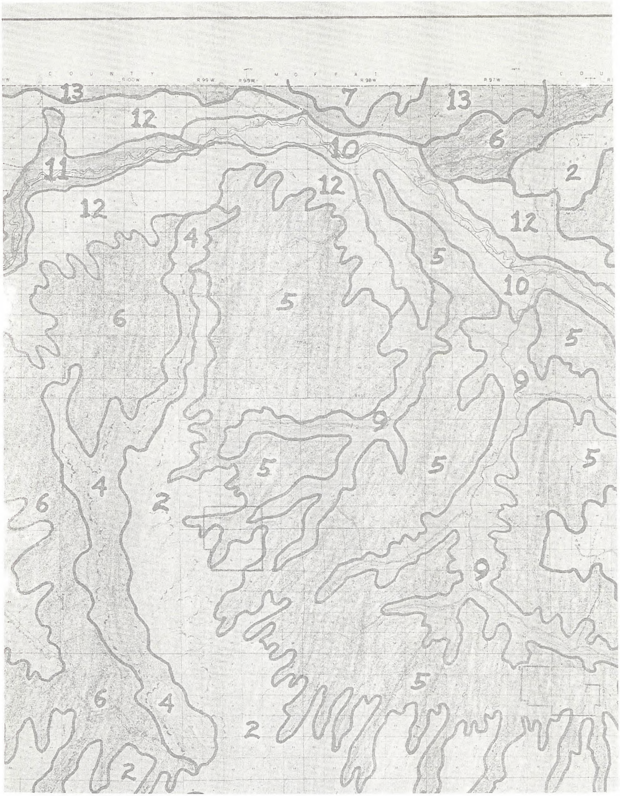

Figure II-18. Soil association map, sites C-a and C-b, Colorado.

Creek basin makes it necessary to discuss the soils in terms of their landscape associations. A soil association map for Tracts C-a and C-b is shown on Figure II-18 and a description of the soils is given below. The primary source for the map is the Soil Conservation Service. Boundaries of Tract C-a and C-b are shown on the map which also includes the proposed spent oil-shale area, Douglas Creek.

Tract C-a has the following soil associations (numbers following headings are keyed to soils map):

<u>Moderately deep and deep, dark colored soils of the upland</u>(No. 2)

Landscape: The landscape consists of steep lower mountain slopes of rugged relief dissected by narrow valleys and streams. Gently sloping areas occur on the lower footslopes, swales, fans and alluvial bottomlands.

Soils: The soils have formed largely in Green River shale materials. The dominant soil component occurs mainly in brush covered areas. These soils are moderately deep to deep. The surface soil is 8 to 15 inches thick and very dark brown in color. Organic matter content is high; surface textures are loamy with loams and sandy loams being most common. This is underlain by a light to dark brown subsoil that is one to four feet thick and ranges from sandy clay loam to clay in texture. Many subsoils contain gravel, stone and rock fragments. Lime is usually leached to depths of 40 inches or more. On steep colluvial slopes coarse fragments from higher lying rock ledges and outcrops are usually scattered over the surface.

The second major soil component of the association occurs mainly under forested areas. These soils are found in steep north facing canyons and on north facing slopes. Most of these soils will have surfaces covered by forest litter. The surface soil is 2 to 6 inches thick and loam or fine sandy loam in texture. This is underlain by a leached fine sandy loam to light clay loam subsoil. The substratum is shaly or sandstone material or bedrock occurring at depths of 10 to 40 inches.

A third component occurs in the open grass park areas; the soils are generally more than 20 inches deep over very stony or fractured bedrock materials. The surface is a loam or stony loam less than 12 inches thick. The loamy subsoil often contains some rock fragments.

Moderately deep and deep soils are intermingled in this association. Deep soils have formed in valley fill and may have dark colored buried soils within the upper four feet of the profile. Some dark surface soils are usually thick and extend to depths of 20 inches or more. Under the moderately deep soils, sandstone or shale occurs at depths between 20 and 40 inches.

Included in this association are small areas of very shallow soils over sandstone or shale, wet loamy soils in narrow swales and valley floors. Scattered small areas of rockland or rock outcrops also occur.

Interpretations: The greater depth of soils and a relatively higher degree of profile development indicates that this soil association is the most stable in the Tract. It is part of a high water producing area for tributaries to the White River.

Erosion is generally moderate. Because of the silty nature of the Green River parent materials the runoff waters from eroding soils may carry a high silt load. Care is needed to protect any vegetation on these soils.

Shallow dark colored soils of mountain cliffs and ridges (No. 4)

Landscape: This soil association extends as a narrow band less than three miles, seldom more than a mile or two wide, in a north-south direction across the western boundary of the Piceance Basin. Conspicuous features of the landscape are the light colored cliffs and escarpment of the Cathedral Bluffs which face westward toward the valley of Douglas Creek (proposed spent shale area). The area along the west face of the bluff is rugged, with a maximum relief of about 3,000 feet. The area east of the crest or the Cathedral Bluffs slopes gently northeastward. Above the cliffs are sharp rolling wind-swept ridge crests which divide Douglas Creek from Yellow Creek, while below are very steep talus slopes.

Soils: Soils of this association are predominantly shallow. Underlying shales or fine grained sandstone are usually found at depths of 6 to 20 inches. Soil depth changes frequently within short distances. Shaly loams and channery sandy loams are common surface soil textures on the steep upper slopes. Deep soils containing high proportions of shale and stone occupy lower colluvial slopes.

The major component of this association consists of high cliffs, escarpments and bare exposures of shale, sandstone, marl and limestone bedrock. Plant roots enter most of the residual beds and most shales can be readily penetrated with digging tools.

Interpretations: Erosion within this association is mainly geologic in character. Accelerated erosion is principally by wind on ridge crests where overgrazing has denuded shallow loamy soil areas. Gullying is limited to narrow drainageways occupied by deep friable soils.

<u>Shallow rock and deep moderately dark colored soils of the upland</u> (No. 5)

Landscape: The landscape is highly dissected by creeks and their intermittent tributaries. There is a repeating pattern of narrow, gently sloping alluvial valleys along creeks flanked by canyons or very steep rocky slopes which rise to higher lying uplands. Narrow bands of rolling upland or mesas form divides between upper reaches of creek tributaries.

Soils: The dominant soil component of this association is shallow over weathered Green River shale which occurs at 10 to 20 inches below the surface. The surface soil is loam to silt loam 2 to 5 inches thick; subsoil is silty clay loam. Small shale fragments occur throughout the profile increasing with depth.

A second component is similar to the dominant except that it is deeper to the Green River shale which occurs at 30 inches or more below the surface.

A third component has soils that are moderately deep to deep. Soil textures are gravelly loam to gravelly sandy loam throughout the profile. They contain an abundance of small shale fragments and varying amounts of cobble and/or stones. These soils are formed in recent colluvial materials and on side slopes below the Green River shale cliffs.

Included in this association are deep dark colored soils on north slopes and in alluvial valleys. Small areas of salt affected soils, rock outcrops and cliffs of fine grained, limey shales and sandstones are included.

Interpretations: The soils of this association are highly erosive due to the soft silty nature of the parent materials. Silt content of excessive runoff water is generally high. Water erosion on gravelly pinon-juniper slopes is principally along roads and hunting trails. Erosion control measures are necessary around new construction sites and on new roads in order to minimize water erosion hazards caused by disturbance of soils and destruction of protective vegetation.

Shallow and moderately deep, cobbly, stony and shaly soils (No. 6)

Landscape: The landscape is highly dissected by intermittent streams. It contains a repeating pattern of narrow, alluvial valleys bordered by steep conyons with rocky slopes below cliffs or bluffs topped by sloping uplands and mesas.

Soils: The dominant soil component in this association is shallow over shale of the Wasatch formation. Shale occurs at 10 to 20 inches below the surface. These soils are light colored, low in organic matter and gravelly to stony loam in texture. They are generally calcareous throughout the profile.

A second component of lesser extent is similar to the dominant except that the soils are deeper, contain less rock fragments and are more silty in texture. These soils occur in colluvial-alluvial positions of the landscape.

A third component of this association is moderately deep to deep and silty to loam textures. These soils have developed from local wind deposited materials, and occur on the flatter mesas.

Included in this association are deep dark colored alluvial soils in valley bottoms and saline-alkali soils in low areas. Shaly badlands with cliff-like topography and gullied land also occur.

Interpretations: The soils of this association are highly erosive and have fragile stability. Water erosion on rocky, gravelly pinon-juniper slopes is principally along roads and hunting trails. Trails and roads along steep upper slopes have had a striking effect in concentrating runoff water. Deep gullying and destructive bank cutting is visible along all intermittent creeks and head cutting is common on side drains. Detrimental flood deposits are left on alluvial fans and bottomlands which formerly supported stands of grass. Any runoff carries a high silt content. Extreme care is needed to protect and maintain any vegetation on the soils of this association.

Re-establishment of vegetation is difficult due to the low rainfall and unstable soils. On-site checking on most of these soils is necessary before starting any construction. Erosion control practices are necessary to prevent gully erosion.

Moderately deep to deep, silty, narrow valley alluvial soils (No. 9)

Landscape: The landscape is generally associated with the narrow bottomlands of narrow valley areas such as Big Duck, Corral and tributaries of Yellow Creek.

Soils: The dominant component in this association is deep well drained with loam or silt loam surface soils and clay or silty clay loam subsoils. The soils are generally alkaline.

A second component is very similar to the first but is affected somewhat by a watertable condition.

Included in this association are areas of highly saline or alkaline soils and small areas of gullied land.

Shallow, stony soils, moderately deep to deep wind laid soils and Rockland areas (No. 12)

Landscape: The landscape consists of high terraces, uplands and low mesas. The rockland areas consist of sandstone or shale escarpment-like bluffs and cliffs.

Soils: The dominant soil in this association is shallow over sandstone or shale materials which generally occur at less than 20 inches below the surface. The soils are light colored and have a gravelly to stony loam texture throughout the profile.

A second soil component has developed in moderately deep to deep local wind deposited materials derived for the most part from sandstone with some shale influence. These soils have loamy surface textures and clay loam textures in the subsoil with slight to moderate lime accumulations. These soils occur mainly on top of the high terraces and low mesas. The Rockland areas are composed of sandstone or shale.

Also included in this association are small areas of deep clayey soils derived from shale; areas of saline or alkaline soils; moderately deep stony loam colluvial soils and deep medium textured alluvial soils along the drainage bottoms. Small areas of mixed coarse textured gravelly and cobbly outwash and rough gullied land also occur in this association.

Interpretations: Most of the soils in this association have high susceptibility to water erosion because they are derived largely from soft silty shale materials. A combination of steeply sloping land and high intensity rainstorms during the summer greatly increase the severity of this hazard. Most runoff waters carry a high silt content. Extreme care is needed to protect and maintain all vegetation on these soils. Re-establishment of vegetation is difficult in this area due to low rainfall and unstable soils. Erosion control measures are necessary around construction sites or new roads to prevent gullying.

Many salt affected areas occur on the alluvial soils in this association along Douglas Creek and its tributaries.

Tract C-a. Important plants occurring on tract are:

Serviceberry

Pinon Pine

Bitterbush

Big sagebrush

Indian ricegrass

Dryland sedges

Balsam root

Mutton grass

Needle and thread grass

Bluebunch wheatgrass

Western wheatgrass

Native blue grasses

Basin wildrye

The ground views (Figures II-15 and II-16) and aerial view (Figures II-14) show the characteristic vegetation and distribution of pinon pine on the Tract.

g. Grazing

Tract C-a contains vegetative types that offer forage and protective cover to wildlife and cattle.

Cattle utilize the area generally during the spring and fall for a period of about five months. The tract and waste area extend across normal routes of travel from lower ranges to the higher elevations.

Six hundred animal unit months of feed are produced for cattle on the tract. There are two separate ranch operations with 1200 head of cattle-grazing allotments that cover an area around the tract.

Fences and water facilities are on and adjacent to the tract tract to control the livestock and service the area.

h. Aesthetics

Tract C-a is located in an area subjected to few disruptive noises and offers unobstructed views of the surroundings. The air is clear, and visibility is limited only by natural land forms and the horizon. Visibility ranges of 100 miles or more are common.

The main roads are in drainage bottoms and are not visible in general views of the area. Other works of man are limited and obstruct the view only in limited areas.

Noises associated with man's activities, that can be heard short distances from the point of origin, are limited to scattered drilling rigs exploring for oil or gas or coring the oil shale.

The Cathedral Bluffs, west of the tract, are an unusual land form. They are nearly vertical rock cliffs several hundred feet in height. They are visible for several miles from the north and west as well as from the highway from Rangely to Grand Junction. The Bluffs are considered a scenic area because of their gray color and unique form.

i. Recreation

Tract C-a and the surrounding area have a sizeable mule-deer population. The fall deer hunt is a major recreation activity in the tract. A local hunting club, having surface patent rights, utilizes four small buildings in the tract as a hunting camp during the big-game hunting season.

j. Archeological and Historical Values

Tract C-a does not include any points of historic interest nor sites of archeological discovery.

k. Socio-Economic Status

With the exception of a private hunting camp and a few unimproved dirt roads, Tract C-a has no existing economic or social development. See Volume I of this Environmental Statement for a description of the area.

2. COLORADO Tract C-b (Piceance Creek Basin)

a. Physiography

Tract C-b is located in the central part of the Piceance Creek Basin, a short distance southwest of Piceance Creek. The topography (see Figure II-3) is characterized by narrow, steep-walled valleys and broad rounded ridges. The general topographic form is that of a northward sloping plateau that has been dissected by north flowing streams draining into Piceance Creek. Altitudes in the tract range from about 6,400 feet in the northeast corner on Stewart Gulch to about 7,100 feet on a ridge in the southcentral part. Greatest relief between valley floor and nearby ridge top is about 400 feet. Photographs of the area are shown in figures II-19 and II-20.

Figure II-19 Ground view Site C-b, Colorado, showing characteristic valley land form and vegetation (Standard Draw).

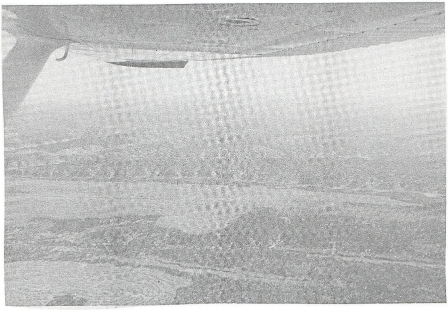

Figure II-20. Oblique aerial view, Site C-b, Colorado, looking eastward across the tract.

b. Climate

Tract C-b is classified as semi-arid in climate with annual average precipitation amounts ranging from about 10 inches to a maximum of 18 inches, depending on altitude. The total number of days with precipitation amounts greater than .01 inches is about 40. Approximately half of the annual precipitation occurs as snow. Accumulated snow depth on higher terrain may exceed three feet for short time periods. Precipitation during the warmer months occurs mainly with local thunderstorms which are more frequent over higher terrain. Thunderstorms are often severe with strong local gusty winds and high precipitation rates causing local flash flooding.

The mean maximum temperature in January is about 38°F and the mean minimum about 5°F. The highest recorded in January is 60°F and the lowest is -35°F. The mean maximum temperature in July is about 86°F and the mean minimum about 45°F. The highest recorded in July is 98°F and the lowest is 30°F. The frost free period is approximately 90 days.

Prevailing winds are from a southwesterly direction, but gusty winds may occur from other directions depending on large-scale atmospheric circulation. Local topographic features have a strong influence on wind flow and create well organized mountain and valley wind flow patterns. In all seasons when local flow regimes predominate the most frequent wind direction is from the northeast (upslope) during the warmer part of the day; and the most frequent direction during the colder part of the day is from the southwest.

Night-time temperature inversions occur frequently over the Piceance Creek Basin in the lower few hundred meters above the terrain because of strong radiation cooling in the rather dry atmosphere.

c. Geology and Mineral Resources

Tract C-b is located in the geologic setting described in section II of Volume I of this Environmental Statement. Details for the tract are given below and section is shown on Figure II-21. The beds in Tract C-b strike to the east or northeast in most of the tract. The axis of a syncline is sub-parallel to the northern boundary of the tract, and north of the axis the strike of the rocks is to the northwest. Dip in most of the area is north to northwest at the rate of 150 feet per mile. Along the northern boundary the dip is southwest at the rate of 200 feet per mile

Oil-shale value, as shown by assays from core in nearby holes, increases in a northerly direction. The Mahogany zone contains more than 100 feet of shale that averages 30 gallons of oil per ton and the lower zone possibly contains an additional 300 feet of shale averaging 30 gallons of oil per ton with a total in-place resource of about 830,000 barrels per acre. Overburden on the Mahogany zone varies from a minimum of 800 feet to a maximum of 1,250 feet and averages 1,100 feet. Nahcolite is present in pods in the lower part of the

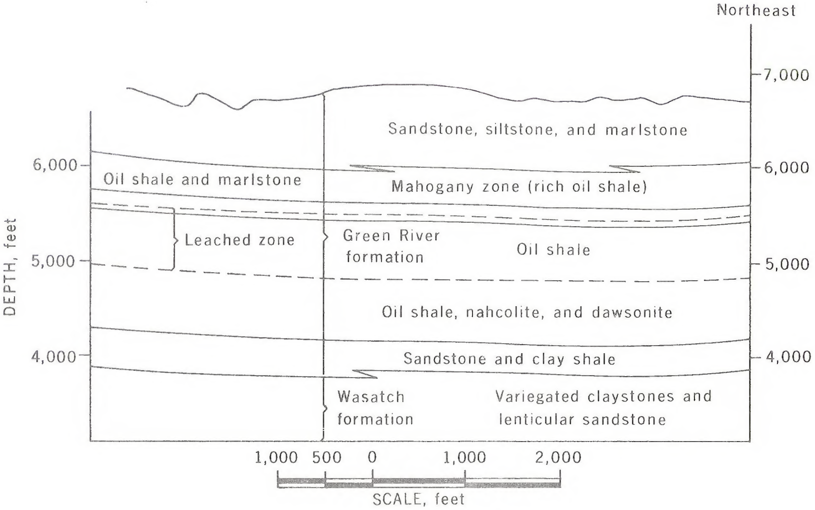

FIGURE II-21. - Generalized Cross Section for Tract C-b, Colorado lower zone and may be bedded in the northwest part of the tract. Oil shale containing dawsonite in varying amounts may attain a thickness of 300 feet in parts of the area. No oil or gas has been found in Tract C-b; however, commercially significant amounts of gas and small amounts of oil have been produced from the Douglas Creek Member of the Green River Formation, and the Wasatch, Fort Union, and Mesaverde Formations elsewhere in the Piceance Creek Basin. The Fort Union and Mesaverde Formations being considered in the Rio Blanco gas stimulation proposal underlie the entire tract at a depth of 2,000 or more feet below the base of the oil shale.

d. Water Resources

Tract C-b is drained by tributaries of Piceance Creek. The tributaries carry water only during periods of snow melt or following heavy rain or thundershowers. Piceance Creek is less than a mile north of the northeast corner of the tract. Fresh water is present in the alluvium along Piceance Creek and the larger tributary valleys. However, prior water rights and Colorado water law would limit development and use of alluvial ground water or the water from Piceance Creek.

Data from five test wells on and near Tract C-b indicate that the transmissivity of upper zone (land surface to base of Mahogany) is about 400 gallons per day per foot and the transmissivity of the underlying leached zone is about 6,000 gallons per day per foot.

Because of the need to lower the water level below the underground mine workings, more ground water would be pumped initially than would be consumed in spent shale disposal, retorting and other operations attendant to the production of 50,000 bbl/day of shale oil. Maintaining a water level beneath the mine workings would result in water pumped to waste during the early years of mining but the yield would decrease to less than consumptive use before the mine was worked out. The dissolved solids content of the ground water would cause the water to be usable to marginal for some purposes initially, but the pumped water would deteriorate with time as water having a higher dissolved solids content moved into the cone of depression. The quality of water would be suitable for many of the larger consumptive uses such as spent shale disposal.

Samples of water obtained during drilling of a core hole by the air rotary method in the southwestern part of the tract contained about 7000 mg/1 of dissolved solids while drilling in the upper part of the Parachute Creek Member. The discharge at that time was more than 300 gallons per minute. After drilling the entire thickness of the Parachute Creek Member, the well yielded more than 500 gpm and the water contained more than 2,000 mg/1 of dissolved solids.

After yield of the mine declines to less than consumptive use, additional ground water can be obtained by drilling more wells further from the mine or surface water can be obtained from the White River or Colorado River. Tract C-b is about 25 miles from the White River by way of the Piceance Creek valley and is about 30 miles from the Colorado River at the mouth of Parachute Creek. A firm supply of water from the White River would require construction of an upstream dam and reservoir as well as conveyance from the river to the tract. Water is available for purchase from existing reservoirs on upstream tributaries of the Colorado River. The quality of water from both rivers is good.

e. Fish and Wildlife

Tract C-b is inhabited on a seasonal or year long basis by a diverse assoication of wildlife species including mule deer, elk, mountain lion, coyote, bobcat, rabbits, grouse, doves eagles, and hawks, as well as numerour small bird and mammal species.
This tract, lying within the intermediate range zone averaging 6,800 feet, receives some intermittent use by wintering herds of deer.

Tract C-b lies immediately adjacent to an important surfaced highway on Piceance Creek, and unimproved roads parrallel west Stewart and Scandard Gulches. As a result, the tract is currently subject to the disruptive impact of sparse traffic flows, as well as the effects of intensive livestock operations conducted on several large ranches which have headquarters in the valley of Piceance Creek. Although large portions of the tract contain significant wildlife resource values, game harvest and general recreational use is limited through current actions of controlling landowners. Recreation-oriented activities, primarily sport hungint, account for several hundred man-days use annually.

Current land-use objectives related to Tract C-b acreage involve domestic livestock grazing as well as optimum production of indigenous wildlife species. Populations of a number of birds and mammals designated as game species, as well as various carnivores, are managed on a sustained-yield basis, consistent with food and other habitat requirements. No fishing habitat exists on the tract.

f. Soils and Vegetation

Tract C-b has the following soil associations (numbers following headings are keyed to soils map, Figure II-18).

Moderately deep and deep, dark colored soils of the upland (No. 2)

Landscape: The landscape consists of steep lower mountain slopes of rugged relief dissected by narrow valleys and streams. Gently sloping areas occur on the lower footslopes, swales, fans and alluvial bottomlands.

Soils: The soils have formed largely in Green River shale materials. The dominant soil component occurs mainly in brush covered areas. These soils are moderately deep. The surface soil is 8 to 15 inches thick and very dark in color. Organic matter content is high; surface textures are loamy with loams and sandy loams being most common. This is underlain by a light to dark brown subsoil that is one to four feet thick and ranges from sandy clay loam to clay in texture. Many subsoils contain gravel, stone and rock fragments. Lime is usually leached to depths of 40 inches or more. On steep colluvial slopes, coarse fragments from higher lying rock ledges and outcrops are usually scattered over the surface.

The second major soil component of the association occurs mainly under forested areas. These soils are found in steep north facing canyons and on north facing slopes. Most of these soils will have surfaces covered by forest litter. The surface soil is 2 to 6 inches thick and loam or stony loam less than 12 inches thick. The loamy subsoil often contains some rock fragments.

Moderately deep and deep soils are intermingled in this association. Deep soils have formed in valley fill and may have dark colored buried soils within the upper four feet of the profile. Some dark surface soils are usually thick and extend to depths of 20 inches or more. Under the moderately deep soils, sandstone or shale occurs at depths between 20 and 40 inches.

Included in this association are small areas of very shallow soils over sandstone or shale, wet loamy soils in narrow swales and valley floors. Scattered small areas of rockland or rock outcrops also occur.

Interpretations: The greater depth of the soils and a relatively higher degree of profile developement indicates that this soil association is the most stable in the Tract. It is part of a high water producing area for tributaries to the White River.

Erosion is generally moderate. Because of the silty nature of the Green River parent materials the runoff waters from eroding soils may carry a high silt load. Care is needed to protect any vegetation on these soils.

Shallow rock and deep moderately dark colored soils of the upland (No. 5)

Landscape: The landscape is highly dissected by creeks and their intermittent tributaries. There is a repeating pattern of narrow, gently sloping alluvial valleys along creeks flanked by canyons or very steep rocky slopes which rise to higher lying uplands. Narrow bands of rolling upland or mesas form divides between upper reaches of creek tributaries.

Soils: The dominant soil component of this association is shallow over weathered Green River shale which occurs at 10 to 20 inches below the surface. The surface soil is loam to silt loam 2 to 5 inches thick; subsoil is silty clay loam. Small shale fragments occur throughout the profile increasing with depth.

A second component is similar to the dominant except that it is deeper to the Green River shale which occurs at 30 inches or more below the surface.

A third component has soils that are moderately deep to deep. Soil textures are gravelly loam to gravelly sandy loam throughout the profile. They contain an abundance of small shale fragments and varying amounts of cobble and/or stones. These soils are formed in recent colluvial materials and on side slopes below the Green River shale cliffs.

Included in this association are deep dark colored soils on north slopes and in alluvial valleys. Small areas of salt affected soils, rock outcrops and cliffs of fine grained, limey shales and sandstones are included.

Interpretations: The soils of this association are highly erosive due to the soft silty nature of the parent materials. Silt content of excessive runoff water is generally high. Water erosion on gravelly pinon-juniper slopes is principally along roads and hunting trails. Erosion control measures are necessary around new construction sites and new roads to minimize water erosion hazards caused by disturbance of soils and destruction of protective vegetation.

Moderately deep to deep, silty, narrow valley alluvial soils (No. 9)

Landscape: The landscape is generally associated with the narrow bottomlands of narrow valley areas such as Big Duck, Corral and tributaries of Yellow Creek.

Soils: The dominant component in this association is deep well drained with loam or silt loam surface soils and clay or silty clay loam subsoils. The soils are generally alkaline.

A second component is very similar to the first but is affected somewhat by a water-table condition.

Included in this association are areas of highly saline or alkaline soils and small areas of gullied land.

Tract C-b. Important plants occurring on the tract are:

Serviceberry

Pinon Pine

Juniper

Bitterbrush

Dryland sedges

Western wheatgrass

Mutton grass

Bluebunch wheatgrass

Indian ricegrass

Balsam root

Big sagebrush

Native blue grasses

Needle and thread grass

Basin wildrye

Characteristic vegetation of the area is shown in Figures II-19 and II-20.

g. Grazing

Tract C-b contains vegetative types that offer forage and protective cover to wildlife and cattle.

Cattle utilize the area for a period of about five months each year, generally during the spring and fall. The tract and waste area extend across normal routes of travel from lower ranges to the higher elevations.

Six hundred fifty animal unit months of feed are produced for cattle on the tract. There are five separate ranch operations with 7,781 head of cattle grazing a common allotment that covers an area around the tract.

Fences and water facilities located on and adjacent to the tract are to control the livestock and service the area.

h. Aesthetics

Tract C-b is in an area subjected to few disruptive noises and offers unobstructed views of the surroundings. The air is clean, and visibility is limited only by natural land forms and the horizon. Visibility ranges of 100 miles or more are common.

The main roads are in drainage bottoms and are not visible in general views of the area. Other works of man are limited and obstruct the view only in limited areas.

Other impacts are related to noise associated with man's activities. These activities that can be heard at a distance from the point of origin include discharging firearms, noise from vehicles, and noise from scattered drilling rigs exploring for oil or gas or coring into the oil shale.

i. Recreation

Tract C-b and the surrounding area have a sizeable mule-deer population. The fall deer hunt is the primary recreation activity in the tract.

j. Archeological and Historical Values

Tract C-b does not include any points of historic interest nor sites of archeological discovery.

k. Socio-Economic Status

With the exception of a few unimproved dirt roads, Tract C-b has no existing economic or social development. See Volume I of this Environmental Statement for a description of the area.

3. Utah Tracts U-a and U-b (Uinta Basin)

a. Physiography

Tract U-a is immediately south of the White River in the eastern part of the Uinta Basin. The valley of the White River occupies a narrow strip about 800 feet wide in the north-central part of the tract(Figure II-6). Southam Canyon, a slightly meandering drainage, extends northwestward across the tract and joins the White River just outside the tract. Numerous minor drainages in the tract are tributary to Southam Canyon and to White River, the only perennial stream. The topography (see Figure II-6 and II-7) is characterized by high, sinuous ridges bounded by cliffs and separated by lower areas of narrow branching ridges and stream valleys. Innumerable small buttes are spaced randomly along the drainage divides. Altitudes within the tracts range from about 4,900 feet on the White River to about 5,960 feet in the south-central part. Greatest altitude difference in a short distance is about 450 feet in one-half mile in the south-central part of the tract.

Figure II-22 A view of the central portion of Tract U-a from the N½ of Sec. 28, T. 10 S., R. 24 E.

Tract U-b is located immediately south of the White River in the eastern part of the Uinta Basin. The White River is an all year stream and is a mile or so from the northwestern corner of the tract. The canyon of Evacuation Creek trends northward across the central part of the tract. East of Evacuation Creek the topography is characterized by rounded forked ridges with scattered ledges and cliffs. West of Evacuation Creek the terrain is more rugged and is characterized by ledges and cliffs along the canyon walls and numerous buttes along the drainage divides. See Figures II-22 and II-23. Altitudes range from 4,950 feet along the White River to about 5,850 feet near the southwest corner. Greatest altitude difference in a short distance is about 300 feet in one-half mile in the southwestern part of the tract.

Figure II-23 A view looking west across Evacuation Creek from Sec. 13, T. 10 S., R. 24 E., of the NW portion of Tract U-b.

b. Climate

The climate of both tracts U-a and U-b is semi-arid with annual precipitation amounts ranging from about 8 inches at lower elevations to 10 inches over higher terrain. Near the site about 10 inches of precipitation occur per year with about 4 inches from May to September mostly from thunderstorms, and 6 inches October to April.

Approximately 25 days per year have precipitation amounts in excess of .01 inches. Severe local, summer thunderstorms may cause strong gusty winds and local flash flooding. The average annual snow accumulation is about 10 inches. Open areas may remain free of snow for most of the winter.

The area has dry hot summers with an average July maximum temperature of 95° F. and an extreme of 105° F. The winters are relatively dry with cold temperatures. The extreme minimum recorded is -25° F, and an average minimum for January of 8° F. The frost free period is approximately 110 days.

The prevailing winds are from the west and southwest with large local variations in lower levels because of mountain and valley wind patterns. The general drainage flow is from the Roan Plateau northward to the White River; therefore, the wind direction would be southerly when local flows predominate during the cooler part of the day when strong inversion conditions exist.

The mean maximum mixing depth of the Basin is about 400 meters in January, and approximately 3,200 meters in July. A high frequency of night-time inversions, particularly during the fall and winter seasons, creates limited atmospheric despersion.

c. Geology and Mineral Resources

Tract U-a. The general geology of the tract is described in section II Volume I of this Environmental Statement. Details for the tract are given below and Figure III-3 shows a representative section for the tract. The strata in Tract U-a dip north-westward at about 200 feet per mile. There are no significant surface faults in the area. Oil-shale thicknesses in Tract U-a are unknown because there has been no core drilling in the tract. It is estimated that the oil-shale sequence that averages 30 gallons of shale oil per ton is about 45 feet thick. This is bases on extrapolation of oil-yield assay data from core holes outside the tract and mechanical logs from exploratory wells within the tract. Overburden above the Mahogany zone ranges from 550 feet to 1,225 feet and the average is approximately 850 feet. Nahcolite is probably present in the tract as very thin lenses or beds and small pods. There are no reports of significant amounts of bituminous sandstone in the tract, surface or sub-surface, and no obvious gilsonite veins. The Southman Canyon field has produced gas from the Wasatch Formation in Tract U-a. Although the Uinta Formation produces gas in some parts of the Uinta Basin, it is very unlikely that it contains gas in Tract U-a.

Tract U-b. The general geology of the tract is described in section II Volume I of this Environmental Statement. Details for the tract are given below and figure II-24 shows a representative section for the tract. The strata in Tract U-b dip westward and northwestward at 200 to 400 feet per mile. There are no significant surface faults but there is much evidence of jointing, especially in the beds of the upper Green River Formation. Assayed samples from core holes in tract U-b show the average thickness of oil shale yielding an average of 30 gallons of oil per ton to be approximately 50 feet. Overburden above the principal oil-shale beds ranges from 300 to 1,250 feet and the average is about 700 feet. Nahcolite occurs as very thin lenses or beds and small pods in the upper part of the Green River Formation. No oil or gas has been discovered in the tract and there is no known occurrence of significant amounts of bitumen in sandstone. One narrow gilsonite vein (less than 2 inches wide) outcrops in the west-central part of the tracts.

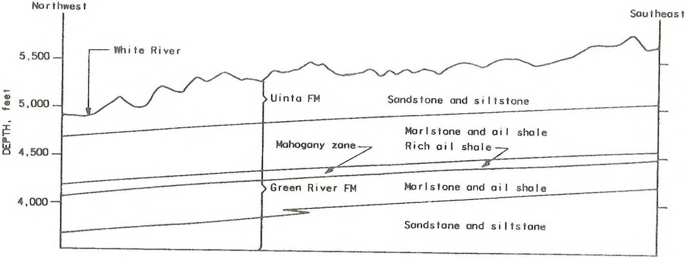

FIGURE II-24. - Representative Section for Tracts U-a and U-b.

d. Water Resources

Tracts U-a and U-b adjoin each other and are described as a unit. The tracts are within a mile or so of the White River. Mean flow of the river in this reach is about 700 cfs, and the weighted average dissolved-solids concentration is about 400 mg/l. However, development of a dependable supply from the White River would require acquisition or development of water rights and the storage of flood waters. Water could also be obtained from Green River and Flaming Gorge Reservoir by diverting at a point on the Green River about 30 miles to the west of the tracts.

Ground water occurs above and in the oil shale, but data are not available on possible yields of wells in the aquifers, or the quality of water that might be developed, although the yields probably will be small. One well record in the vicinity of the tracts reported "fresh" water at a depth of 600 feet. Ground water at greater depth, in and adjacent to the oil shale, can be expected to contain from 1,000 to 3,000 mg/l of dissolved solids. The ground water probably moves through the tracts in a northwesterly direction and is tributary to the White River.

e. Wildlife and Fish

Proposed test-least sites Tracts U-a and U-b contain a healthy association of wildlife species, including mule deer, mountain lion, coyote, bobcat, rabbit, chukar partridge, dove, and raptors as well as numerous small bird and mammal species. The tracts contain habitat of specific value as deer winter range and sustain about fifty hunter-days use by sportsmen anually. Important eagle (bald and golden) nesting and roosting sites are present along drainage escarpments, while the general area is occasionally frequented by the rare prairie falcon. Waterfowl, aquatic furbearers, and various species of sport fish utilize the White River system. Catfish are found in the White River adjacent to the tracts.

f. Soils

Tracts U-a and U-b. Two soils units have been mapped in and near these tracts. The units are described below and their distribution is shown on Figure II-25.

Composition of map unit 58 by Great Soil Groups (1949); Great Group, Subgroup or Family (1965); is estimated as follows:

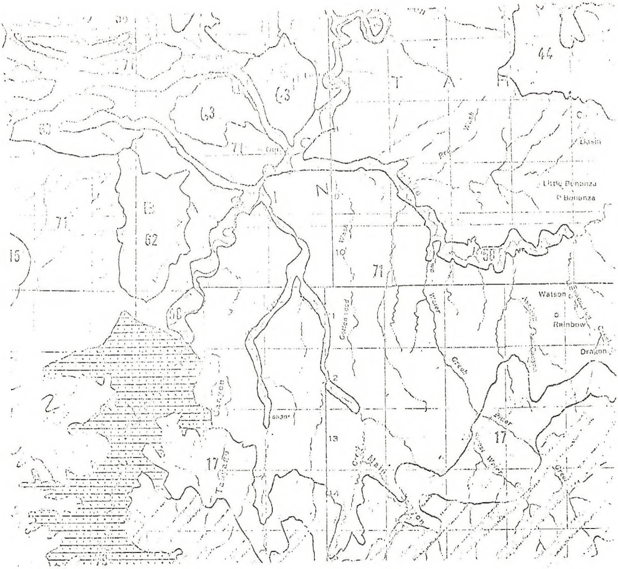

Figure II-25 Soil association map of area in and around Tracts U-a and U-b. From Soil Association Map, State of Utah, prepared by U. S. Soil Conservation Service; scale, 1 inch equals approximately 8 miles. Numbers are keyed to text.

Percent	1949 Great Soil Group	1965 Great Group, Subgroup or Family
25	Alluvial	Aquic Xerofluvents
30	Alluvial	Aquic Ustifluvents
20	Alluvial (Solonetz)	Typic Torrifluvents (with inclusions of Typic Natrargids and Vertic Fluvaquents)

This association occurs along recent flood plains and low terraces adjacent to major rivers (White River). Relief is smooth to gently undulating.

The Aquic Xerofluvents are deep soils that have grey, calcareous loamy or silty surface horizons underlain by stratified subsoil that ranges in texture from coarse loamy or coarse silty to fine sandy loamy or fine silty. Mottling is common below 10 inches unless the soil has been artifically drained. Water table ranges between 10 and 40 inches. The Abraham Soil series is representive of this subgroup.

The Aquic Ustifluvents are deep soils with brown to pale brown, moderately calcareous, loamy surface horizon, underlain by stratified coarse loamy to fine loamy subsoils. They are mottled below depths of 20 inches. Water table ranges between 20 and 40 inches. The Green River Soil Series is representative of the subgroup.

Typic Torrifluvents are deep soils with light colored calcareous loamy or silty surface, coarse silty, fine loamy or fine silty subsoils. The 2 ravola Soil Series is typical of this subgroup.

Permeability is moderate for all of these soils except for the Natrargids which have slow permeability. Runoff is medium to rapid and sediment production is high because of stream cutting during periods of high stream flow.

Native vegetation is cottonwood trees, willows, salt cedar, greasewood and associated grasses and forbs.

These soils are in Hydrologic Group B and D.

Composition of map unit 71 by Great Soil Groups (1949); Great Groups, Subgroup, or Family (1965) and land types is estimated as follows:

Percent	1949 Great Soil Group	1965 Great Group, Subgroup or Family
50	Red Desert	Typic Torriorthents
25	Rendzinas Lithosols	Lithic Calciorthids
	(Solonetz)	(with inclusions of Lithic Natrargids and Badlands)

Typic Torriorthents are shallow soils over weathered soft marine shales. They have thin light yellowish brown calcareous fine loamy or fine silty surface horizons and fine silty or clay subsoils. The soft shale bedrock usually is at depths of less than 20 inches. Relief is undulating to rolling.

Chipeta and Persayo Soil Series are representative of this subgroup.

Lithic Calciorthids are shallow over sandstone or interbedded sandstone or shale bedrock. The soils are light colored; calcareous sand or coarse loamy surface horizons; underlain by a loam or stony loam accumulation zone.

No Soil Series has been established for this subgroup.

All of these soils are well drained; permeability is low; runoff is rapid and sediment production is high especially from intense summer storms.

Native vegetation is shadscale, greasewood, saltbush, galleta grass and Indian ricegrass.

These soils are in Hydrologic Group D.

Tracts U-a and U-b. Important Plants Occurring in these tracts are :

Big sagebrush

Black sagebrush

Pinon Pine

Juniper

Galleta junegrass

Salina wildrye

Winterfat

Shadscale

Indian ricegrass

Greasewood

Four-wing saltbush

Bull grass

Characteristic vegetation is shown in photos, Figures II-22 and II-23.

g. Grazing

The average forage density for these tracts varies from 3- to 15-percent with an average vegetative yield of about 350 pounds per acre. The growing season in this area begins in late March with seed dissemination from July through November. The area has periodic infestations of poision weeds including lococ weed (Astraguisus sp.) and halogeton (Halogeton lomeratus). Loco weed thrives after a favorable wet summer and is grazed in its green stage in the winter. Ther is a tendency for Halogeton to rapidly invade distrubed soils.

The public lands in the area including the proposed lease tracts are used as winter sheep range by several livestock operators under grazing permit from the Bureau of Land Mangement. About 1400 sheep utilize 730 AUMs* on each of the tracts each winter. Some 21,000 sheep trail through Tract U-b twice each year along the main county road and Southam Canyon Road.

h. Aesthetics

Tracts U-a and U-b are characterized generally be desert shrub and pinon-juniper trees to form a highly aesthetic semi-desert landscape. Wildlife and domestic animals utilize the area for winter grazing. They are often visible from travel routes. Erosion has produced unusual and interesting scenery on the rugged canyon walls along the White River.

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*Animal Unit months

i. Recreation

Tracts U-a and U-b. There are no developed recreation facilities in the area. Recreational use of the land in the general area is presently quite light with an estimated 50 visitor days and consists mainly of hunting (deer, rabbit, and chukar partridge), rockhounding, and sightseeing. Recreational use of the White River is light--a few river runners and fishermen. Most of the visitors live within 100 miles of the tracts.

In addition to identified wildlife habitat values, the Utah tracts possess unique recreational value inherent in their relative isolation from commercial development. Although the eastern portion of the lease unit is bisected by an unimproved county highway and a gilsonite transmission pipeline, the general area retains a basically primitive quality. The dissected and eroded terrain has a scenic beauty enjoyed by recreationists.

j. Archaeological and Historical Values

There are no archeological or historic sites on the tracts, but the following points of interest are located near the sites.

Two rock overhangs with evidence of the Fremont culture, a farming group of Indians dating in the 11th Century A.D., were found within one-half mile of the White River at the County Bridge crossing. There may be other evidence, possibly some pithouse village sites, in the rest of the main canyon and near the mouths of the watered side canyons emptying into the White River. Historical sites of importance are present in the area immediately adjacent to the proposed use area. These are at the road crossing of the White River (Ignacio Stage Stop and Old Bridge) and in the gilsonite mining area. The sites of the mining camps of Rainbow and Watson, the remains of the narrow-gauge Uintah Railway which served the area until 1938 and the remains of many abandoned gilsonite workings represent interesting relics of a rare mining activity, and are all adjacent to the south boundary of the development area.

There are no historic sites listed for Uintah County, Utah, in the National Register of Historic Places.

The Colorado Historic Society recognizes the historic significance of the abandoned Uintah Railroad and related sites located along the Colorado-Utah State Line.

k. Socio-Economic Status

With the exception of a few oil and gas wells of the Southman Canyon Field, and access roads on tract U-a, there is no existing economic or social development on the tracts U-a and U-b. See Volume I of this Environmental Statement for a description of the area.

4. Wyoming Tracts W-a and W-b. (Washakie Basin)

a. Physiography

Tract W-a is located on the southwestern flank of the Washakie Basin and includes part of the Kinney Rim. See Figure II-10 and II-26. A southwest-facing escarpment, below the Kinney Rim, extends along the western side of the tract. To the east of the escarpment the topography is controlled by resistant strata that form dip slopes inclined northeastward. A few narrow, steep-sided drainages have been cut into this slope. Altitudes within the tract range from about 7,200 feet at a point below the Kinney Rim escarpment and on the dip slope in the eastern part of the tract to about 8,200 feet on the Kinney Rim. Maximum relief along the escarpment is about 900 feet.

Tract W-b is located on the southwestern flank of the Washakie Basin. The west-facing escarpment below the Kinney Rim extends approximately along the western margin of the tract. See Figure II-11. East of the escarpment the surface slopes rather uniformly eastward except where broken by narrow east-trending drainages. The Altitude along most of these drainages is less than 7,100 feet near the eastern boundary to about 8,200 feet on Kinney Rim. Greatest relief on the escarpment along the west side is about 700 feet.

Figure II-26.--Aerial view of Kinney Rim, Washakie Basin, Wyoming, looking southeast from Section 2, T. 14 N., R. 100 W., toward Wyoming sites W-a and W-b in upper center and right portions of the photographs.

b. Climate

Tracts W-a and W-b. The climate of these tracts is semi-arid with annual precipitation ranging from 10 to 12 inches which occurs mostly in the winter and early spring. Temperatures fluctuate from minus 40°F. to 90°F. Extreme temperatures recorded in the area are 55°F. below zero and 107°F.

The growing season ranges from 70 to 100 days between killing frosts. A killing frost is 28°F. or less. The area has 65 to 75 persent of sunshine; the percentage is lower during spring and winter and higher in the summer and fall. Winds are relatively strong over the area especially along the top of the Kinney Rim. The prevailing wind direction is from the west. During the cooler times of the day downslope winds are from the southwest, and during the warmer times of the day winds blow from the northeast. The most severe weather conditions occur with outbreaks of Arctic air which bring northeasterly winds and extremely cold temperatures.

The mean maximum mixing depth is approximately 100 meters in January and 3,000 meters in July.

c. Geology and Mineral Resources

Tracts W-a and W-b. The general geology of the area in and around the tracts is described in section II Volume I of this Environmental Statement. Details for the tracts are given below. Rocks in the tracts strike to the northwest and dip to the northeast at rates of 700 to 900 feet per mile on the west to more than 1,800 feet per mile on the east. Two north-trending normal faults less than a mile long displace the oil shale by as much as 100 feet. The west side is downfaulted.

U.S. Bureau of Mines Washakie Basin Core Hole 1 is in the northern part of tract W-a and assay values of cores from the Laney, Wilkins Peak, and Tipton Members of the Green River Formation are assumed to be representative of the value of the oil shales of these members underlying both tracts. U.S. Bureau of Mines Washakie Basin Core Hole 1A was drilled 1½ miles west of tract W-a and assays from this core were considered to be representative of the value of the oil shales in the Luman Tongue of the Green River Formation underlying the tracts.

There is no oil shale underlying the tracts that averages 30 or more gallons per ton in thicknesses greater than 10 feet. However, in the lower half of the oil-shale bearing part of the Laney Member, two zones between 10 and 20 feet thick average more than 25 gallons of oil per ton containing an in-place resource of about 55,000 barrels per acre. Two zones in the Laney Member average 15 gallons of oil per ton: one about 145 feet thick in the upper part of the oil-shale bearing segment of the Laney, and the other about 85 feet thick in the lower part of the oil-shale bearing segment of the Laney. These two units have a combined in-place resource of about 260,000 barrels per acre. The uppermost 40 feet of the Wilkins Peak Member averages more than 15 gallons of oil per ton and has an in-place resource of approximately 45,000 barrels per acre. The upper 30 feet of the Tipton Member averages more than 15 gallons of oil per ton and has an in-place resource of approximately 35,000 barrels per acre. There is no overburden on the oil-shale-bearing segment of the Laney Member near the western margin of the tracts. The overburden increases abruptly eastward to a maximum of 2,400 feet and the average is 600 feet. The minimum overburden on the top of the Wilkins Peak is 900 feet, the average 2,200 feet, and the maximum 4,900 feet. The minimum overburden on the Tipton is 1,200 feet, the maximum 5,200 feet, and the average 2,500 feet. The minimum overburden on the top of the Luman is 1,600 feet the maximum 5,600 feet, and the average 2,900 feet.

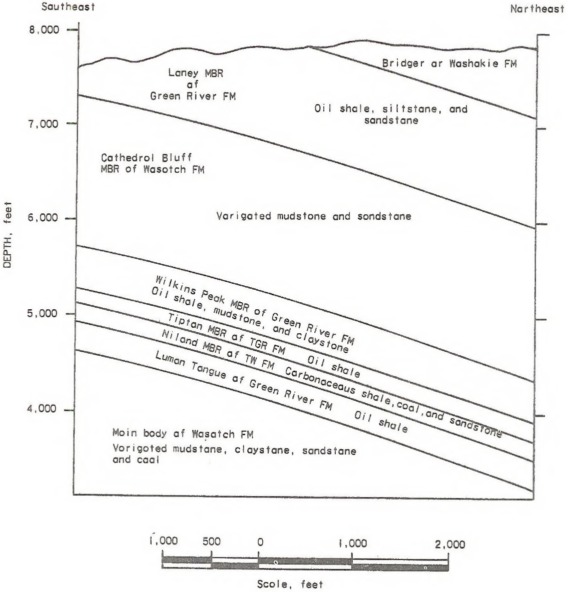


FIGURE II-27. Generalized Section far Tracts W-a and W-b

d. <u>Water Resources</u>

Tracts W-a and W-b. Ground water hydrology of the region in which the tracts occur is cursorily described in a report by Welder and McGreevey (1966). Water occurs above, below, and probably in the shale, and deep water is under artesian pressure. Permeabilities of the aquifers probably are low.

Chemical quality of the ground water in the Laney Member near the tracts is good, having a dissolved-solids concentration of less than 1,000 mg/l. No data are available on water quality on the deeper members and the aquifer characteristics of all the oil shale beds are unknown. Yields from wells will probably be small.

Streamflow in the vicinity of the tracts is intermittent and is dependent largely upon snowmelt and runoff immediately after storms. Small amounts of ground water are discharged from a few springs. Water supply for development of Tracts W-a and W-b could be obtained from Flaming Gorge Reservoir about 50 miles west of the tracts, of from Fontevelle Reservoir by diverting at a point on the Green River about 45 miles northwest of the tracts.

e. <u>Wildlife</u>

Tracts W-a and W-b. Despite the rather harsh conditions presented on the high, northern desert habitat, a broad variety of wildlife species utilize these tracts on Kinney Rim intermittently, seasonally, or on a yearlong basis. Included are mule deer, antelope, wild horse, mountain lion, coyote, bobcat, rabbit, sage grouse, dove, eagle, and hawks, as we-l as numerous small bird and mammal species. No angling habitat exists on the tract.

f. Soils

Tracts W-a and W-b. A general soil map of Sweetwater County is shown in Figure II-28. The soils of the tracts are classified as Haplargids, Torriorthents and Salorthids. They are developed on high dissected plateaus of the Green River, Bridger, and Wasatch Formations. Slopes range from nearly level, moderately sloping (75 percent of the basin), to steeply sloping (20 percent of the basin). Soil textures vary from sandy, loamy to clayey.

Sixty percent of the soils in the basin are estimated to be shallow, less than 20 inches to bedrock; the remainder of the soils are moderately deep to deep. Erosion hazards are generally moderate to high. Wind erosion is moderate to high. Wind erosion is more of a problem than water erosion because of the low rainfall--10 to 14 inches. Soil reaction is commonly alkaline to strongly alkaline.

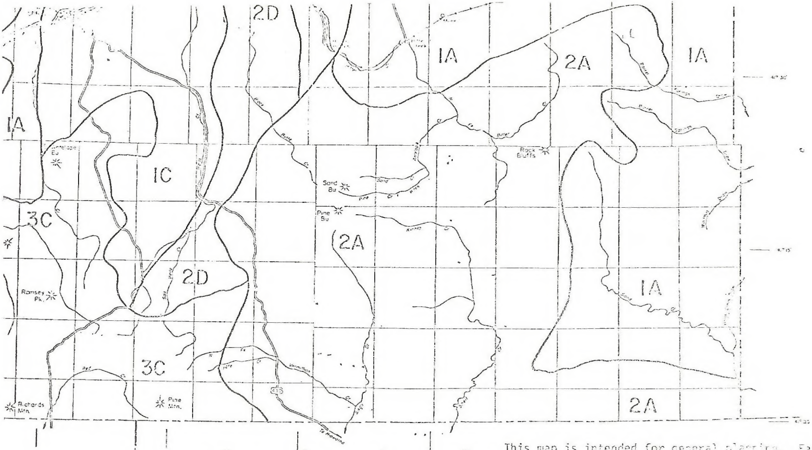


Figure II-28. GENERAL SOIL MAP

SWEETWATER COUNTY

(PORTION - Oil Shale Tracts)

WYOMING

OCTOBER 1970

5 0 5 10 15

This map is intended for general planning. Each delineation may contain soils different from those shown on the map. Use detailed soil maps for operational planning, and on site inspection for more detailed decisions.

Soils of Residual Uplands: Elevation 7,000 to [illegible] feet: Precipitation 10 to 14 inches

2A Washakie Basin; Delaney and Kenney Rims
2B Pilot Butte-White Mountain-Fire Hole Canyon
2C Lost Soldier-Twin Buttes
2D Black Buttes
2E Batrum-Pinch Basin

See following page for number designations.

Land types such as shale badlands and sand dunes also occur in the basin.

Tracts W-a and W-b.-- Important plants occurring in these tracts are:

Big sagebrush

Black sagebrush

Mountain mahogany

Bluebunch wheatgrass

Thickspike wheatgrass

Gardner's saltbush

Western wheatgrass

Indian ricegrass

Shadscale

Sandberg bluegrass

Greasewood

Alkali sacation

g. Grazing

Tracts W-a and W-b. Sheep belonging to two operators use the tracts during the late fall, winter and spring. Cattle belonging to one operator use the area during the summer and fall.

There is very little potential for additional livestock forage production except through (1) water development to improve distribution and (2) limited vegetative manipulation by seeding or sagebrush spraying.

The major livestock-oriented problem is lack of water for proper distribution. There are several springs in the immediate area, primarily along the east slope of Kinney Rim. Stockwater reservoirs are widely scattered throughout the surrounding area, therefore existing watering areas are very important.

Any damage to this water source as a result of oil shale development, either to the ground water supply or contamination of the surface water, would result in serious effects on livestock and wildlife use.

h. Aesthetics

Tracts W-a and W-b. The aesthetics attraction of the basin is the land form; notably the Kinney Rim escarpment, which extends for about twenty miles, uncluttered and semi-remote in character. The area is sparsely inhabited and only few primitive roads exist.

i. <u>Recreation</u>

Tracts W-a and W-b are situated in a remote, undeveloped area having semi-primitive characteristics. The area is attractive for sport hunting, rock collecting, camping and general sight-seeing. Access is by roads originating at Interstate 80 approximately 25-30 miles to the north, from Wyoming State Road 430, about 15 miles west of the tracts, or from Powder Wash, Colorado, 15 miles southeast of the roads.

It is estimated that, despite the sparsity of surrounding human populations, and the absence of all-weather access, a total of several hundred man-days recreational use are expended annually within tract boundaries.

j. <u>Archaelolgical and Historical Values</u>

Tracts W-a and W-b. The Kinney Rim area is in the heart of the historic Wind River Shoshone and Commanche country. Indications are that compsite and animal kill sites might be found in the area dating from present to historic times back some 10,000 years or more.

There are presently no known archaeological or historic sites on the tracts.

The National Register of Historic Places lists no sites in Sweetwater County, Wyoming.

k. Socio-Economic Status

With the exception of unimproved roads on Tracts W-a and W-b, there is no existing economic development on the tracts. See Volume I of this Environmental Statement for a description of the area.

III. Mining and Processing Options on Selected Tracts

Volume I Section I, of this Environmental Statement outlined the technology generally available for oil shale development. The Oil Shale Field Task Force has inspected each nominated tract and has analyzed the data largely developed during informational core drillings. This section contains best estimates of the manner by which each tract may be developed. Subsequent chapters of this volume examine the environmental consequences of such development.

Three systems of processing are considered to be technically feasible: (1) Underground mining-surface processing, (2) surface mining-surface processing, and (3) in situ processing. Each of these is examined below.

A. Mining, Surface Processing Systems

The flow of materials through a mining, surface-processing "typical" 50,000 barrels per day plant is shown in figure III-1. Details of that system are presented below for the "typical" system---subsequent sections of this chapter will examine specific resource requirements for a specific tract. In situ processing is discussed separately.

1. Underground Mining

A conceptual view of the entire system is shown in figure III-2. It is assumed throughout that processed shale that cannot be backfilled into mined-out areas will be placed in a suitable manner in box canyons as shown in this drawing. The Mahogany zone and, where feasible, the lower zone would be mined using the room-and-pillar method on those tracts in either Colorado or Utah.

The detailed diagrams and discussions that follow are necessarily based on an assumed design and set of conclusions for an oil shale complex. This approval was adapted for purposes of illustration; however, it is recognized that actual operations, if they do eventually occur, very probably will vary in details from the "typical" system in regard to processes and procedures used, flow rates, yields, and in other engineering details.

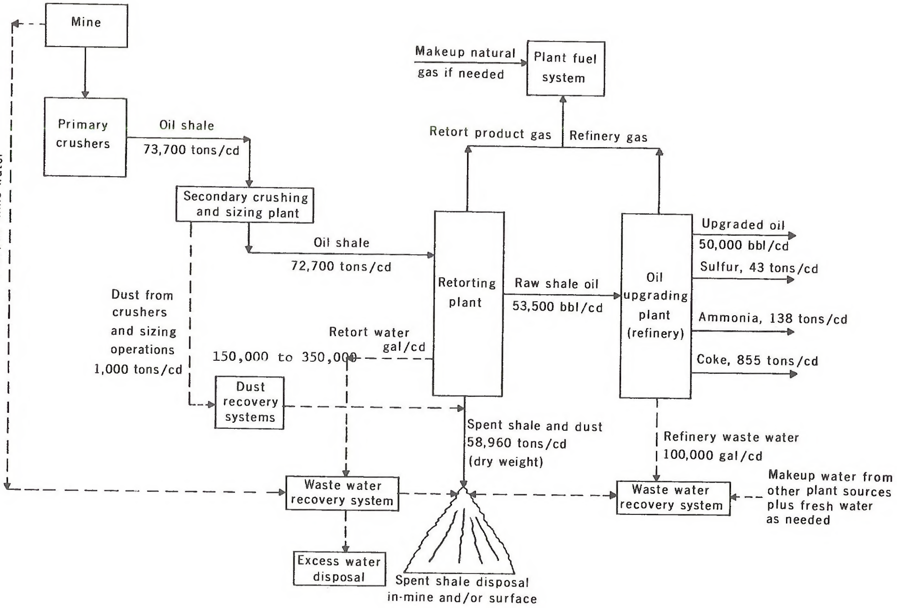


Figure III-1.-Flow Diagram of 50,000 Barrel Per Calendar Day (cd) Underground Oil Shale Mine and Processing Unit

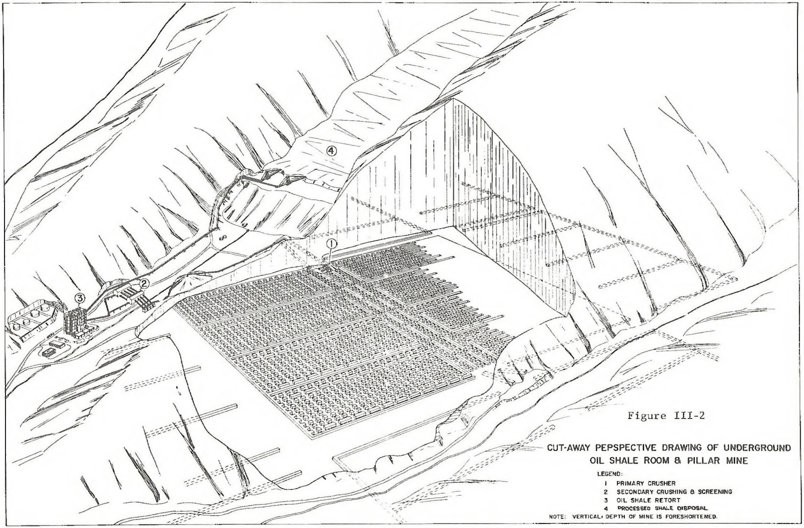


Figure III-2

CUT-AWAY PEPSPECTIVE DRAWING OF UNDERGROUND OIL SHALE ROOM & PILLAR MINE

LEGEND:

1 PRIMARY CRUSHER
2 SECONDARY CRUSHING & SCREENING
3 OIL SHALE RETORT
4 PROCESSED SHALE DISPOSAL

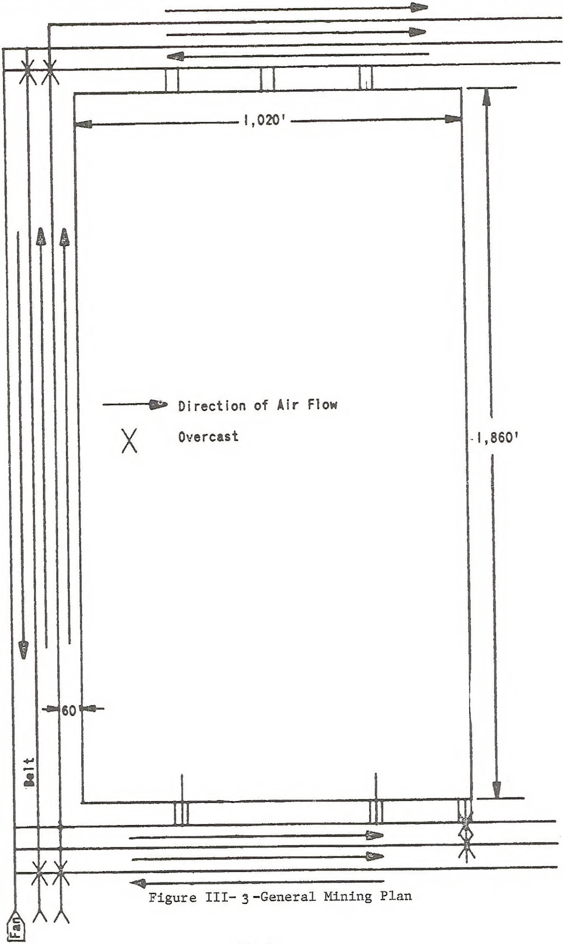
NOTE: VERTICAL DEPTH OF MINE IS FORESHORTENED.

Entrance to the working area would be gained by 4 vertical concrete-lined shafts 20 to 30 feet in diameter. Each would be about 1,500 feet deep located near the center of the tract and sunk to about 150 feet below the bottom of the lower shale horizon. This would provide space for the sump, surge bins, and skip pockets. Dewatering wells and/or grouting would be used to reduce water flow into shafts and shaft stations. Shaft pillars would be designed to protect the installations from the effects of possible ground movement and/or ground subsidence. Percentage extraction is estimated to be 60 percent of the oil shale in place in the Mahogany zone.

A system of main heading, 30 ft. wide by 31 ft. high with 60 ft. barrier pillars between headings would be driven on the top heading level to connect the shafts (figure III-3). The center heading would be for the belt conveyor, and the other 2 headings would be for ventilation and for transportation of mine personnel, supplies, and equipment.

The general mining plan would be to mine one side of the mine on the advance to the tract limits and to mine the other side of the mine on the retreat. With this system, full production (73,700 tons/day) would be achieved within the shortest time. Development headings would also consist of 3 entries which would be identical in size and function to the main headings.

Production panels would be mined by a 30-foot-high-heading and a 20-foot-high-bench. Rooms and pillars would be 60 ft. wide. (Figure III-4). Ramps would provide access from haulage level to bench level.



$^1/_4" = 60'$

Figure III- 3 -General Mining Plan

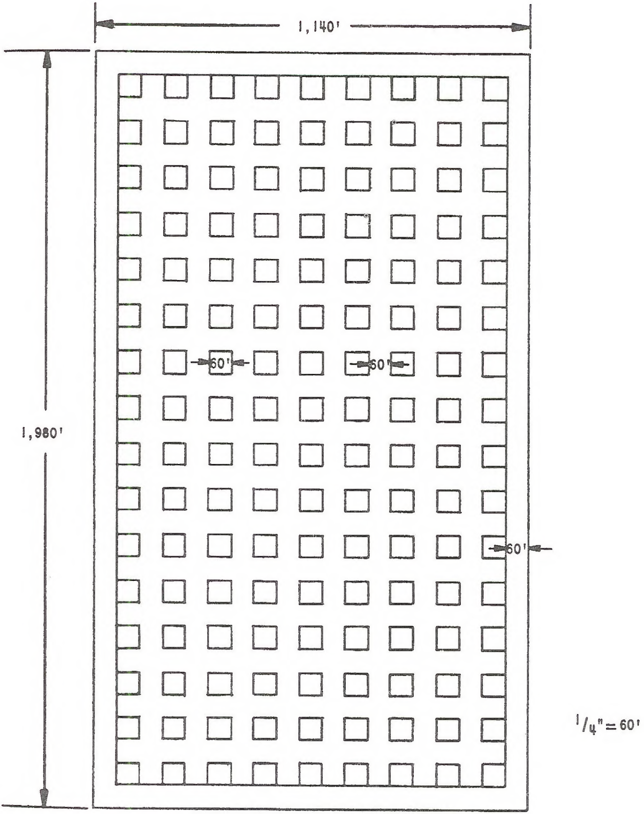


Figure III- 4.- Plan View of a Panel

Heading or benching rounds would be drilled with drill jumbos using percussion, rotary, or rotary-percussion drills. Rounds would be blasted with ANFO-type explosives and the broken shale loaded into diesel-powered trucks with front end loaders. Trucks would haul the shale to portable crushers at the panel entrance where it would be reduced to minus 10.5 inches. Crusher discharge would be carried by a 60-inch conveyor belt; dust from mining and primary crushing operation would be controlled by water sprays.

The roof would be supported by rock bolts. Size and spacing of these supports would be determined by on-site tests as would be the size of barrier pillars between panels and main headings. Sixty-foot pillars are chosen for the purpose of this estimate.

Ventilation requirements would be determined by measurements of air volumes, pressures, velocities, dust, and noxious gas content. For the purpose of this example, two 1 million cfm fans were located underground in the intake shafts. Air would be exhausted through the shale-hoisting shafts. Direction of ventilation air flow would be controlled by doors, regulators, overcasts, and bulkheads. Mined-out production panels would be backfilled with processed shale and bulk-headed off.

Crushed shale would be transported by the 60-inch main haulage belt to underground surge bins having a capacity of about 50,000 tons. Shale from the surge bins, would be fed to skip pockets from where it would be hoisted in skips to secondary crusher feed bins on surface.

Methods for mining the lower zone will have to be developed, although some modified form of the room-and-pillar system is envisioned.

A barrier or sill pillar would be left between the mining horizon and the overlying leached zone to reduce the inflow of ground water. The mining layout, size and location of rooms and pillars would have to be developed. Because of the depth and the need for barrier pillars, percentage extraction is estimated to be 50 percent of the oil shale in place.

By 1975, it is assumed that shafts have been completed and mining of the main headings begins in the Mahogany zone. By 1978, full production (73,700 tons day) is reached. To maintain full production from the Mahogany zone with an extraction ratio of 60 percent will require that an area with a radius of about 1 mile be mined in about 5 years.

Mining of the lower zone would start below the mined-out section of the Mahogany zone in 1978 and would reach a maximum of about 63,000 tons/day by 1988. The remaining 10,700 tons per day needed for full production would be produced from the Mahogany zone which will enlarge the mine area at the rate of about 1/8 acre per day.

About 60 percent of the processed shale could be back-filled. This offers several advantages over surface disposal; it reduces the impact on the surface environment and would help stabilize the mine structure. Backfilling the mined out openings would therefore reduce hazards from subsidence and reduce ground movements which might increase inflows of ground water. If mined-out areas are not backfilled, surface subsidence can be expected to be of larger magnitude, and possible disruption of natural surface drainage may occur.

When backfilling, processed shale could be mixed with water and pumped in the form of a slurry through pipelines for disposal in mined-out, underground areas. Main pipelines would move the slurry at a velocity that would hold the solids in suspension and plastic pipelines would deliver the slurry from the main lines into the abandoned mining panels. As the slurry is discharged away from brattice-covered timber dams, solids in the slurry would settle out.

Drain water would be collected and pumped to setting sumps near the shafts, then pumped to the surface where it could be reused in the slurry operations.

2. Suface Mining

Of the selected tracts, only Colorado Tract C-a is believed to be amenable to surface development. The mining plan for this hypothetical mine was therefore developed around the specific characteristics of that tract and scaled to a production level of 100,000 barrels per day.

On this tract, the mine would be restricted to the tract limits and the ultimate pit slope was assumed to be 45 degrees. A development plan for a mineral property of the size being considered would require extensive, detailed engineering studies of the type normally used for actual commercial mining. For the purpose of this analysis, general assumptions were made about the pit plan and mining operations in order to estimate the impact of similar open pit mining operations.

Overburden ranging from about 100 ft. to 800 ft. in depth and averaging 450 ft. totals an estimated 7.1 billion tons for a pit laid out with a 1:1 final average slope (45 degrees). Of this amount, about 256 million cubic yards of loose waste material could be disposed offsite in Water Gulch which lies to the west of the tract. While this area has been delineated as a possible disposal site, it is not intended to conclude that Water Gulch will be used. Prior to selecting disposal sites, detailed engineering, geological and environmental studies would be conducted and submitted for approval. Because of the thickness of overburden in this area, future mining of oil shale would probably be by some type of underground method. After about 16 years, sufficient space would have been mined out in the pit to allow room for pit disposal of the overburden.

Because the economic operations are not clearly defined at present, the cut off limit for oil shale grade cannot be determined until actual operations commence. Since oil shale assaying less than an assumed economic grade of 30 gallons/ton will need to be excavated as the pit is opened up, grades that are not considered of economic value at present could be separately stockpiled in a manner that they could be recovered, blended, and processed at some future time.

Total tonnage of shale of 30 gallons/ton or more of lower grade oil shale, and of waste rock is estimated at 11.8 billion tons. Of this, about 52 percent would be oil shale of 30 gallons/ton or more.

Because of the depth of overburden, sufficient time must be allowed for initial pre-stripping of overburden in advance of actual production of oil shale. Further, the initial pit must be laid out so that several bench levels can be developed to provide enough working faces to meet daily production rates (figure III-5). Because of these considerations, mine production would start well in advance of processing; a large amount of bench-development oil shale would be stockpiled for recovery as processing requirements expand.

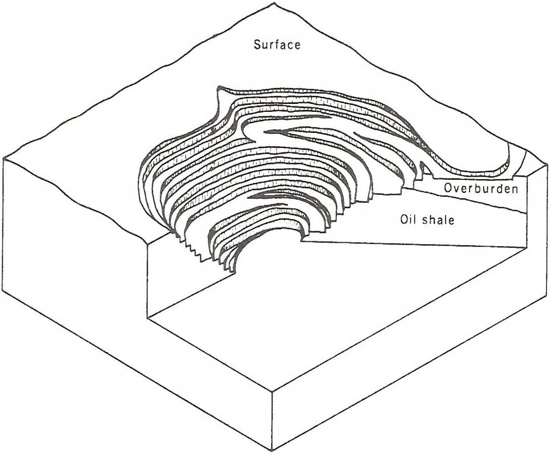
Initial pre-stripping down to the Mahogany zone would amount to about 150 million tons of overburden, which would require an average rate of 30 million tons per year or a rated capacity of 82,000 tons per day.

A 1:1 final average slope (45 deg) and about a 1.4:1 average working slope (35 deg) were selected for the conceptual pit. Bench height was 40 ft and minimum width of operating berm was 110 ft. This matches well with a 15 cubic yard electric shovel and 55 ton diesel-electric rear-dump truck combination.

Much of the overburden and all of the oil shale would probably need to be drilled and blasted. Crawler rotary drills powered by diesel engine-generators would be used to drill blast holes of about 9 7/8 to 12 1/2 inch diameter. Blasting would be with ANFO type explosives.

Initially, the overburden and waste rock would be hauled by truck to the disposal area. After about 16 years, when space became available, waste would be backfilled into mined-out areas of the pit.

Blasted pit-run oil shale would be hauled to primary crushing



Isometric

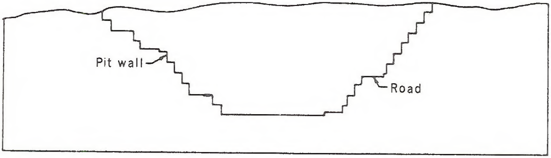


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Figure III-5.-Schematic Open-Pit Development stations in the pit. Each station would consist of a truck dumping hopper, grizzly, vibrating grizzly feeder and a large gyratory crusher. Crushed oil shale would be fed to a 60-inch slope conveyor belt. Two or more conveyor-crusher units would probably be required. Other conveyor systems beyond the pit limits would transport the material to the processing complex, stock-pile and waste areas.

Benches 40 ft high would be mined by shovels in 40 foot cuts; about 1600 cubic feet of material would be available for each foot of advance. At 14 cubic feet/ton, about 114 tons would be available per foot. Assuming that a 30-day supply of oil shale should be maintained for mining ahead of the shovels, about 1 foot of ore face should be available for each 4 to 5 tons of production. Taking the higher factor of 5 tons and an average production of 147,400 tons/day, advance stripping must proceed until about 29,000 feet of oil shale face can be maintained in advance of the shovels.

Surface disposal off site[1/] in the dry canyons immediately west of the Cathedral Bluffs would be feasible, and for the purpose of this illustration, was chosen as the disposal area. From 2.36 to 2.74 million cubic feet per day of the processed shale could be moved as a processed shale-water slurry in a gravity pipeline extending from the plant site and through a tunnel to the lower ends of canyons selected for filling. Figure III-6 shows a schematic of the conceptual disposal system. Processed shale at the rate of

1/ Off-site disposal of overburden or spent shale might take place on Federal State, or private lands. Permission to use Federal lands for disposal would require a special Land Use permit, issued by the Secretary of the Interior. Under 43 CFR 2920.4 "each permittee will be required to pay to the Bureau of Land Management, in advance, a rental determined by the authorized officer as the fair market value of the privileges granted". Disposal on State or private lands would similarly be an expense to the lessee. The cost of shale oil will thus reflect the cost of any off-site disposal.

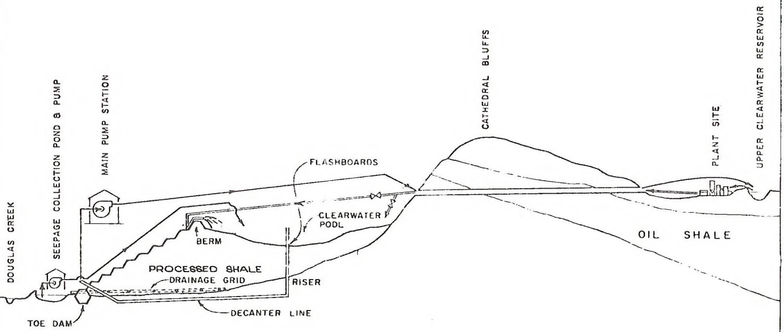

Figure III-6.-Processed shale disposal system cross section schematic

118,000 tons day would be crushed. screened and slurried (about 50 percent solids) at the plant site, and pumped into the primary disposal pipeline (50-in. I.D. reinforced concrete pipe).

A small earthen dam would be constructed near the mouth of a dry canyon and a smaller impoundment dam would be built below to contain seepage and runoff water. The slurry of processed shale and water would be discharged behind the first dam until the material had been built up to the crest. Then, a second berm would be built above the filled-in area (the pipe discharge system relocated) and the process repeated until the slurry would be deposited behind the dam where the solids would settle out and the water (with dissolved solids) would be pumped back to the plant site for reuse in the slurry.

The moisture content of the processed shale in the dam should reduce to about 20 percent by weight or less through drainage and desiccation. Compaction to a dry density of about 90 pounds per cubic foot could be reached. This would be about optimum for maximum dry density as measured by the standard proctor compaction test. Formation of a natural pozzolana-cement type compound in the processed shale should aid in reduction of leaching.

Because flash floods may occur, a system of dams and canals would be necessary to intercept fresh runoff water and route the water around the dam for discharge into Douglas Creek.

During the life of the mine, the volume of processed, compacted shale would fill several canyons. As one canyon was filled, disposal would begin in the next canyon. Revegetation of the first canyon would begin as soon as the disposal process was completed.

Seepage water from the disposal dam would be collected in the seepage collection pond (below the toe dam) and pumped to the main pond.

Clear water, decanted from the surface of the tailings pond would be fed through a system of vertical risers and decanter lines to a major pump station from where it would be pumped to a reservoir at the plant site for re-use.

An estimated 8 to 13 cubic feet per second of water could be required for this system of disposal.

3. Crushing, screening and briquetting

A schematic diagram of the crushing, and screening operations is shown as figure III-7. The run-of-mine shale is conveyed directly to the receiving hoppers at the crushing plant. The underground concrete hoppers are sized to provide 24-hour surge storage. The shale from the bottom of the hopper is conveyed to the primary crusher feed bin at a rate of 3070 tons per hour. Conveyors, 48 inches wide and 200 feet long, are required. The shale is dumped into three parallel storage bins the shale is fed by magnetic vibratory feeders to the primary gyratory crushers where the size of the shale is reduced to minus 10.5 inches. The crushed shale is conveyed to underground surge bins sized for 24-hour holdup.

The shale from the bottom of the surge bins is transported to the secondary crusher feed bins on 48-inch wide belt conveyors.

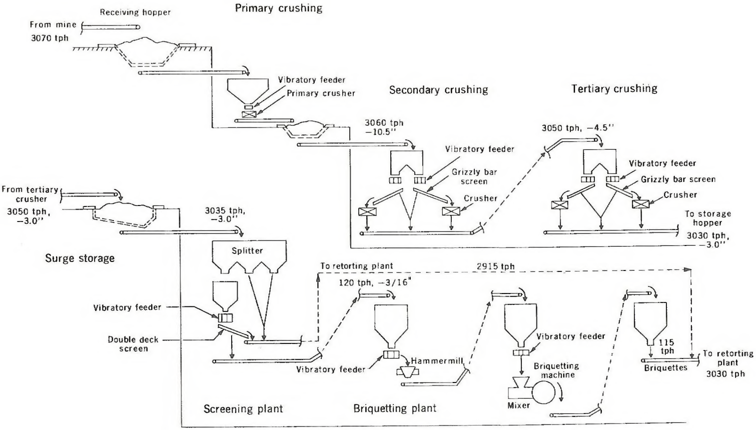

Figure III - 7.- Crushing, Screening, and Briquetting Plants, Schematic Flow Diagram (Two Identical Plants)

The shale at a rate of 3060 tons per hour is fed from the storage bins to double hopper feed bins in the secondary crushing system. From each surge bin the shale is fed by magnetic vibratory feeders to the vibrating grizzly bar screens. The minus 4.5 inch material (47 percent of the total) falls through the screen to the product conveyor from the secondary crushers. The shale is then conveyed back under the screens, picking up the material that originally passed through the vibrating grizzlies, and is transported to tertiary crushing.

Three feed hoppers in tertiary crushing receive the shale. Magnetic vibratory feeders are used to feed the vibrating screens; the minus 3-inch material is screened out and falls on the product conveyors from the tertiary crushers. The plus 3-inch material (35 percent of the total) then feeds to the tertiary crushers where it is reduced in size to minus 3 inches. The shale is then transported by the return conveyors, picking up the material that passed through the 3 inch screens, to the main conveyor and is conveyed to surge storage hoppers (3-day holdup).

From the surge storage hoppers 3035 tons per hour of shale is fed to the splitter in the screen house. Sixty-five percent of the shale by passes the screens and feeds directly to the surge vin for feed to the retorting plant. The double-deck screens (in parallel plus one spare) remove the minus 1-inch material on the top screen and minus 3/16 inch material on the bottom screen. The screens are fed by vibratory feeders. The shale from the top of the screens feeds to the conveyor that ransports the bypass to the retorting plant and the fines from the screens, 3025 tons per hour, are conveyed to the briquetting plant.

The overall dust losses in the crushing and screening operations are estimated to be 1.3 % of the shale handled. Half of this loss is assumed to occur in crushing and transporting and the balance in screening.

The fines are conveyed to the briquetting surge bin No. 1 on a 20-inch belt conveyor. This fine shale is then fed to vibratory feeders to two parallel hammer mills where it is reduced in size to minus 14-mesh. From the mills the shale is conveyed to surge bin No. 2. A vibratory pan feeder is used to feed the milled shale to two parallel double-paddle horizontal mixers where it is mixed with crude oil which serves as a binder. From the mixers the material flows by gravity into the briquetting machines.

The briquettes are moved by conveyor to a surge bin and then are conveyed back to theretort feed system (see figure III-8).

4. Retorting

The retorting plant (comprised of 12 individual, 56-feet diameter retorts) would be located in close proximity to the mine mouth. A schematic of an individual retort is given in figure III-8.

The shale from the 3-hour surge bins and the briquettes from the briquetting plant are fed to the retort feed hoppers, atop the retorts,

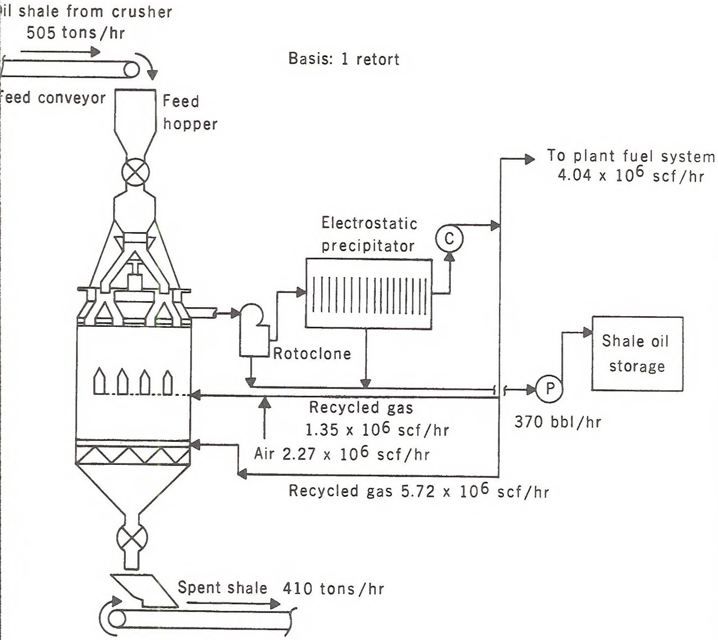

Figure III-8 Schematic Flow Diagram of Retorting System

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using belt conveyors equipped with automatic trippers to feed the individual retorts.

For 100,000 bbl/day shale oil production, twelve retorting plants each process 505 tons per hour of shale and briquettes and produces 370 barrels per hour of crude shale oil, 4.04 million standard cubic feet per hour of excess low heating value gas (about 100 Btu/cubic foot), and 410 tons per hour of spent shale.

The shale bed in the retorts is maintained at a depth of approximately 18 feet. The fresh feed at the top of the unit is preheated by the off gases from the retort combustion zone. The shale, at a rate of 500 pounds per hour per square foot of cross sectional area, moves through the preheat zone of the retort. The combustors, located near the midpoint of the shale bed, are fired with recycled low Btu-gas burned with air to heat the shale to the maximum temperature of $1,700^{o}$ to $1,800^{o}$ F.

About 82 percent of the recycled gas is fed to the bottom of the retort and is utilized to cool the spent shale to about 200^{o} F prior to discharge. The remainder of the recyled gas with the combustion air is fed directly to the combustor.

The gases from the top of the retorts, with entrained crude shale oil, flow through rotoclines and electrostatic precipitators for separation of gases and oil. The crude is then pumped to storage tanks located at the retorting site. The low Btu gas is compressed for recycle and for use as fuel, elsewhere within the processing complex.

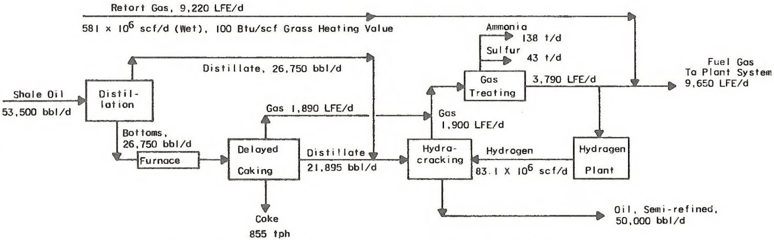
The crude shale oil (370 barrels per hour) flows from each retorting plant, by pipeline to upgrading storage tanks.

5. Upgrading

Upgrading the shale oil would be similar whether surface mining or undergound methods were employed. A 50,000 barrel per day is described, therefore the values would need to be doubled for a 100,000 Barrel per day plant. The crude oil from storage is heated in a tube still and then charged to a distillation column (see figure III-9). The crude charge is separated into a heavy fraction and vapors, these fractions being approximately equal in quantity. The overhead product (vapor) is cooled and depropanized to yield a distrillate product, (26,750 barrels per day). The uncondenses gases, consisting of C_3 and lighter gases, are utilized as described later.

The bottoms (heavy fraction) from the distillation columns are fed through a heater to the delayed coking units. The feed is preheated to about 940° F prior to being charged to the drums. The distillate product from the coking units is cooled and depropanized and then, together with the distillation overheads, is charged to hydrogenation. The coke from the drums, 855 tons per calendar day, is stored for sale. The hydrocrackers operate at 835° F and 1,500 psig and produce a product containing about 60 volume percent material in the gasoline boiling range. The uncondensed gas is used for plant fuel. The liquid hydrogenated product, having a gravity of about 42° API, is pumped to storage as the major sales product.

The gas streams from the hydrogenation, delayed coking, and distillation units contain the sulfur and nitrogen available for recovery, the recoverable materials being in the form of hydrogen sulfide and amonia. The streams are processed as follows: An ammonia-water wash is used to remove the hydrogen sulfide from the coker and distillation gases, and a water wash is used to extract the ammonia and hydrogen sulfide



1/ LFE is Liquid Fuel Equivalents With Gross Heating Value 6.3 X 10^6 Btu

FIGURE III-9. 50,000 Borrel Per Calendar Day Refinery from the hydrogenation gas. The combined ammonia-hydrogen sulfide-water solution is then heated to 170° F to drive off the hydrogen sulfide which is scrubbed with sulfuric acid to remove traces of ammonia. The hydrogen sulfide is reacted with air in a Claus kiln to form sulfur which is recovered as a hot liquid and stored for sale. The ammonia-water solution is pressurized to 230 psig and heated to 330°F to liberate the ammonia, which is cooled, condensed, and stored for sale in liquid form.

About 89 percent of the washed gas from the gas treating plant is steam reformed to produce the hydrogen needed for hydrocracking. The gas used for hydrogen generation is converted to produce 76 percent of the hydrogen theoretically available with complete conversion of the gas. Using methane as an example (other hydrocarbons in the coker gas react in an analogous manner) the conversion involves two steps:

$$CH_4 + H_2O \longrightarrow CH + +3H_2O \qquad (1)$$

$$CO + H_2O \longrightarrow CO + H_2 \qquad (2)$$

with the overall result being:

$$CH_4 + 2H_2 \longrightarrow CO_2 + 4H_2 \qquad (3)$$

The first reaction takes place in tubes at 50 psig and 1,400° to 1,500° F using a nickel catalyst and an excess of steam. The endothermic heat of reaction is supplied by burning retort gas in the furnace surrounding the tubes. The hydrogen yield then is increased by catalytic water-gas shift conversion at 800°F, as illustrated by equation (2) above. A hypersorber is used for hydrogen purification before compression and introduction to the hydrocracking unit.

Product oil would be shipped to a final processing facility through a 12 inch pipeline.

B. In Situ Processing

A conceptual plan for 50,000 barrels per day commercial operation has been presented in Volume I. Specific application of this concept is included in the description of the tracts where this technique may be applicable and would involve the flow requirements shown in figure III-10. However, it should be noted that in situ processing is in the experimental phase of development and there is no assurance that commercial technology can be developed.

C. Personnel Requirements

The number of shale industry employees for a given tract is determined by the processing system used and the level of production. For the three processing systems previously mentioned, it is believed that the following sequences of direct industry employment will apply.

1. Underground Mining and Surface Processing (50,000 Barrels per day Production).

During the first three-years of application of this system on a given tract an estimated 200 employees would be required for pre-commercial field investigations and process design. The commercial construction and development period, lasting about thirty-six months, would require an average of about 1,000 employees. At steady state, full-scale, commercial operation, an estimated 1,300 permanent employees of all types would be needed.

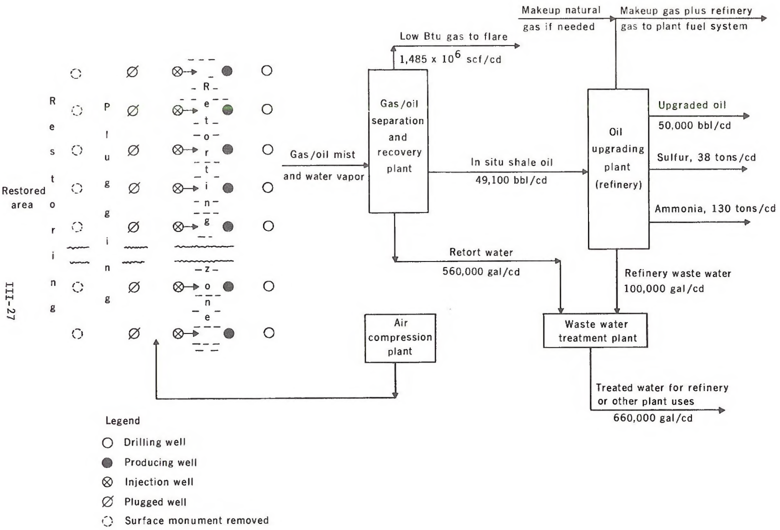


Figure III-10. Flow Diagram of 50,000 Barrel Per Calendar Day In Situ Recovery System

2. Surface Mining and Surface Processing (100,000 barrels per day Production).

During the initial three-year term of a surface mining operation on a lease, about 200 employees would be required for preconstruction field studies and design. The commercial construction and development period, which would extend thirty-six months would involve an average of about 1,400 employees, with a peak as high as 1,700. Approximately 1,800 permanent employees will be required if and when steady state commercial operation is finally attained.

3. In Situ Processing (50,000 barrels per day production).

For the first year of the lease, an estimated 100 employees will be required for field investigations and process design. During the construction period, lasting approximately 36 months, employment will average about 600 employees. If commercial operation is attained, employment will approximate 1,500 employees.

D. Development Requirements

In the sections to follow, the development of each of the six selected tracts is examined with respect to applicable processing options. Included in this evaluation are the mining, rates of productions of oil and process wastes, methods of waste disposal, services and roads required and their location, and land surface areas which might be used. These are the essential technical parameters which describe the on-site and related off-site activities that could be expected on each tract. They provide the basis for the assessment of the environmental impact of the proposed leasing program upon the six sites and surrounding region, as set forth in Part IV.

Common to each of the tracts is the need for oil storage, pipelines, power and access roads. The impact of these on the environment would be similar, the magnitude being determined by their size, length, and probable route. These "common" factors are set forth in table III-1. and will not be repeated for the specific tracts.

1. Wyoming Tracts W-a and W-b

Two adjacent tracts, W-a and W-b, have been selected for leasing in Wyoming. Only one technical option, in-situ recovery, has been considered for the extraction of shale oil from these tracts because of the nature of the shale resources available. No specific environmental differences were discovered during field investigations; therefore the impact's on these adjacent tracts have been considered together in subsequent chapters of this Volume.

1. In Situ Processing Systems

In situ retorting of oil shale contemplates removal of oil from the shale in place, by heating the shale while it is underground. Various means of supplying or creating heat have been tried or proposed including underground combustion, heated natural gas or carbon dioxide gas, superheated steam, hot solvents, and combinations of the above.

A number of experiments attempting to conduct in situ retorting through wellbords from the surface have been investigated in field experiments during the past 20 years, by both industry and government.

Table III-1. Summary of utilities and facilities for the 6 tracts

Area	Tract	Power	Natural Gas	Water	Oil Pipeline	Storage	Roads
Colorado	Ca 100,000 B/CD Surface mine	200 Megawatts generated on site	18" pipeline extension one-mile away	Approximately 17 cu ft/sec from in-place ground water. Construction of 6 miles 18" pipeline	18" pipeline extension to existing line at Rangely	Steel Vessels 80 acre requirement	Rifle, Colorado would probably serve as the railhead. Access to the site will be from the Piceance Creek road to Ryan Gulch; thence south and west some seven miles on the Ryan Gulch road; then north and west to the 84 Ranch; and from this point, west to the mine site Widening, paving, and straightening of some 15 or 16 miles of road will be required. Alternate routes may be developed from the Douglas Creek road, which would provide more direct access to Grand Junction.
	Cb 50,000 B/CD Underground mine	100 Megawatts generated on site	12" pipeline construction 6 miles from Little Hills Triangle	Approximately 8.5 cu ft/sec construction of 16" pipeline, 30 miles long	40 miles 12" line to Rangely	Steel Vessels 40 acre requirement	Ingress to the tract from the Piceance Creek road is currently blocked by patented lands along the creek bottom, but BLM is attempting to secure entry permission via Scardard Gulch. Access is therefore assumed via this road, which must be widened and paved. In addition, a heavy duty bridge will be required across Piceance Creek.
Utah	Ua and Ub 50,000 B/CD Underground	100 Megawatts generated on site	12" pipeline construction 15 miles to Bonanza, Utah	Approximately 8.5 cu ft/sec construction of a 10 mile 16" pipeline to the White River	6 miles construction north of the tract 12" pipeline	Steel Vessels 40 acre requirement	There is a paved state highway to Bonanza. From there it will be necessary to build eight miles of primary roads and a bridge across the White River.
Wyoming	Wa and Wb 50,000 B/D In-Situ	50 Megawatts generated on site	12" pipeline construction 30 miles south of tract	Approximately 3 cu ft/sec construction of 50 miles 10" pipeline west to either the Flaming Gorge Reservoir or the Fontonelle Reservoir	Construction of 35 miles of 12" pipeline, northeast to Patrick Draw Oil field	Steel Vessels 40 acre requirement	Improved vehicular access to the tracts would involve development of 25 miles of improved road connecting to either Interstate Highway 80 to the north, or Wyoming State Highway No. 430 to the West.

Two major problems to date with this approach have been:

(1) Insufficient naturally occurring permeability, or failure to artificially induce sufficient permeability to allow effective heat transfer and passage of gases and liquids; and

(2) Inability to remotely control the process with sufficient accuracy through wellbores from the surface. Besides surface wellbores, other methods proposed for introducing heat underground include mine shafts, tunnels, and fractures created by a variety of techniques.

A commercial in situ processing system has not yet been demonstrated. Additional field-scale operations are needed, since it is quite difficult to design meaningful laboratory-scale experiments. Such field tests can be conducted on Wyoming Tracts W-a and W-b, as well as on others of the six selected lease sites.

Because of the more experimental current status of in-situ oil shale technology, it is expected that a longer period of development time will be required before commercial level production might be shown to be feasible and subsequently attained.

In situ processing systems technology could involve surface injection from the injection wells, in which heat is introduced underground from the injection wells the shale retorted in place, and the oil pumped to the surface through production wells.

The pertinent technical parameters for in-situ processing on either of the two Wyoming tracts are summarized below. The figures given are for a combined production of 50,000 barrels of upgraded shale oil per day from tracts W-a and W-b.

Production Rates (probably not until at least 6th year of the leases): 50,000 barrels/day of shale oil. Land surface required; 50 acres.

To illustrate the dynamic nature of an in situ project, consider the two tracts in Wyoming. It is estimated that these two tracts will require 100 wells/row which are to be drilled on a monthly basis, figure III-11 Five rows of wells will comprise various phases of the ongoing project, with ongoing activities including the retorting itself, preparations for the next series of wells, and restoration. This active area will cover 115 acres which will be continuing to move as new wells are drilled and old ones plugged prior to removing the surface monuments for purposes of restoration. It will take about 3 years to fully restore the area; therefore, 835 acres will be in some phase of restoration while 115 acres will have active drilling, plugging, etc. The cumulative land which will be disturbed with time is shown in Table III-2. At the end of 20 years this world include 600 acres for acess roads and utilities, 50 acres for surface facilities, 115 acres for well activities and 835 acres undergoing restoration.

(2) Colorado Tract C-a

Three technical options are considered below for extraction of shale oil (and possible associated minerals) from this tract. Based upon available technology these are: Underground mining and surface processing; and in situ processing by surface well extraction. To illustrate these technical options along with the cumulative land requirements, an analysis has been constructed as shown in Table III-3.

(a) Underground mining and surface processing.

Both industry and the Bureau of Mines have demonstrated the feasibility of the room-and-pillar method for mining oil shale in the Mahogany Ledge zone. Methods for mining the lower zone would,

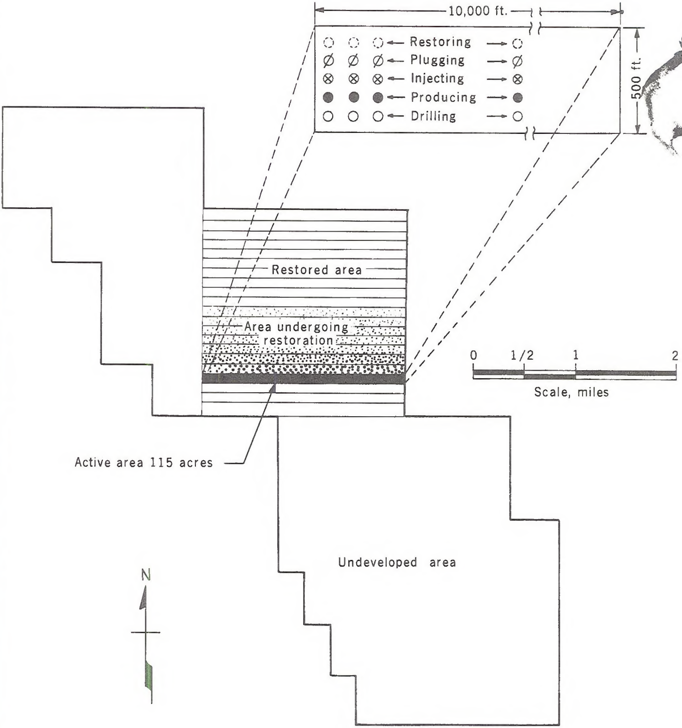


Figure III-11.-Wyoming Tracts W_a and W_b In-Situ Recovery, Conceptual Development Approach

Table III-2. - Land requirements for tracts W_a and W_b in acres

	5 years	10 years	20 years	30 years
IN SITU	300	1,600	1,600	1,600

Table III-3. Land requirements for tract C_a in acres

			5 years	10 years	20 years	30 years
SURFACE	Surface disposal	With restoration	2,450	2,700	3,000	3,100
		Cumulative land disturbed	2,450	3,200	4,700	6,300
		Canyons	(figure III-14)	D	C,D & E	A,B,C,D,E & F
	Surface disposal with backfill	With restoration	2,450	2,700	2,375	2,375
			2,450	3,200	3,355	3,355
		Canyons	(figure III-14)	E	E	E
UNDERGROUND	Surface disposal	With restoration	350	700	850	1,110
			350	700	1,450	2,210
		Canyons		B	B & C	B,C & D
	Underground disposal 60 percent	Cumulative land disturbed	350	600	800	1,090
				D	D	D
IN SITU			300	775	775	775

however, have to be developed. Extraction per panel should be at least 60 percent of shale in place in the upper beds, but would probably decrease progressively with depth to 50 % or less for the deep shales underlying the Mahogany Ledge.

The pertinent technical parameters for this method of shale processing are summarized below:

(1) Production Rates (after 5th year of lease): 50,000 barrels/day of shale oil; 73,700 tons per day raw shale (average, 30 gallons/ton); disposal of 58,960 tons/day of retorted shale. Land surface area required for plant: 140 acres.

(2) Processed Shale Disposal: Three options are considered:

a. Surface disposal off-site in canyons 8 miles west of Tract C-a. Land area required: 73 acres/yr. A possible area delineated for this disposal is shown in figure III-12. Assuming a 30-year underground mine development, the area designated B, C, and D could be used for disposal of spent shale.

b. Disposal of 60% in mined-out areas underground, 40% on surface. During first 3 years of production, all processed shale would be disposed on the surface off-site, 8 miles west of tract C_a, until sufficient underground space was available for partial disposal. Land area required: 220 acres (first three years), plus 30 acres/year thereafter. In figure III-12 the off-site area required is shown as canyon D for a 30 year mine development. A cross section drawn through the canyons is shown in figure III-13. As illustrated the canyons would be filled

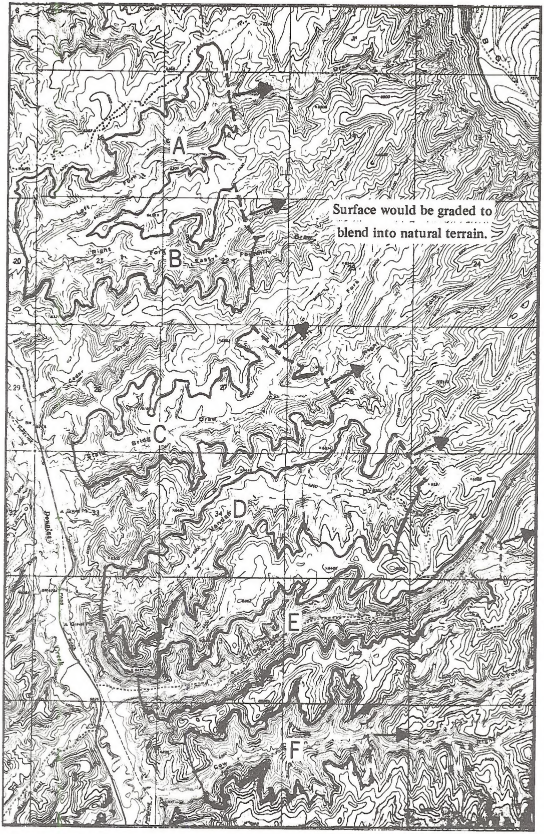


Figure III-12.-Possible area for Spent Shale Disposal, tract C-a.

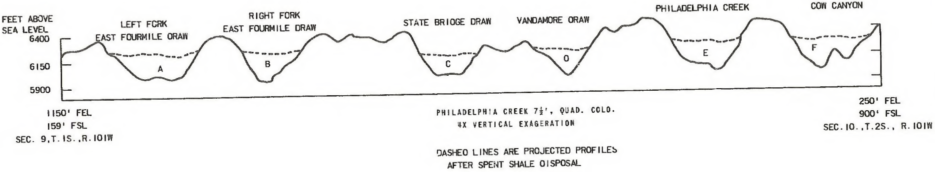


Figure III-13.-Cross section of possible disposal area for Tract C_a

to a depth of about 250 feet should they be utilized. It should be emphasized that the canyons delineated may or may not be used. They were only chosen to depict the surface area requirements necessary for spent shale disposal for a 50,000 or 100,000 barrel per day retorting plant.

b. Surface Mining and surface processing.

This method would involve the excavation and disposal of overburden, mining of the oil shale and associated minerals, processing, disposal of processed shale, disposal of any excess ground water produced in the open pit, and restoration of the mined-out areas. Following is a summation of the pertinent technical parameters:

(1) Production Rates (after 5th year of lease): 100,000 barrels/day shale oil; 147,400 tons/day raw shale (30 gallons/ton); disposal of 118,000 tons/day retorted shale. Land area required includes 150 acres for facilities plus 40-85 acres/year for mine development.

(2) Overburden Disposal: Overburden is assumed to be stacked on the surface, offsite, west of the tract. Figure III-14 illustrates an area which could be utilized. Overburden disposal would continue for a period of about 16 years. This overburden disposal (256 million cubic yards) would comprise an area of 980 acres and would be disposed at a rate of 50-65 acres/year. An illustration of the canyon fill is shown in figure III-15.

(3) Processed Shale Disposal: Two options are considered:
a. Disposal offsite, in canyons west of Cathedral Bluffs, area required: 140 acres/year.

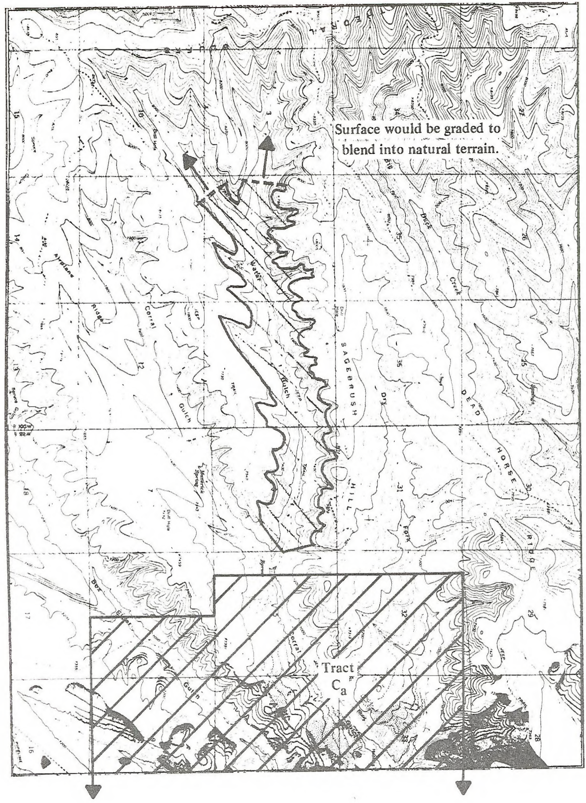


Figure III-14.-Possible area for Spent Shale Disposal Tract c-a.

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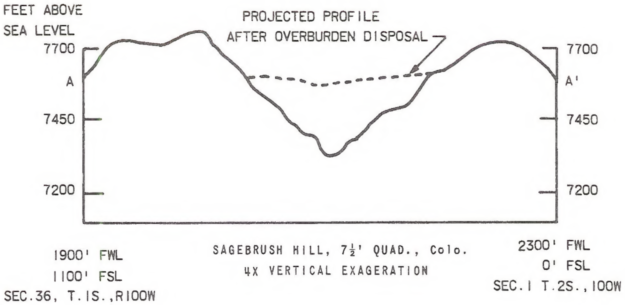

FIGURE III-15.-Cross Section of Canyon Fill for Overburden Disposal, Water Gulch

b. Disposal offsite, as above, for about 16 years, or until sufficient pit area is available, and then backfill into mined-out area of pit. Offsite area required: 875 acres. Figures III-12 and III-13 illustrate those areas which would be large enough to contain the spent shale should this form of mining be selected.

C. In Situ Processing System

Because of the currently nebulous status of in situ oil shale technology, it is expected that a longer period of development time will be required before commercial-level production might be shown to be feasible, and subsequently attained.

In situ processing systems technology could involve surface injection and extraction wells, in which heat is introduced underground from the injection wells, the shale retorted in place, and the oil pumped to the surface through production wells.

(1) In Situ Production Rates: (probably not until at least 6th year of the lease): 50,000 barrels/day of shale oil. Surface facilities will require 45 acres and an additional 15 acres will be active due to well drilling and completion work. This latter area will be dynamic in that a new row of 13 wells will be going through various phases of restoration. Since tract Ca has a much thicker zone (450 feet) the surface area requirements are considerably less than that for Wyoming and Utah.

3. Colorado Tract C-b

This is the second tract selected in Colorado for leasing. Available technical information and the most likely methods for mining, processing, and waste disposal for this tract are described below. These technical options along with the cumulative land requirements are shown in table III-4. Two technical options are considered for extraction of shale oil from this tract. Based on current technology, these are,

(1) underground mining and surface processing;and

(2) in situ processing by surface well extraction.

a. Underground Mining and Surface Processing.

On the basis of current technology this appears to be the most feasible processing system for this tract. Open-pit mining is not considered to be economic because of the high overburden to ore ratio of the deposits on the tract.

(1) Production Rates (after 5th year of lease): 50,000 barrels/day of shale oil, 73,700 tons/day raw shale, (average, 30 gal/ton). Land surface area required for facilities: 140 acres.

(2) Processed Shale Disposal: Two options are considered as shown in table III-4 and figure III-16:

a. Surface disposal partially on-site. Land area required: 73 acres/year disposal in the areas delineated in figure III-16.

b. Disposal of 60% in mined-out areas underground, 40% on surface. During first 3 years of production, all processed shale would be disposed on surface until sufficient underground space was available. Land area required: 220 acres (first 3 years), plus 30 acres/yr. thereafter. A cross section through the described canyons before and after disposal is shown in figure III-17.

Table III-4. - Land requirements for tract C_b in acres

<table>
<tr><th></th><th></th><th></th><th>5 years</th><th>10 years</th><th>15 years</th><th>20 years</th></tr>
<tr><td rowspan="5">UNDERGROUND</td><td rowspan="3">Surface disposal</td><td>With restoration</td><td>350</td><td>700</td><td>850</td><td>1,110</td></tr>
<tr><td>Cumulative land disturbed</td><td>350</td><td>700</td><td>1,450</td><td>2,210</td></tr>
<tr><td>Canyons</td><td></td><td>A</td><td>A & B</td><td>A,B & C</td></tr>
<tr><td colspan="2" rowspan="2">Underground disposal 60 percent</td><td>350</td><td>600</td><td>800</td><td>1,090</td></tr>
<tr><td></td><td>A</td><td>A</td><td>A</td></tr>
<tr><td>IN SITU</td><td colspan="2"></td><td>300</td><td>790</td><td>790</td><td>790</td></tr>
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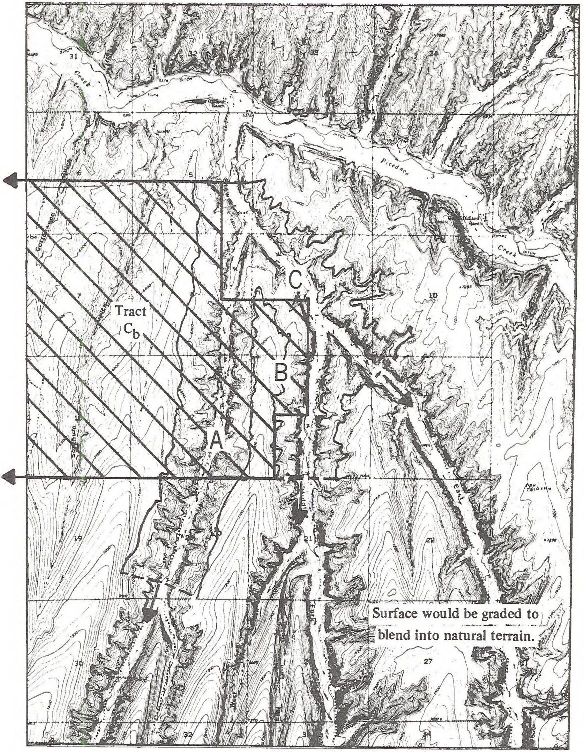

Figure III-16. -Possible area for Spent Shale Disposal, Tract C_b

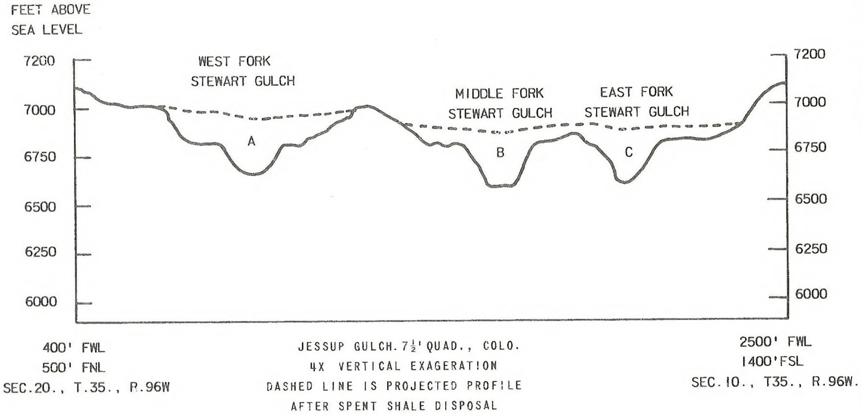

Figure III-17.—Cross Section for Possible Areo for Disposing of Spent Shole

b. In Situ Processing System

As was true on Colorado Tract C-a and in situ retorting of oil shale on tract C-b involves heating the shale in its underground locations.

The pertinent technical parameters for in situ processing are summarized below:

(1) Production Rates (probably not until at least 6th year of the lease): 50,000 barrels/day of shale oil. Land surface area required for facilities: 50 acres. As was stated for tract C-a, a similar active well area and retoration area will be undergoing development. In this case, 15 wells will have to be drilled each month as the underground retorting continues to move.

4. Utah Tracts U-a and U-b

Two adjacent tracts, U-a and U-b, have been chosen for leasing in Utah. Since these tracts are adjacent and no significant environmental differences were discovered during field investigations, their environmental impacts have been considered together. Two technical options are considered for extraction of oil shale from these tracts:

(1) Underground mining and surface processing, and

(2) in situ processing by surface well extraction.

Surface (open pit) mining is not considered to be economic on either tract, because of the high overburden/ore ratio of the deposits on both tracts.

These options and cumulative land requirements are illustrated in table III-5 and figure III-18.

Table III-5. - Land requirements for tracts U_a and U_b in acres

			5 years	10 years	20 years	30 years
UNDERGROUND	Surface disposal	Cumulative land disturbed	350	700	1,450	2,210
		Canyon	A	A	A	A
	Underground disposal 60 percent	Cumulative land disturbed	350	600	800	1,090
		Canyon	A	A	A	A
IN SITU			300	1,790	1,790	1,790

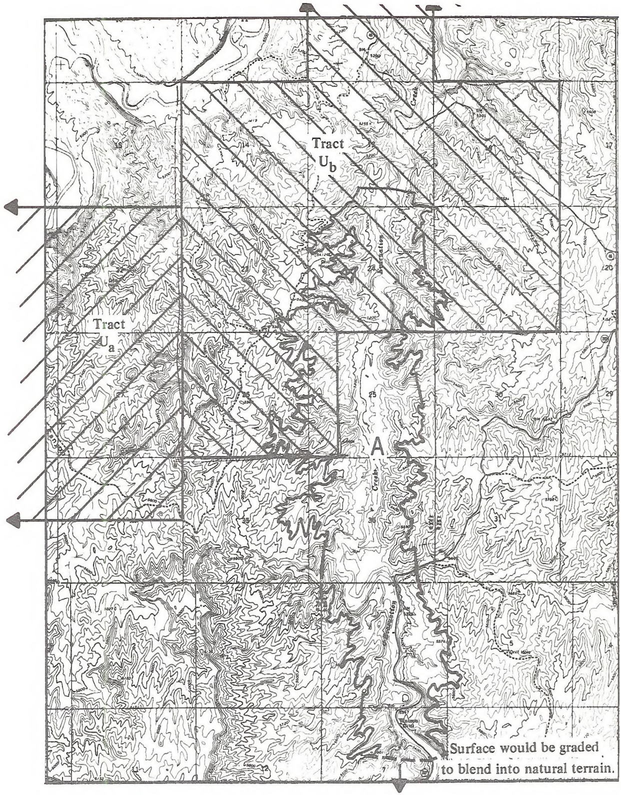

Figure III-18. -Possible area for Spent Shale Disposal, Tract U-b.

As shown in figure III-18, a possible disposal site is located on and south of tract U_b. This area is only shown to illustrate the acreage requirement and is not intended to be the area where the spent shale will be disposed. The developing company will be specific in delineating those sites which would be needed to be approved prior to commercial development. In this case the canyon width averaged about 4,000 ft. If the spent shale was piled to a depth of 250 feet, a canyon length of 25,800 feet would be required. The terrain after disposal would be similar to that shown by the cross section in figure III-19.

a. Underground mining and surface processing

The pertinent technical parameters for underground mining and processing of sites U_a and U_b are summarized below. The figures given are combined production of 50,000 barrels/day from the tracts.

(1) Production Rates (after 5th year of lease): 50,000 barrels/day, two tracts; 73,700 tons per day raw shale (average, 30 gal/ton); disposal of 58,960 tons/day of processed shale. Land surface required for facilities: 140 acres.

(2) Processed Shale Disposal: Two options are considered:

(a) Surface disposal in part on-site and adjacent land, assuming a dump 250 ft. high. Land area required: 73 acres/yr.

(b) Disposal of 60% in mined out areas underground, 40% on surface. For first three years of production, until sufficient underground space is created, all disposal would be on surface. Land area

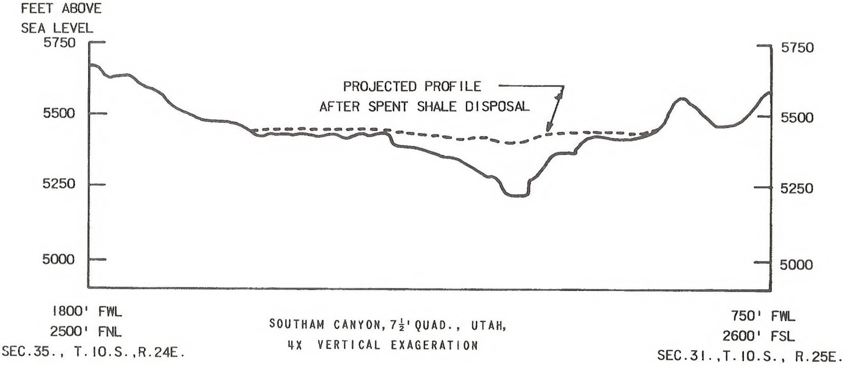

Figure III-19.-Cross Section for Spent Shale Disposal Tract U_a and U_b, Evacuation Creek required: 220 acres (first three years), plus 30 acres acres/year thereafter.

b. In Situ Processing System

The pertinent technical parameters for this method of shale processing are summarized below:

(1) Production Rates (probably not until at least 6th year of the lease: 50,000 barrels/day of shale oil. Land surface area required for facilities: 50 acres. With an average oil shale resource height of 48 feet it will require about 120 wells to recover 50,000 bbls/day. Due to the contact area required to retort the shale underground, approximately 120 wells per month would need to be drilled and completed to sustain the combustion zone. A large number of these wells could be drilled prior to starting the in situ test.

IV . ENVIRONMENTAL IMPACT OF PROPOSED ACTION

The leasing of six tracts in three States for oil shale development would produce both direct and indirect changes in the environment. The impacts involved include those on the land itself, on water resources, air quality, fish and wildlife, grazing, aesthetics, recreation, and cultural values; and finally, alterations in the existing social and economic environment. A discussion of the cumulative effects on the land in the oil shale regions has been discussed in Chapter III of this Volume. That discussion covered the effects on the land that will be brought about by surface mining, underground mining, above-surface processing, and in situ production and processing. The present chapter discusses the direct impact on the land surface of the six tracts.

A. Impact on Land

The major impacts on the land itself on each tract, as a result of the proposed leasing program, are concerned with the amount and kinds of surface disturbances involved, and their effects on the soil and vegetation. Changes in land use (e.g. in wildlife habitat, grazing patterns, etc.) are described under other sections of this statement. The land surface changes involved have been assessed over an entire 20 year lease period provided under the prototype program. In most cases, this would include 5 years of pre-production activity, and 15 years of actual, full-scale production. An estimate is also made for the changes involved over a 30-year period.

For the six tracts as a whole it is estimated that between 8,000 to 11,000 acres of land surface, both on-site and off-site, would be disturbed in the construction of mines, excavations, plant facilities, storage areas, and processed shale disposal areas. An additional 1,700 to 2,000 acres, some on-site but mostly off-site, would be, in part temporarily, and in part permanently disturbed in the construction of roads, and of utility corridors for power, natural gas, water, and shale oil produce lines. (The total maximum of approximately 3,000 acres disturbed by shale industry-related activities is less that 0.1% of the oil shale land surface area in the three States.)

For each of the individual 5,120 acre tracts, the impact on the land involved is discussed below. Reference is made to Chapter III of this Volume for a description of the mining and processing operations applicable to each tract.

1. Colorado Tract C-a

The amount of on-site and accompanying off-site disturbance associated with this tract would depend upon the mining and processing system selected by industry, since the site has potential for shale oil recovery by all three major processing systems--underground mining, surface mining, or in situ processing.

If underground room-and-pillar mining were to be used on this site, the estimated land surface areas which would be disturbed would include the following for production of 50,000 bbl/day of shale oil: Plant facilities, including product storage, would disturb 140 acres, on-site. Processed shale could total 290 million cubic yards and would require 1,100 acres for total surface disposal on-site, or only 450 acres on-site if 60 percent of the waste were to be returned underground to the mine after the third year of operation. If off-site canyon areas west of Cathedral Bluffs were to be used for disposal during a 20-year operation, some 1,000 acres off-site involving 10,000 linear feet of State Bridge Draw and 9,200 linear feet of Right Fork of east Four Mile Creek, would be permanently disturbed. In a 30-year operation, 484 million cubic yards of processed shale would be disposed of and disturb 12,400 feet of Vandamore Draw, 10,000 feet of State Bridge Draw and 10,000 feet of the Right Fork of East Fourmile Draw. If 60 percent of the processed shale is returned underground, 7,800 linear feet of State Bridge Draw will be required in a 20-year operation, and 12,900 linear feet of Vandamore Draw will be required for disposal in a 30-year operation.

Finally, 175 to 225 acres of surface, most of which would be off-site (see Chapter III), would be temporarily disturbed to create utility corridors and roads. Most of the surface for the pipeline utility corridors would subsequently be restored to its original state, following construction.

Surface mining to produce 100,000 barrels per day of shale oil production on Tract C-a would disturb some 1,800 acres on-site over the first 20 years of the lease. Some 200 acres of the tract would be disturbed for plant facilities, probably on the western edge of the tract. New land surfaces and topography would be created if overburden and processed shale were used to backfill the open pit. A minimum of 16 years of operation under the original lease is estimated to be required, however, before the backslope would be established and the pit opened to a size permitting backfill with overburden and thence processed shale.

In the intervening years, an additional 980 acres of surface, off-site (possibly northwest of the tract), would be disturbed to furnish a disposal area for overburden removed from the pit. This canyon could be filled to a height of 250 feet sloped for drainage, and side contoured to permit revegetation. If the overburden were disposed of in Water Gulch, a total of 17,000 linear feet would be disturbed. This area would no longer be needed for overburden disposal in the latter years of the lease, as overburden would be returned directly to the pit.

It would appear that processed shale could be permanently placed in dry canyons immediately west of the Cathedral Bluffs, on land devoid of oil shale. Some 2,200 acres of canyon land would be permanently altered for this purpose, including the disturbance of 14,000 linear feet of Vandamore Draw, 16,000 linear feet of Philadelphia Creek and 8,700 linear feet of State Bridge Draw. Therefore, over the first 20 years, about 5,000 acres would be disturbed both on- and off-site.

Processed shale from a 30 year operation would disturb 6,650 acres, 10,000 linear feet of Left Fork East Fourmile Draw, 10,000 linear feet of Right Fork East Fourmile Draw, 10,000 linear feet State Bridge Draw, 18,000 linear feet of Vandamore Draw, 16,000 linear feet of Philadelphia Creek and 7,500 linear feet of Cow Canyon. An alternative mode of operation might be to return the spent shale to the pit after 16 years or until the pit opening was large enough to permit return as backfill. In this latter case, approximately 900 acres of canyon lands offsite would be permanently filled, contoured, and revegetated. This disposal method will result in disturbance of 15,300 linear feet of Philadelphia Creek. Total disturbance using this mining option would be 3,655 acres.

As in the case of underground mining some 175 to 225 acres of surface would be disturbed for utility corridors and roads (see description of this land impact on this tract, above).

In situ processing of shale, if technically feasible on Tract C-a, could produce the least surface disturbance. It is estimated that 50 acres of surface would be occupied by above ground processing facilities at any one time and 110 acres would be undergoing restoration as described in Chapter 3 of this Volume As these surface facilities were moved to conform to the portion of the underground strata of the tract being retorted, the original surface could be restored once more.

If either underground or in situ mining is carried out on Tract C-a, some surface subsidence might occur. In the case of the underground mining, if processed shale is returned to the mine as backfill, subsidence will probably be slight or might be avoided altogether. There are insufficient data at present to predict whether any subsidence would take place if in situ processing is employed on the tract.

The soils and vegetation on the adjacent land to Tract C-a have been described in this volume in Chapter II. The degree of disturbance of these soils and their vegetative cover as a result of the development of the oil shale resources of the tract is directly proportional to the surface areas involved. The amounts of surface disturbance involved for each of the mining methods applicable to the tract were set forth earlier in this chapter.

Obviously, the greatest initial impact on soils and vegetative cover would occur if open-pit mining were employed on the tract. This would eventually result in the destruction of 1,800 acres of presently existing vegetative cover, and the disturbance of 1,200 acres of top soil on the tract, as the pit reached its eventual depth of approximately 1,400 feet.

It is estimated that no more than half the area to be mined would be disturbed before restoration and revegetation operations were initiated. Approximately 35 percent of the Tract C-a surface area contains top soil materials suitable for stockpiling and redistribution to the surface of backfill areas or processed shale dumps, should these be necessary to aid in revegetation.

Revegetation would require fertilization and irrigation on a continuing basis until growth is self-sufficient. Studies to date have indicated processed shale can be revegetated with crested wheat, western wheat, Indian rice, Kentucky bluegrass, sweet clover, four wing salt bush, sage, juniper, and Engelmann.

spruce. Other native and introduced species are also currently under investigation. It should be noted, for comparison, that present native vegetation on the tract is of three major types -- sage brush, pinon-juniper, and mountain browse.

In addition, impacts on the soil and its vegetation will be created both on-site and off-site along utility corridors and roads. Following construction of the service corridors and burial of pipeline, the surface topography would be restored and the disturbed surface revegetated as soon as practical.

2. Colorado Tract C-b

This site has the possibility of being developed by either an underground mining following by surface processing, or by in situ processing. Because of unfavorable overburden to ore ratios (as high as 5:1) it is not contemplated that open-pit mining would be used on this tract.

If underground room-and-pillar mining is used on this site, the estimated land surfaces which would be disturbed are essentially the same (except for off-site areas) as those previously described for underground mining on Tract C-a. These areas would include the following: Plant facilities, including product storage, would permanently disturb 140 acres, on-site. In a 20-year operation, processed shale would require 1,100 acres for total surface disposal on-site and near-site which would result in the disturbance of 19,200 feet of the West and Middle Forks of Stewart Gulch. Alternatively, 450 acres on-site would be disturbed, if 60% of the waste were to be returned underground to the mine after the third year of operation and about 7,800 linear feet of West Fork of Stewart Gulch. In a 30-year operation with total processed shale disposal on the surface, 32,400 linear feet of West, Middle, and East Fork of Stewart Gulch would be disturbed; 12,900 linear feet of the West Fork of Stewart Gulch would be disturbed if 60% were backfilled in the mine. If the lower zone shales were eventually to be mined, and the accompanying saline minerals recovered in substantial quantities, it is possible that all of the remaining processed shale could eventually be returned underground as mine backfill, with no further need for surface disposal.

Finally, approximately 170 to 200 acres of surface, most of which would be off-site (see Chapter III), would be temporarily disturbed to create utility corridors and roads. Most of the surface for the pipeline utility corridors would subsequently be restored to its original state following construction.

In situ processing of shale on Tract C-b could produce the least surface disturbance. It is estimated that 50 acres of surface would be occupied by above ground processing facilities at any one time and 140 acres would be disturbed due to well activity and restoration. As these surface facilities were moved to conform to the portion of the underground strata of the tract being retorted, the original surface could then be restored.

If either underground or in situ mining is carried out on Tract C-b some surface subsidence might occur. In the case of underground mining, if processed shale is returned to the mine as backfill, of if overburden is not excessive, such subsidence might be avoided altogether. There are insufficient data at present to predict whether any subsidence would take place if in situ processing is employed on the tract.

The soils and vegetation on and adjacent to Tract C-b have been described in Chapter III of this ~~Document~~. Pinon-juniper on the slopes and ridges, and sagebrush, rabbit brush, and greasewood in drainage bottoms were the major vegetative types. The degree of disturbance of the soils and their vegetative cover as a result of the development of the oil shale resources of the tract is directly proportional to the surface areas involved. The amounts of surface disturbance involved for each of the processing methods applicable to this tract (underground mining plus surface retorting, or in situ processing) were set forth earlier in this chapter

The surface of Tract C-b is similar to that for Tract C-a.

It is located in essentially the same annual precipitation zone (15 to 17 inches per year), and has the same general range of elevation (6,600-7,000 ft). Erosion on the site should be low. There are no significant north-facing slopes.

Plant species adaptable to the site are the same as those mentioned for Tract C-a. Approximately 25 percent of the surface area contains topsoil suitable for mixing or top dressing processed shale piles, if required for establishing revegetation on the processed shale dumps. Adequate fertilization and care in irrigation for up to two or three years may be required.

3. Utah Tracts U-a and U-b

These two adjacent sites are each considered to have the potential for either underground mining and surface processing, or for in situ processing. Because of high overburden to ore ratios (5.6/1 to 14/1 on U-a, and up to 7.0/1 on U-b) open-pit mining is not practical on either tract. Since the two sites are adjacent, their land impacts are essentially the same, and are hence considered together.

If underground room-and-pillar mining were used on these sites, the estimated total soil and vegetation surface areas which would be disturbed on the two sites (assuming a production of 50,000 barrels per day) would be as follows: Plant facilities, including product storage, would permanently disturb 140 acres, on-site. In a 20-year oil shale operation, processed shale would require 1,100 acres for total surface disposal on and near the site, disturbing 15,600 linear feet of Evacuation Creek. About 450 on-site acres would be required, if 60 percent of the waste were to be returned underground to the mine and 6,300 linear feet of Evacuation creek would be disturbed. In a 30-year operation with total surface disposal, 25,800 linear feet of Evacuation Creek would be disturbed. If 60 percent of the waste were tc be returned underground to the mine, then about 10,500 linear feet of Evacuation Creek would be disturbed.

Finally, approximately 180-200 acres of surface, most of which would be off-site (see Chapter III), would be temporarily disturbed to create utility corridors and roads. Most of the surface soils and vegetation for the pipeline utility corridors would subsequently be restored to near its original state following construction.

In-situ processing of shale on Tracts U-a and U-b could produce a similar surface disturbance. It is estimated that 50 acres of surface would be occupied by above ground processing facilities at any one time and 1,140 acres would be active with either some phase of well completion or restoration work. As these surface facilities were moved to conform to the portion of the underground strata of the tract being retorted, the original surface could be restored to as near the original condition as possible.

If either underground or in situ mining is carried out on Tracts U-a and U-b, some surface subsidence might occur. In the case of underground mining, if processed shale is returned to the mine as backfill, such subsidence would probably be slight and cause little damage or be avoided altogether.

The soils and vegetation on the two Utah tracts have been described in Chapter II of this Volume. Approximately 85 percent of the vegetation on each site consists of pinon-juniper, while the balance of the vegetation is greasewood and occasional sagebrush in drainage bottoms. The degree of disturbance of the vegetation and the accompanying soils, resulting from development of the oil shale resources is directly proportional to the surface area involved, and the processing methods utilized, as set forth above.

Tracts U-a and U-b are at an elevation of from 4,600 to 5,800 feet, with an annual precipitation of only 10 to 11 inches. While revegetation with plant species adaptable to the sites is feasible, continued irrigation may be required for a longer period of time than in Colorado.

4. Wyoming Tracts W-a and W-b

These two adjacent sites have the greatest potential for development by in situ processing, because of the shallow depths and moderate grade of the shales. It is the method considered here, for a total production of 50,000 barrels per day on the two tracts. Underground mining would be technically possible but is not considered economically feasible.

It is estimated that 50 acres of surface would be occupied by aboveground processing facilities at any one time. About 900 acres will be needed for the active well and restoration areas. As these surface facilities were moved to conform to the portion of the underground strata of the tract being retorted, the original surface could be restored.

For any method of in situ processing, the surface disturbance due to utility corridors and roads would include as much as 600 acres on-site and off-site. This is larger than for any of the tracts in Colorado and Utah because of the greatest distances involved in Wyoming. Most of the surface for the pipeline utility corridors would subsequently be restored to near its original state, following construction.

Data are insufficient at present to predict whether or not surface subsidence will occur.

The soils and vegetation on these two Wyoming tracts have been described in Chapter II of this Volume. Desert shrub and vegetative shrubs are typical growth on the sites and a small portion of the surface is covered by mountain shrubs. The degree of disturbance of this vegetation and the accompanying soils, resulting from oil shale processing, is directly proportional to the actual surface areas disturbed, as set forth above.

The Wyoming tracts, like those in Utah, are in a semi-arid region of only 10-12 inches of annual precipitation. Elevations range from 7,100 feet to 8,200 feet. Revegetation, as required, with plant species adaptable to the sites is feasible, providing that sufficient irrigation water is used, together with fertilization.

B. Impact on Water Resources

1. General

Water requirements for oil shale mining and processing at the six selected lease sites would depend upon the types of mining, retorting, and shale-disposal processing employed in each case.

However, order-of-magnitude consumptive figures were estimated (see Volume 1, Chapter III) which can be considered typical of a given processing sequence on a particular tract.

2. Colorado Tracts

a. Tract No. C-a

This tract has been proposed for open-pit mining because it has a favorable shale to overburden ratio. This tract would also be amenable for underground mining, or even in situ processing. However, since this is the only tract particularly amenable to surface mining, the environmental impact on water resources available to the tract has been considered in terms of an open-pit development. This permits an assessment of this type of mining on water supplies.

If the open-pit operation reaches its full expected capacity of 100,000 barrels per day, the total operation (including spent shale disposal and shale oil upgrading) would consumptively use about 10 to 14 million gallons of water per day, or 15 to 22 feet per second. It is not presently known whether water containing more than 1,000 mg/l of dissolved solids could be used in all parts of the operation. In the event that water pumped from the mine is usable, the mine dewatering process may supply all the water needed. Indeed, it might even be able to supply water for use on other tracts. On the other hand,if the ground water with-drawn could not be used, the operation would be faced with the dual problem of disposal of waste water and importing a water supply.

Surface water can be obtained from either the Colorado or White Rivers. Direct flow water is available from both rivers part of the time, but must be augmented with storage water to obtain a firm water supply. Some water from the Colorado River could be obtained from the existing Green Mountain and Ruedi Reservoirs, and a possible future source of water would be the authorized West Divide Reclamation Project. In the White River it may be possible to obtain water from the proposed Yellow Jacket Project, Rio Blanco Reservoir, or Sweetbriar Reservoir if they were constructed by the time water is required. Water from either the Colorado or White River Basin would have to be conveyed to the tract through facilities to be constructed by the operator, except for those facilities to be constructed by the proposed Yellow Jacket Project. Ice formation undoubtedly will hinder transport of water via canals, therefore buried pipelines would be necessary.

Where pit excavations penetrate water-saturated materials, as much as several tens of cubic feet per second of ground water would have to be pumped. This ground water may be highly saline, but usable for some purposes. Pumping large quantities of ground water from tract C-a would cause water levels and artesian pressures to decline and could dry up some springs and seeps in the vicinity of the tract.

The Environmental Protection Agency's nondegradation policy and the lease stipulations prohibits discharge of excess saline water into streams. The stipulations in the lease prevent such discharge. If accidental release were to occur, however, saline water would get into the surface water system. For example, if water were to be discharged into a tributary of the Colorado River at a rate of 33 cfs, and had an average dissolved-solids concentration of 1,000 mg/l, the salinity concentration of the Colorado River at Hoover Dam would be increased by 2.5 mg/l. If the average concentration were 1,500 mg/l, the salinity concentration of the Colorado River at Hoover Dam would be increased by 4.5 mg/l. Excess saline water would have to be desalted or be disposed of by some alternate method, such as injection into highly saline geologic zones, or by evaporation in impervious impoundments. The lower part of the leached zone appears to be a likely place to inject waste water, but pressure-head build up caused by injection probably would cause saline ground water to move into the upper portion of the leached zone causing it to become more salty, and could even increase the possibility of seismic activity if safe injection pressures were exceeded.

Discharging treated waste water or other water of acceptable quality into a stream channel and increasing its flow would increase channel erosion and hence sedimentation, if such channels were dry or the streams were relatively small. Even with the best of controls sediment loads in the streams near the site may also be increased for short periods from other processes related to the construction and operation of an open-pit mine on Tract C-a, including (1) disposal of spent shale, (2) disposal of overburden, (3) storage of crushed shale, (4) plant construction, and (5) road and pipeline construction.

Precipitation at the rate of about 1 inch in 24 hours occurs at the site about once each year. More than 3 inches of precipitation has been known to fall within 24 hours in the vicinity. Rainfall of high intensity could wash considerable quantities of sediment from piles of crushed or spent shale or overburden, if not adequately protected, or from land surfaces left barren during construction.

Processed shale probably could be transported from the tract to the disposal site as a 50% water slurry. Water pumped from the mine would be used to transport the processed shale. In order to prevent significant seepage of contaminated water into streams or into aquifers, water draining from the slurry would be caught in a holding basin, or behind a small downstream dam that would also catch run-off and most underflow. The resulting water after settling, still high in dissolved solids, could best be recycled as slurry make-up water. Storage tanks and pipelines at the retorting facility offer a recognized potential for stream pollution. Failure of one of the tanks or lines could release a quantity of oil into nearby streams or aquifers. The risk of a spill from pipelines is very small and spills from oil storage tanks would be contained behind dikes that would be designed to hold one and a half times the tank(s) capacity.

If a large open-pit mine on Tract C-a intercepts the channel of one or more streams, the streams would be diverted around the mine to prevent flooding of the pit.

The above predictions of environmental impact have assumed that the oil shale at site C-a would be developed by open-pit mining, as proposed in the site-nomination documents. As previously mentioned, it also is possible that the site may be developed using underground mining 1/ or in situ processing. 2/ In the event one of these other processes is used, oil production is estimated to be 50,000 bbl/day and water requirements will correspondingly be only one-half of the amounts estimated for open-pit mining. The same general discussions apply to providing water as were true for the open-pit process.

Dewatering of the underground mine or in situ site also would be required. Disposal of the dewatering water will present the same sort of problem as does disposal from an open pit, but because the shaft would penetrate to the bottom of the oil shale much faster than would the open-pit, the volume of water would probably be greater initially, resulting in excess water that would require disposal or use on other leases. After the desired water level was established the yield would decline.

1/ For a more detailed analysis of underground mining water resource problems, see Tract C-b discussion.

2/ See Tract U-a discussion for a further analysis of in situ water resources impacts.

In situ development potentially could cause problems of ground-water contamination from the retorting process and from shale left in place. It is difficult to judge either the type or the severity of these problems until an in situ process is perfected and a prototype operation is undertaken.

b. Tract No. C-b

Conventional underground mining, using the room and pillar method, is considered as the most likely to be employed at tract C-b. Such a method is expected to produce oil at the rate of about 50,000 barrels per day, and would require processing water at the rate of about 5.5 million gallons per day (8.5 cfs), which would be consumptively used.

Underground mining operations would penetrate aquifers of the Green River Formation, and dewatering of the mine could therefore be a serious problem. The volume of ground water which would have to be pumped may range from 10 to several tens of cubic feet per second. Water pumped from the upper part of the leached zone might be used in plant operation, but water from the lower part of the leached zone may be extremely saline and could present a disposal problem. Injection of waste water into the lower part of the leached zone is a possible means of disposal of the highly saline water but might increase the rate of movement of saline water towards the mine. Mine dewatering would reduce the artesian pressure along Piceance Creek, and hence deplete stream-flow, thus infringing on the water rights of senior holders. This could have economic effects for land and water rights holders and also cause some loss of fish and wildlife habitat and water supply.

Pumping this quantity from the leached zone could result in intrusion of moderately or very saline ground water into the mine. In the event that adequate amounts of water of good quality cannot be developed on the tract, water may be obtained from the White or Colorado River, as discussed under Tract No. C-a.

As discussed in the earlier description of other tracts, potential erosion and sediment pollution problems would exist from storage of overburden, spent shale, and crushed shale, and from plant, roadway, and pipeline construction. The reader is referred to the previous discussion of Tract C-a for a more detailed analysis. Quantitative predictions of the amount of erosion cannot be made, but the magnitude of the problem might be significant in the absence of adequate control measures.

After mining by the room and pillar method has progressed sufficiently, processed shale could be disposed of by backfilling of the mine. Potential ground-water contamination problems could occur from materials leached from the shale. Data are inadequate at the present time to completely predict quantitatively the amounts or types of material that may be leached from the shale by ground water. Were leaching to occur in any significant quantity, it would constitute a long-term problem. The salinity of leach waters from spent shale is such that significant addition to surface water would also have effects of adding to salt concentrations of the Colorado River system.

Surface subsidence is a potential problem in any mining operation and must be considered here in view of the hydrology of the Basin. Subsidence generally directly affects drainage patterns by altering the slope of streams. However, the subsidence effects, at this site, on the streams are not expected to be severe because the channels have a considerable slope. Backfilling of the mines with processed shale would reduce potential subsidence problems.

Stream and ground-water pollution from accidentially spilled oil must be considered, as they have been for other tracts. Again, however, the danger is no greater than for oil storage areas anywhere, providing that protective measures reflecting proper safety precautions are taken.

Although this discussion has treated subsurface mining as the probable method of development of tract C-b, this site also is suited to development by in situ methods. Problems of water supply, dewatering, and waste water disposal would be about the same as described for subsurface mining.

In situ development potentially could cause problems of ground-water contamination from the fracturing process, the subsequent underground retorting process and from the processed shale left in place. It is difficult to judge completely either the type or the severity of these problems until the details of the processes are known, or possibly until a prototype operation begins.

Fracturing across the Mahogany Zone could, however, facilitate upward movement of artesian water from the deeper leached zone increasing the amount of water that would have to be removed to sustain the process. Fracturing and retorting would increase porosity and permeability and possibly alter existing hydraulic gradients, thus perhaps producing some long-range changes in the direction and rate of ground-water flow. The processed shale remaining underground, being more highly fractured after retorting, would be more susceptible to subsequent leaching by ground water moving through the strata.

Further discussion of environmental problems in water resources, caused by in situ development is presented below in connection with the evaluation of the Utah tracts, where the in situ process is more likely to be employed.

3. Utah Tracts U-a and U-b

These two adjacent sites could be developed as in situ operations, or by conventional room and pillar underground mining. At full scale in situ operation, the tracts may produce a total of as much as 50,000 barrels of oil per day, and consumptively use 5.5 million gallons of water per day (8.5 cfs). It is doubtful that water could be supplied from aquifers, but up to 1 cubic foot per second could possibly be available from the in situ water produced in retorting. For the remainder it would be necessary to use surface water.

The Utah Division of Water Resources presently holds a pending application (No. 36979) for the appropriation of 350 cubic feet per second plus 250,000 acre-feet of water from the White River, its tributaries and underground. Part of this could possibly be used by the oil shale industry but storage of flood water would be necessary to assure a dependable year round supply. A pipeline would be required to bring the required 8.5 cubic feet per second from the White River to the tract. The salinity concentration of the Colorado River at Hoover Dam could be increased about 0.5 mg/1 as a result of this consumptive use.

The specific in situ process details are not known, but it is assumed that dewatering of the working strata will likely be required in any case. Ground water to be removed might be expected to have a dissolved-solids concentration as much as 3,000 mg/1, which would prohibit its disposal by discharge into streams.

However, the volume to be removed is expected to be relatively small compared with the volume pumped from other types of mines and sites, and injection of waste water may be a workable solution to the problem at this site.

The process water resulting from underground retorting must be disposed. Any scheme other than complete recycling will have some environmental effects. If returned underground,the flow path of injected water cannot be predicted without detailed knowledge of the injection site.

Spent shale from the in situ process would be left in place, and therefore would not require surface disposal. However, leachate which may be introduced into the ground water from this source might affect the quality of ground water, but the amount and degree to which this will occur cannot be predicted until a process is proven and its details defined and the post-retorting hydrologic characteristics of the site are determined. More laboratory and experimental studies, as well as field monitoring of a prototype site would be necessary.

Depending upon the type of in situ process to be used, ground-water contamination also could result during the in situ extraction. Solvents and gases that may be injected or released by the retorting organic matter, could escape into aquifers if pressure conditions were favorable. A further evaluation of the environmental impact of in situ processing at this site would be made when the process to be used is clearly defined, and when the characteristics of the aquifers are defined by field exploration.

Some stream sedimentation problems might occur from materials eroded during drilling in situ boreholes, and during plant, roadway, and pipeline construction at the site. Most of this erosion would take place during periods of snowmelt and runoff from thunderstorms.

Surface-water and ground-water pollution might result from spillage of oil or breakdown of treatment or waste injection facilities. Adequate safety precautions should avoid this hazard, which is no greater for this site than for other areas.

It is also possible that the two Utah tracts could be developed by underground mining and surface retorting, using the room and pillar method with inclined shafts. If oil production attains a rate of 50,000 bbl/day from the two tracts, water consumption would again be approximately 8.5 cfs. The same general discussion of potential surface and sub-surface water supplies that was presented above for in situ retorting would apply, as would the observations regarding increased salinity of the Colorado River.

Problems of mine dewatering are similar to those discussed for in situ processing. However, the size of the excavation for a room and pillar operation would be larger than the underground retorting zone for the in situ operation on these tracts; therefore, the potential volume of water removed could be greater.

Subsidence caused by pillar collapse in the underground mine could affect drainage patterns in the region of the mining operation. However, backfilling the mining rooms with spent shale as soon as work in an area is completed would reduce the potential subsidence.

Potential ground-water contamination from contact with the spent shale, or from slurry leachate could be of concern for these tracts, as was previously noted for Tract C-b and for other underground mining sites. Reference is made to the discussion of environmental impact for Tract C-b for a more detailed explanation of this problem.

Potential sediment and chemical stream pollution from accidental spillage, pipeline construction, road construction, and plant construction, must be considered at the Utah tracts, just as they were considered in appraisal of other sites. (See the section on environmental effects at Tract C-b for a more complete discussion of these topics).

4. Wyoming Tracts - W-a and W-b

Both of these adjacent tracts would most probably be developed using an in situ method. However, the technical details of the in situ processing system cannot be described at the present state-of-the-art.

Oil production at the two sites may reach a total rate of 50,000 barrels per day. Consumptive use of water for this production would be about 8.5 cubic feet per second.

Small amounts of fresh water are available from the shallow aquifer on the tracts, but shallow wells on the tracts could not supply the needs of the industry. Some water supplies might be obtained from wells tapping deeper aquifers, but few data are available from which to predict the amount and quality of water that might be found. Because streamflow in the area is intermittent, pumping of ground water is not expected to have a significant effect on streamflow.

Possibilities for reservoir storage of surface water exist to partially meet the above projected shale industry annual needs of about 6,000 acre-feet. However, in view of high reservoir evaporation losses and high construction costs, in-depth planning cannot be given to this possibility until after the ground water resources are explored more completely. The latter study would require considerably more data on aquifer characteristics and water quality than are now available.

The 6,000 acre-feet per year of water required for this development could be supplied from either the existing Fontenelle or Flaming Gorge Reservoir on the Green River. This would require construction of a pumping plant and pipeline to bring the required water from the river to the tracts.

If surface water is used to supply the water requirements for this development, the salinity concentration of the Colorado River at Hoover Dam would be increased less than 0.5 mg/l, as a result of the annual consumptive use of the 6,000 acre feet of water.

Liquid process wastes might be disposed of underground. Feasibility of subsurface disposal would depend upon locating a suitable deep aquifer. Injected effluents enter the ground-water system and might ultimately find their way into surface water. It could be decades or centuries under most condition before injected fluids emerged. Any delayed effects of this nature would be difficult to correct and additive to the Colorado River system salinity problems.

It probably would be necessary to dewater the in situ operation, but no data are available for predicting how much ground water would have to be pumped. Data are not available to predict the quality of the water to be produced by the dewatering, or if the quality of ground water would be changed by pumping large quantities.

The in situ process eliminates most of the common problems of overburden storage and storage of spent shale. However, small amounts of material would be excavated, and these represent potential pollution problems caused by sediments being washed into streams.

Because details of the in situ process to be employed are not known, it is impossible to predict the effect of the underground retorting on the quality of ground water. Solvents or oils might escape into the aquifers if not contained. Spent shale left in place could also leach organic and inorganic contaminants to ground water after the in situ processing is completed and dewatering is stopped. Contaminants reaching the surface water in any significant quantity would also add to the salt problems of the Colorado River watershed.

Several possibilities exist for stream pollution from mining on the tracts. These include accidental spillage of oil from pipelines or tank failure, land erosion and consequent stream sedimentation from construction of pipelines, roads, and plant facilities, and possible waste discharge necessitated by the breakdown of waste treatment or disposal facilities.

C. Impact on Air Quality and Noise

1. Air Quality

As noted in Volume I of this analysis, the primary sources of potential air pollution from oil shale processing are the following: particulates from mining and processed shale disposal operations, crushing and grinding, and general solid-materials handling: burning of process gases from either surface or in-situ retorting, or of refinery off-gases from shale oil upgrading; burining of any supplemental fuels, for example, for on-site power generation; and possible air contamination due to surface vehicles and traffic.

The means for prevention of air quality degradation from these various sources are reviewed in Volume I and apply to the contemplated operations on each of the six selected tracts. Hence, they are not repeated here. One phenomenon affecting air quality, which is likely to be encountered on the Colorado tracts, and probably on the Utah tracts as well, is atmospheric temperature inversions. These would influence the rate of atmospheric dispersion of stack gases. Inversion heights, are a function of altitude above ground level (not mean sea level), and inversions are often encountered in arid and semi-arid valleys. (See Volume I, Chapter III for a more complete analysis)

Combined residual concentrations of sulfur would be 57 to 85 tons per day, and 21 to 29 tons of NO_2 would be emitted. Up to 40 tons of dust per day may also be emitted from each mining-surface processing complex. The impact of these emissions on ambient air quality has yet to be established.

2. Noise

During initial exploration and construction phases on any of the selected tracts the higher noise levels resulting from diesel tructs, compressors, mixers, drills, and other general construction machinery and vehicles might have some undesirable effect on certain wildlife on or near the sites. Oil shale region animal species sensitive to noise, in decreasing order of effects, are: mountain lion, bear, elk, mule deer, antelope, sage grouse, blue grouse and migratory birds. Small mammals, furbearers, and non-game birds would not be significantly affected by noise, but their numbers in the vicinity of oil shale operations would decrease in proportion to disturbance and habitat lost.

Once commercial-level operations are obtained at each site, it can be expected that the general noise level on each tract would rise considerably. For the in-situ extractive processes, underground blasting, compressors, pumps, etc., would provide obvious noise sources. Conventional strip mining would require power shovels, earthmovers, conveyors, grinders etc., that would generate considerable noise. Similar problems, but with less intensity would occur with underground mining techniques. Retorting and upgrading processes would emit noises quite similar to those for petroleum refinery operations, although the level of such noise would depend on the specific processes employed.

A general increase in the noise level of all residential areas associated with each of the tracts can be expected, as wage earners, supporting personnel, and their families move into population centers and transform less populated communities into those with the characteristic of more urban environments.

D. Impact on Fish and Wildlife

1. General

The following discussion is directed to tract-specific impacts of the six proposed oil shale installations on fish and wildlife resources. Impacts of both a localized and regional nature have already been discussed in Chapter III of Volume I of this analysis.

2. Colorado Tracts

a. Tract C-a

The 16-miles of trail and presently unpaved road from the Piceance Creek Highway to the site would be widened and paved, resulting in a combination of new pressures on fish and wildlife populations in the existing relatively inaccessible tract vicinity. Hunting pressure and other human uses would be locally increased in the tract vicinity. Increased harvest of game would cause additional game population reductions unless counteracting regulatory management was implemented. The most significant wildlife impact, as compared with impacts at other tracts, on and in the vininity of Tract C-a would be loss of its semi-remote characteristics and hunting qualities, as a result of visual and audio impacts of roads, pipelines, transmission lines, signs, air traffic, etc.

Human activities accompanying construction and operation would also cause a net effect of stress and disturbance to existing behavior and activity patterns of wildlife. Although the impact of each particular disturbance in itself would be relatively small, the net effect over the life of the lease at Tract C-a would be a chronic disturbance and displacement of wildlife in the tract vicinity. Most species would by nature avoid such areas and periods of disturbance. However, some species, such as mountain lion, elk, and peregrine and prairie falcon, would be intolerant and portions of the tract vicinity would be completely lost to them as habitat. Species which would be most affected by such disturbances include mountain lion, bear, elk, mule deer, antelope, bobcats, sage grouse, blue grouse, and migratory birds.

If an air strip were constructed on or near the site and regular air traffic were to commence, aerial disturbance of mule deer, wild horses, and other animals could occur. Mule deer and other species would possibly be vulnerable to stress caused by low level flights. The extent of such aerial disturbancecof wildlife at Tract C-a would be dependent upon the resulting volume of air traffic and adaptability of species.

Surface mining techniques could result in the eventual disturbance of approximately 1,400-acres in the 30-year time frame, on the 5,130 acre tract, plus an additional 4,850 for processed shale and overburden disposal, plus 400 acres for access roads and utilities. Surface land disturbances resulting from the mining and accompanying processing and disposal operations would result in the direct loss or reduction of wildlife food and cover in the form of partial or complete removal of existing vegetation, both on- and off-tract. The impact of food and cover loss upon wildlife populations would occur principally in the loss of production capacity for the developed acres, which in turn would be reflected in lower populations of animals. As shown by McKean and Bartmann (1971), the loss of surface vegetation on each section (640 acres) within areas of good deer habitat, can result in a potential reduction in carrying capacity for up to 50 mule deer for that section. Thus, removal of winter browse would result in a corresponding reduction in mule deer numbers. Permanence of such losses would be dependent upon the time required for and success of re-establishing useful wildlife food and cover.

As in the case of on-tract operations, off-tract construction of roads, and utility and oil transmission corridors would result in at least temporary physical loss of some wildlife habitat. The 16-miles of present unpaved road from the Piceance Creek Highway to the site would probably be widened and improved. Utility corridors would probably include a three-mile electric transmission line, a one-mile extension of a natural gas pipeline, construction of a 25-mile water transmission line from the White River, and a 30- to 50-mile oil transmission pipeline. A total of between 175 and 225 acres of right-of-way surface, most of it wildlife habitat, would be initially disturbed by utility corridors.

Through the physical effects of both the mining operations and the anticipated possible use of ground water for processing and development activities, it is anticipated there could be some lowering of water levels affecting springs and seeps in the tract vicinity. Drying of such features would result in a disruption of the natural plant-animal complex associated with each, including the related distribution of big game, cattle, and wild horses. Two known springs on the tract would be destroyed.

Areas stripped of natural cover would become vulnerable to wind and water erosion, until stabilized through vegetation or other means. Available information does not permit quantitative predictions of erosion extent on and in the vicinity of Tract C-a. However, an estimated 6,650 acres of land surface with erosion potential varying from very low to very high would at one time or another be exposed.

Mule deer have historically summered each year on the higher elevations of the Cathedral Bluffs-Roan Divide near Tract C-a, and then cross the tract in order to winter in the Piceance, Yellow Creek, and White River drainages. Oil shale construction and operation activities both on- and off-tract, road traffic, fences, other obstacles, and increased human use on Tract C-a would be expected to result in some blockage and rerouting of this traditional migration pattern.

It would be reasonable to expect some loss of birds, particularly raptors, which come in contact with overhead power distribution lines.

Although the magnitude of such bird losses cannot be accurately predicted, they would be expected to be of relatively minor importance.

Vegetation adjacent to dirt roads and trails would be regularly covered with vehicle-caused dust. This would constitute a minor, but chronic, problem, since such vegetation would lose its wildlife food value until washed off by subsequent rains.

In the unlikely event that an accidental oil spill were to occur through breakage of the product pipeline or oil storage facilities, adverse impacts would result upon vegetation, wildlife, and fish habitat exposed to the loss. Impacts from such a loss would depend upon several variables, including volume and location of losses, season, and the particular vegetation, fish and wildlife species exposed to the oil.

The prototype operations would have the potential to degrade water quality, through the contribution of toxic substances, including oil, to surface waters and from siltation resulting from both on- and off-tract construction activities. Aquatic life and habitat within degraded aquatic habitat would be adversely affected. Such aquatic habitat does not exist on Tract C-a itself, but does exist downstream in trout ponds on Ryan Creek, and annually in intermittent Yellow Creek and in the White River. Species which would be affected include trout, huckers, and shiners.

The anticipated rate of development of the prototype oil shale program in Colorado could over six years result in the influx of an estimated 30,000 oil shale related persons into regions in or near the Piceance Basin. The impacts of this population increase are discussed under Impact on Fish and Wildlife in Chapter III of Volume I.

b. Tract C-b

The tract is primarily suited for underground, room and pillar mining. Thus, major surface disturbance directly on this 5,114-acre tract would be confined to either: (1) an area totalling approximately 1,100 acres if underground disposal of the processed shale were employed or; (2) 2,200 acres if only surface disposal is used. In the event that the in-situ technique were selected, on-tract surface disturbance would be confined to an area about 800-acres.

Off-tract disturbances would be expected to result from: a one-mile extension of electric power transmission lines, a six-mile natural gas pipeline; a 30-mile long cross-country water transmission line from the White River; and a 30 to 40-mile long crude oil pipeline. A surfaced highway exists along Piceance Creek adjacent to the site, so off-tract improved road development can be limited to a two-mile long connecting link from the tract to the highway. A road network will, of course, be required on-tract. It is estimated that all of the above off-tract disturbances would total some 200-acres, a portion of which is wildlife habitat. It is possible that an additional 1,000 acres could be required for off-site spent shale disposal.

Development on Tract C-b would cause basically the same types of impacts on wildlife resources as those already described for Tract C-a, although the impacts would vary with respect to magnitude and be somewhat smaller. Similar impacts would include: additional accessibility with accompanying human use; increased hunting pressure with subsequent reductions in game populations and some loss of the tract's semi-remote hunting qualities; disturbance of behavior and activity patterns of wildlife; loss of both on- and off-tract habitat of intolerant species, such as mountain lion, elk, and peregrine and prairie falcon; aerial disturbance of mule deer and other animals in the event an air strip were constructed; both on- and off-tract reductions in wildlife food and cover with a corresponding reduction in animal populations; drying up of some natural surface water features, such as springs, seeps, etc., with a corresponding disruption of the associated plant-animal complex; a minor loss of birds, particularly hawks and eagles, usually through contacts with power distribution lines; the potential for accidental oil losses with adverse impacts upon vegetation and animals; the potential for introduction of toxic substances and silt to the White River with accompanying adverse impacts upon aquatic biota.

3. Utah Tracts U-a and U-b

Since these two Utah tracts adjoin one another, their impacts on fish and wildlife resources will be discussed together.

Impacts on fish and wildlife habitat would be dependent upon the mining methods used on the tracts. The two tracts are collectively best suited to underground mining method and underground disposal. With this technique, on-site physical disturbance would be confined to an area totalling approximately 1,100-acres. With surface waste disposal, some 2,200-acres would be disturbed on each tract. If Tract U-a were subjected to in-situ processing, the disturbance of surface, and hence wildlife habitat, would be approximately 1,800 acres. Off-site processed shale dump areas were not assumed in the analysis.

Off-tract disturbance, as on the Colorado tracts, would be expected to include utility corridors and roads. Utility needs for the two tracts would be expected to involve a 10-mile electric power transmission line; a 15-mile natural gas pipeline; and possibly construction of a 10-mile water transmission line from a proposed diversion site on the White River. Road construction would consist mainly of a surfaced highway, to be extended from a surfaced road at Bonanza, located 15 miles to the north. A 25- to 50-mile oil product line would be required, as a tie-in to an existing transcontinental pipeline. The off-site disturbance of all of the above may involve as many as 200-600 acres of surface, a portion of which is wildlife habitat.

Development on and adjacent to the adjoining Tracts U-a and U-b would cause basically the same types of impacts as those already described in detail for Colorado Tract C-a and summarized for Colorado Tract C-b. The impacts would, however, vary in magnitude because of site-specific characteristics of fish and wildlife and their habitat.

There is a potential for downstream degradation of aquatic habitats, since the tract boundaries lie adjacent to, or within a short distance of, the White River. The White River in the vicinity of Evacuation Creek has populations of catfish, brown bullheads, suckers and the rare and endangered squawfish, hump-backed sucker and boney-tail chub.

The anticipated rate of development of the prototype oil shale program in Utah could over six years result in the influx of an estimated 10,000 persons into the surrounding region. Of these, approximately 2,000 would be directly involved with mining, processing and construction activites at test-lease sites. The impacts of this population increase are discussed under Impact on Fish and Wildlife in Chapter III of Volume I.

4. Wyoming Tracts W-a and W-b

Since the two Wyoming tracts adjoin one another, impacts of their development upon fish and wildlife resources will be discussed together.

It is assumed that an in-situ processing system will be used on both of these tracts, with resulting surface disturbance of approximately 775 acres per tract.

Off-site surface disturbances to wildlife will result from construction of service and utility lines and roads to the tracts. A power transmission line will be required, probably from the Jim Bridger plant (Pacific Power and Light) 40 miles to the north, near Rock Springs, Wyoming. Natural gas may be secured at the Powder Wash or Hiawatha oil fields, located in Colorado approximately 30 miles to the south, or from Rock Springs, Wyoming. Either source will involve construction of a 30- to 40-mile, cross-country gas pipeline.

Water requirements of less than 3 cfs would probably be met through a pipeline diversion from Flaming Gorge Reservoir, approximately 50 miles to the west. Improved vehicular access would involve development of 25 miles of new road, to connect the test-lease sites with Interstate 80 to the north or about 13 miles of new road to connect with Wyoming No. 430 to the west. A connecting oil product pipeline 25- to 50-miles long will be required to tie-in with a transcontinental line located approximately 25 miles to the north. The above utility corridors and roads may initially involve disturbance of as much as 600 acres of surface, of which a portion is wildlife habitat.

Development on and adjacent to Tracts W-a and W-b would cause basically the same types of impacts as those already described in detail for Colorado Tract C-a and summarized for Colorado Tract C-b. The impacts would, however vary in magnitude because of site-specific characteristics of fish and wildlife and their habitat.

In the event that toxic substances, including oil or silt were to reach the Vermillion Creek and the Green River, adverse impacts would occur on aquatic organisms and their habitats.

Vermillion Creek has populations of suckers and trout, while Green River is designated as an outstanding trout stream.

The anticipated rate of prototype oil shale development in Wyoming could result in the influx of as many as 7,000 persons, of which approximately 1,300 would be directly involved in overall processing operation. The impacts of this population growth on fish and wildlife resources are discussed under Impacts on Fish and Wildlife in Chapter III, Volume I.

E. Impacts on Grazing

1. Colorado Tracts

a. Tract C-a

Although this tract is of minor agricultural value, development of it would affect grazing use. The land areas devoted to mine plant sites, residences, tank farms, overburden waste areas, spent shale dumps, and roads would remove some of the land from grazing use.

The entire lease area would not need to be removed from forage production at one time, and assuming restoration and revegetation of the mined and other disturbed areas is successful, grazing would be displaced for only a portion of the lease period.

There are three options that appear to be feasible for mining oil shale from this tract: (1) open pit, (2) underground, and (3) in situ. Disposal of overburden and spent shale can be made in canyons that are located off-tract about 8 miles west of the tract.

At the end of 30 years of lease operation, the effects on grazing by each feasible mining method would be as follows:

Operation	Total Acres Affected	Lost Grazing for Duration AUMs/yr.	Temporarily Lost Average AUMs/yr.
Open Pit	6,650	50	15
Open Pit (w/backfill)	3,655	50	10
Underground	2,210	30	5
In Situ	1,510	50	5

Column (2) relates to the total acres that are affected, on- and off-tract. Column (3) refers to those AUM's (Animal unit month) lost for the duration of the lease as a result of the plant, storage, and related facilities, including roads. Column (4) refers to those AUM's lost temporarily for grazing because the acreage involved is in various stages of ore removal, rehabilitation and revegetation.

The utility corridors would not remove a significant amount of forage, and restoration is generally accomplished in 2 years.

The rate of gain on young animals could be lowered due to the activity disturbing the livestock.

b. Tract C-b

Development of this tract by a room and pillar underground mine and the associated utilization of land area would affect grazing use. Land area devoted to plant sites, residences, tank farms, overburden waste areas, spent shale dumps, and highways will be removed from forage production.

The entire lease area would not need to be removed from forage production at one time; assuming restoration of the mined areas is successful grazing would be displaced for only a portion of the lease period.

It appears feasible that Tract C-b could be mined either by underground or in situ methods, or both. Disposal of overburden and spent shale can be made in canyons that are located on- and off-tract.

At the end of 30 years of lease operation, the effects on grazing by each feasible mining method would be as follows:

Operation	Total Acres Affected	Lost Grazing For Duration AUMs/yr.	Temporarily Lost Average AUMs/yr.
Underground	2,210	30	5
In Situ	1,630	50	5

The column designations are the same as described above under Tract C-a.

Rate of gain on young animals could be lowered due to the activity disturbing the livestock.

The utility corridors would not remove a significant amount of forage and restoration is generally accomplished in 2 years.

2. Utah Tracts

The two tracts, U-a and U-b, are adjoining and are therefore considered together. Impacts of development would be similar to those described for the Colorado tracts. The primary grazing use which would be affected would be winter sheep range

It appears feasible that Tracts U-a and U-b could be mined either by underground or in situ methods, or both. Disposal of overburden and spent shale can be made in canyons that are located on- and off-tract.

At the end of 30 years of lease operation for both tracts, the effects of grazing by each feasible mining method would be as follows:

Operation	Total Acres Affected	Lost Grazing For Duration AUMs/yr.	Temporarily Lost Average AUMs/yr.
Underground	2,210	15	5
In Situ	8,700	50	20

The column designations are the same as described above under Tract C-a.

3. Wyoming Tracts

Impacts of development of the two Wyoming Tracts, W-a and W-b, would be similar to that described for the Colorado tracts. Current surface use is primarily by deer, elk, and some wild horses. There is one licensed livestock operator in the area.

It appears that Tracts W-a and W-b could only be mined by in situ methods.

At the end of 30 years of lease operation on the tracts, the effects of grazing by in-situ mining would be as follows:

Operation	Total Acres Affected	Lost Grazing For Duration AUMs/yr.	Temporarily Lost Average AUMs/yr.
In Situ	7,270	57	17

The column designations are the same as described above under Tract C-a.

Impact on Aesthetics, Recreation, and Cultural Values

L. Colorado Tracts

Presently the area is remote and used primarily by hunters and oil, gas and ranching personnel. There is little incidence of air pollution, other than vehicular raised dust and smoke from occasional wildfires, whereas, the primary source of intermittent noise pollution is related to aircraft passage, as well as from scattered drilling rigs exploring for oil, natural gas or oil shale resources. The natural landscape of the area is in some places marred by road and trails, cleared fence lines and gas pipelines on cleared rights-of-way.

With the proposed project (open-pit type mine) the tract would lose its natural quiet at the mine and plant site. Noises associated with the activities of the operation will be greatest at the mine, plant site, and in the Douglas Creek drainage adjacent to the active shale disposal site.

The clear air may be degraded by dust from waste or vehicles. Impact from the mine and retort may not be significant in the immediate area during the summer months since normal corrective lifting will put particles into prevailing winds aloft. However, inversions during the winter months may trap and concentrate emissions over the Piceance Basin and could result in further accumulation of particulate contaminants. Dust from the spent shale disposal area on Douglas Creek, under night-time inversions which are common in the drainage area during the summer could result in increased air pollution if not properly controlled.

The visual impact from the disposal of spent shale and overburden storage would be notable until restoration activities are completed. The plant would be visible from ridge tops miles away. Spent shale disposal in the Douglas Creek drainage would alter the view of Cathedral Bluffs from the Douglas Creek drainage from the top of the bluffs. However, the development of an open-pit operation would provide a scenic vista which could increase tourist traffic.

Some visual impact on the asymmetric landscape would result from utility rights-of-way such as pipelines, powerlines, and roads. During the first five years, surface mine development would eliminate approximately 50 percent of the existing recreation on the tract and at the disposal site in the Douglas Creek area; 60 percent at 20 years; and 70 percent at 30 years. Recreational activities would be returned unaltered, assuming revegetation is successful.

With underground mining, the impact on recreation would be minimal during the first five years; with 30 to 50 percent at 20 and 30 years respectively assuming no rehabilitation work and 15 to 20 percent with rehabilitation.

With in situ mining the impact on recreation would be approximately 20 percent after 10 years operation.

In addition, camping will be affected in adjacent parts of the area. Deer hunters will be displaced from the site to other areas in the Piceance Creek Basin and/or adjacent regions. These hunters, as well as those related to normal population growth, will increase hunter density thus lowering the existing quality of the hunting experience.

Improved accessibility will create moderate increases in outdoor recreation activities such as: sightseeing, both on and off the road; camping, fishing, etc.; throughout the basin and on adjacent private and public lands (White River National Forest and BLM areas). In addition, the oil shale project may increase visitor use of the basin as a tourist attraction beyond that of normal outdoor recreation activities.

2. Utah Tracts

Presently, the area is characterized by desert shrub and pinyon-juniper communities and the terrain is sharply cut by deep canyons with numerous buttes and spires. It is relatively remote and basically is a primitive area. Recreation visitor use is presently light with an estimated 50 visitor days consisting mainly of hunting, rockhounding and sightseeing.

With the proposed project (underground mining) the area will be changed from its present state to a semi-industrial environment; it is estimated that less than 5 percent of the surface outdoor recreation resources would be affected during the first three years of operation, 15 percent at 10 years, 30 percent at 20 years, and 50 percent at 30 years. With successful rehabilitation 16 to 20 percent of the tract site would be adversely affected at 20 and 30 years respectively.

The required pipelines, powerlines, roads and other service facilities would change an asymmetric type landscape to a symmetric type. Noise created by crushing, and retorting operation of heavy equipment in disposing of spent shales would impact the aesthetic value of the area as would the minor petroleum odors from the retorted hydrocarbon liquids and gases.

It is likely that there will be an increased use of outdoor recreation visitor use both on and around the project areas caused by normal population growth plus that caused by plant personnel and their families for sightseeing, picnicing, hunting, rockhounding, and floating and fishing on the White River.

With in situ mining, the affect upon outdoor recreation would be minimal during the first five years of operation, since the recovery method, if employed, probably would not be initiated before that time.

After three years of an in situ operation, approximately 350 acres a year of new land would be affected, however, with restoration this area should largely be returned for recreational use. The total area, considering restoration, that could be affected during the life of the project could approach 1,800 acres.

3. Wyoming Tracts

Presently the area is characterized as remote, semi-primitive and sparsely settled. A total of several hundred man-days recreational use are expended annually within the tract boundaries.

With the proposed project, the area will be changed from its present state to semi-industrial environment requiring approximately 40-50 surface areas for in situ processing system, and approximately 300 surface acres per year for 25 years.

The activity would change an asymmetric landscape into a symmetric landscape by requiring pipelines, powerlines, roads and other service facilities and create noise caused by crushing and retorting operations of heavy equipment as well as minor petroleum odors from the retorted hydrocarbon liquids and gases.

The installation and associated activity would impair the scenic wide open space views from Kinney Rim and may create an additional amount of outdoor recreation visitor use both on and around the project areas. It is likely that there will be an increased use caused by normal population growth plus that cuased by plant personnel and their families for sightseeing, picnicing, hunting, rockhounding, and fishing.

G. Impacts on Existing Economic and Social Environment

2. Colorado Tracts

Rangely in Rio Blanco County might be expected to be the residence of most of the population generated by the C-a tract in Rio Blanco County. Rangely is also accessible from the Utah tract and one third of the population generated by that tract is projected to reside in Rangely. Thus the population of Rangely could increase from 1,500 to 9,350. If the C-a tract proves to be inaccessible from existing communities in the winter because of snow conditions, an entirely new community could develop close to the tract to house up to 8,700 people associated with this tract.

Meeker in Rio Blanco County might be expected to be the residence of almost all the population associated with the C-b tract in Rio Blanco County. The population of Meeker could increase from 1,500 to 7,650.

Rifle, Glenwood Springs, and a number of smaller communities in Garfield County would be expected to receive more than half of the 18,500 population increase associated with plants on non-federal lands. Rifle could increase from 1,500 to 5,500, Glenwood Springs from 4,100 to 8,100, and such towns as Grand Valley and Debeque could have a combined increase of 2,000.

Grand Junction, in Mesa County, would get the remaining population associated with the non-federal plants. In addition, part of the population associated with the C-a tract could reside in Grand Junction. The population of Grand Junction could increase from 20,170 to 30,000. The expansion of public facilities in Grand Junction necessitated by this population increase may be difficult to finance since the oil shale plants with this new population will be in Garfield County. The property taxes on these plants will therefore be collected by Garfield County.

The three Colorado counties have formed an Oil Shale Regional Planning Commission to study the regional impact of an oil shale industry and to advise the individual counties of their findings. Each of these counties has their own planning commission. Rio Blanco and

and Mesa Counties have adopted zoning ordinances with high quality standards for subdivisions and mobile home parks.

These regulations include such provisions as a minimum lot size of 5 acres for lots not served by public sewer and the requirement that each space in a mobile home park be served by running water and a public sewer.

Zoning and planning can control the quality of new urban developments. However, when a town grows to as much as six times its original size in a short period, there will very likely be disruptions to the routine of both the new population during construction. These disruptions would be caused by the physical activity of construction and by the short-term shortages of utilities, housing, or services that may be caused by poor planning or labor strikes. Such large scale growth can result in a town having an entirely different ethnic, cultural, and religious composition after expansion than it had before.

Non-agricultural employment in the three counties was about evenly divided between white collar and blue collar jobs in 1970. Most of the new oil shale plant jobs will be blue collar, but the urban support jobs associated with these will be both white collar and service. The overall composition of employment therefore will shift toward a larger percentage of blue collar jobs.

These shifts in the composition of urban population can cause antagonisms to develop between the established residents and the newcomers unless an organized effort is made to defuse grievances as they arise.

a. Local Government

Revenues to county governments in Colorado have ranged from $133 per capita in Mesa County and $157 per capita in Garfield County where there is little industry, to $325 per capita in Rio Blanco County where petroleum producing properties contribute to the county tax revenue.

The tax revenue to local governments that will be generated by an oil shale plant and the taxable property belonging to the associated new population is estimated to be approximately $1000 per capita. The net effect of oil shale development therefore will be to raise the per capita tax revenue to the county in which the plant is located. Counties whose population is increased due to an oil shale plant located in an adjacent county may suffer a decline in per capita tax revenue unless tax rates are increased.

In Colorado, the two Federal tracts are in Rio Blanco County and nearly all of the population associated with these plants would be expected to reside in the county. In addition, Rio Blanco County may be the residence of some of the employees of the oil shale plant on the Federal tract in Utah. Rio Blanco County would not get the benefit of any of the local taxes paid by that plant. The net taxes to Rio Blanco County per new resident could therefore be less than $1000 per person.

Several oil shale plants could be built on private lands in Garfield County. If part of the population associated with these plants resided in Mesa County, Garfield County would receive more than $1,000 in tax revenues per new resident. Mesa County on the other hand, with added population but no oil shale plant would receive only those tax revenues generated by the property of the new residents and associated businesses located in Mesa County.

b. Commuting Patterns

As a result of studies conducted by the Rio Blanco Planning Commission, a county road traversing the Piceance Creek Basin has recently been paved to State Highway 64 between Rangely and Meeker and comes within 16 miles of tract C-a and within one mile of tract C-b. The tracts are approximately 40 miles from either Rangely or Meeker via this route.

c. Impact on Indians

There is no sizeable community of Indians existing in the oil shale area.

3. Utah Tracts

The 50,000 barrels per day of oil shale capacity in Uintah County would generate a population increase of about 6,200. The plant site is accessible from both Vernal, Utah, and Rangely, Colorado. Two thirds of the associated population would be expected to reside in Vernal and the population of Vernal could increase from 4,000 to 8,000.

The Planning Commission of Vernal, Utah has developed a planning and zoning program for the whole of Uintah County. It has already been implemented for the city of Vernal but not for the whole county.

Employment in the city of Vernal is approximately 60 percent white collar. The influx of oil shale operating personnel and the accompanying urban support personnel will tend to shift this distribution toward a higher percentage of blue collar workers.

The same sort of social strains can be expected to develop in Vernal as were discussed in the previous section on Colorado tracts.

a. Local Government.

The Uintah County tax revenue in 1962 was $112 per person. An oil shale plant and related residences and business is expected to generate approximately $1000 in local tax revenues per new resident. If some portion of the population associated with the Uintah County federal oil shale lease and plant reside in Colorado, the tax revenues to Uintah County will exceed $1000 for each new resident.

b. Commuting Patterns

The two communities of substantial size nearest the Utah tracts are Vernal, Utah and Rangely, Colorado. Vernal is located approximately 60 miles northwest of the tract sites. The tracts can be reached by going east from Vernal on Federal Highway 40 for 30 miles, south on State Highway 45 for approximately 20 miles and continuing south on a county dirt road for the last 10 miles.

Rangely, Colorado is also approximately 60 miles from the Utah tracts and is expected to be the residence of some of the workers from these sites. Travelling from Rangely will entail driving west on Colorado State Highway 64 for 30 miles, six miles on Federal Highway 40 and south on Utah State Highway 45 for 20 miles, the same route as the Vernal commuters to the county road for the last 10 miles.

c. Impact on Indians

The Uinta Basin, in which tracts U-a and U-b are located, also includes a portion of the Uintah and Ouray Indian Reservation. The reservation lands lie to the west and north of the tracts and therefore, it is expected that neither commuting patterns nor residential developments will affect tribal lands. Vernal, the community which will be the residence of most of the workers for the Utah tracts is also east of the reservation.

The Uintah and Ouray Indian tribes will be affected by the oil shale development through the probable increased useage of their recreational and tourist facilities. These tribes have established these facilities as one of their major sources of income. Almost the entire southern half of the reservation is utilized for recreational facilities, primarily hunting and fishing and the tribes have established a motel complex in the north close to Vernal. The increased population in the area will probably rely to a large extent on the tribal developed recreational facilities and thereby contribute to their income.

An additional impact on the Uintah and Ouray tribes caused by the prototype leasing program may be the creation of employment opportunities. Many of these Indians have had prior experience working in mines and do not have negative attitudes or superstitions about mine work. As one of the tribes main source of income at the present is their recreational and tourist facilities, this program may have a favorable impact upon the Uintah and Ouray tribal economics.

4. Wyoming Tracts

The 50,000 barrels per day capacity in Sweetwater County, Wyoming would generate an associated population increase of about 7,100. These people most likely reside in Rock Springs and Green River. The population of Rock Springs could increase from 11,650 to 17,000 and that of Green River from 4,200 to just over 6,000.

The Sweetwater County Planning Commission has adopted zoning regulations comparable to those of Rio Blanco County, Colorado.

Both Rock Springs and Sweetwater County already have more blue collar employment than white collar employment. The development of an oil shale plant will enlarge the proportion of blue collar employees.

The social disruptions and antagonisms likely to develop in Sweetwater County would be the same as described for Colorado but may be less severe because the towns of Rock Springs and Green River are expected to expand by only 50 percent and already have predominantly blue collar employment.

a. Local Government

The local tax revenue in Sweetwater County in 1962 was $113 per capita. The local taxes to be generated by the oil shale plant and associated residences and businesses are expected to approximate $1,000 per new resident. The average per capita tax revenue to Sweetwater County would therefore be increased by the addition of a shale oil plant.

b. Commuting Patterns

The Washakie Basin tracts are located 50 to 60 miles southeast of Rock Springs and Green River, both of which are located on Interstate 80. Green River is approximately 10 miles west of Rock Springs. From Rock Springs, the workers would drive about 40 miles south on State Highway 430 which passed 10 miles to the west of the tracts. There is no marked road between the tracts and State Highway 430.

c. Impact on Indians

There is no sizeable community of Indians existingiin the oil shale area.

V. Mitigating Measures Included in the Proposed Action

The mitigating measures which would be taken to assure that the environmental concepts presented in this Draft Environmental Statement would be satisfied are contained in the proposed lease which includes stipulations that supplement the Department's regulations governing surface exploration, mining and reclamation of lands (43 CFR Part 23) and the operating regulations for mining (30 CFR 231). The requirements under the lease and regulations would require compliance with all applicable State and Federal regulations. The lease would further provide that future standards that may be promulgated would have to be met unless in consistent with specific provisions of the lease.

Special stipulations developed for this proposed prototype program would place additional requirements on the lessee to insure that the environmental impact caused by prototype oil shale development on the immediate and adjacent area would be minimized.

The proposed lease, and special lease stipulations, and the Department's regulations for mining cited above are presented below.

Form Land Office Serial Number

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

OIL SHALE LEASE

In consideration of the benefits conferred on each party by the terms of this contract, this lease is entered into on by the United States of America, hereinafter called the lessor, acting through the Bureau of Land Management of the Department of the Interior, hereinafter called the Department, and

,hereinafter called the lessee, pursuant and subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920 (41 Stat. 437), as amended (30 U.S.C. §§ 181-263)(hereinafter referred to as "the Act"), and to the terms, conditions, and requirements (1) of all regulations promulgated by the Secretary of the Interior in existence upon the effective date of this lease, specifically including but not limited to the regulations in 30 CFR Part 231 and 43 CFR Parts 23 and 3000, all of which are incorporated herein and, by reference, made a part hereof; and (2) of all regulations hereafter promulgated by the Secretary of the Interior, when not inconsistent with any express and specific provisions of this lease, all of which shall be, upon promulgation, incorporated herein and, by reference, made a part hereof.

Definition. The following definition shall be used in the interpretation of this lease:

"Oil shale" is a fine-grained sedimentary rock containing organic matter which was derived chiefly from aquatic organisms or waxy spores or pollen grains, which is only slightly soluble in ordinary petroleum solvents, and of which a large proportion is distillable into artificial petroleum. This term is applicable to any argillaceous, carbonate, or siliceous sedimentary rock which, upon destructive distillation, will yield at least 15 gallons of oil per ton of oil shale.

Sec. 1. The lessor, does hereby grant and lease to the lessee:

(a) Rights of lessee. The exclusive right and privilege to mine, retort, process by in situ methods, and dispose of all deposits of oil shale and the products thereof, hereinafter referred to as the leased deposits, in, upon, or under the following-described tracts of land, situated in the County of , State of : containing acres, more or less, together with the right, subject to the applicable regulations and the requirements imposed thereunder and the terms of this lease, to construct all such works, buildings, plants, structures, and appliances as may be necessary or convenient for the mining, retorting, processing, and preparation of the leased deposits for market and the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

(b) Lease term. This lease shall be for a period of 20 years and so long thereafter as there is production from the leased deposits in paying quantities, subject to the right of the lessor to readjust the terms and conditions of this lease at the end of each 20-year period as provided in Sec. 3(d) hereof.

Sec. 2. The lessee hereby agrees:

(a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all of the provisions of the lease, except those provisions compliance with which is made subject to the bonds required under subsections 2(r) and 5(e) hereof, and to increase the amount of, or to furnish such other, bond as may be required.

(b) Rental. To pay lessor, annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, 50 cents for each calendar year, such rental for any calendar year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(c) Royalty. (1) Oil Shale extracted by mining methods. (i) Except as otherwise provided in this subsection 2(c), to pay the lessor a royalty of 12 cents on every ton of 2,000 pounds of oil shale containing 30 gallons of shale oil per ton mined for processing under this lease.

(ii) The royalty shall increase or decrease 1 cent, or fraction thereof, on every ton of oil shale mined for each gallon, or fraction thereof, of increase or decrease in shale oil content above or below 30 gallons per ton of oil shale.

(iii) The royalty shall likewise increase or decrease in the same percentage as the percentage of increase or decrease in the combined average value per barrel of all crude oil and crude shale oil produced in the States of Colorado, Utah, and Wyoming as of January 1 of each year, as determined by the Secretary of the Interior, the said average value to be in effect during the entire year beginning on that date. For the purpose of this computation, the initial combined average value shall be the value determined for the year in which actual production commences or for the eleventh year of this lease, whichever is earlier.

(iv) In no event, however, shall the royalty be decreased in the manner prescribed in the 2nd or 3rd paragraphs of this subsection to become less than 4 cents on every ton of oil shale mined under the lease.

(v) The shale oil content of the oil shale shall be determined by the Modified Fischer Assay method and the royalty shall be based on the weighted monthly average of shale oil content of every ton of oil shale mined under this lease. Computations of quantities, assays and royalties shall be rounded to the nearest hundredth.

(2) <u>Oil Shale processed by in situ methods</u>.

(i) Except as otherwise provided in this subsection 2(c), to pay the lessor a royalty of 12 cents on every ton of 2,000 pounds of oil shale which is processed by in situ methods for recovery of shale oil or other products, which oil shale shall be deemed for the purposes hereof to contain 30 gallons of shale oil per ton. The number of tons of oil shale shall be determined by: (1) establishing through calorimetric tests designated by the American Society for Testing and Materials as "Standard" or "Tentative," the total gross heat of combustion in Btu's of all oil and gas products at the well head, adjusted downward by the total gross heat of combustion in Btu's of combustible fluids (gases or liquids) injected as heat carriers, but not for fuel purposes, into the formation being processed; (2) dividing the adjusted total gross heat of combustion in Btu's by 152,700 Btu's (the typical total gross heat of combustion of oil plus gas demonstrated to be present per gallon of shale oil recovered by modified Fischer assay of oil shales containing approximately 30 gallons of shale oil per ton), to arrive at the equivalent number of gallons of shale oil produced; and (3) dividing the equivalent number of gallons of shale oil produced by 30, to arrive at the number of tons of oil shale processed by in situ methods.

(ii) The royalty shall increase or decrease in the same percentage as the percentage of increase or decrease in the combined average value per barrel of all crude oil and crude shale oil produced in the States of Colorado, Utah, and Wyoming as of January 1 of each year, as determined by the Secretary of the Interior, the said average value to be in effect during the entire year beginning on that date. For the purpose of this computation, the initial combined average value shall be the value determined for the year in which actual production commences or for the eleventh year of this lease, whichever is earlier.

(iii) Computations of quantities, assays and royalties relating to tonnage of oil shale shall be rounded to the nearest hundredth.

(3) Additional royalties: In addition to the royalty described in paragraph 2(c)(1)

or 2(c)(2), to pay a royalty on minerals other than shale oil produced from the leased deposits of 3 percent of the quantity or gross value of the output thereof at the point of shipment to market for the first ten years of the lease; 4 percent beginning the eleventh year and for each succeeding year to and including the fifteenth year; and thereafter 5 percent beginning the sixteenth year and for each succeeding year to and including the twentieth year of the lease.

(4) General. (i) Royalties on the leased deposits shall be payable monthly in cash or delivered in kind at the option of the lessor.

(ii) When paid in value such royalty on production shall be due and payable monthly on the last day of the calendar month following the calendar month in which produced.

(iii) When royalty is to be taken in kind the lessee shall be notified 3 months in advance that delivery of royalty products shall be required for a stated period not exceeding 12 months. Royalty products shall be delivered in merchantable condition at the point of shipment without cost to the lessor at such time and in such storage facilities provided by the lessee as may reasonably be required by the lessor, provided, that the lessee shall not be required to hold the royalty products in storage for more than 30 days beyond the end of the month in which produced, and provided further, that the lessee shall in no manner be responsible or held liable for the loss or destruction of the royalty products in storage from causes over which the lessee has no control.

(iv) Upon a showing to the satisfaction of the Secretary that compliance with the requirements prescribed in any exploration or mining plan, or amended, supplemental, or partial plan, approved in accordance with the regulations in 43 CFR Part 23, now or hereafter in force, and the requirements of Sec. 5 hereof, has engendered or will engender extraordinary costs (1) not within the contemplation of the parties on the effective date of such plan, and (2) in excess of the amount of any outstanding bond filed and maintained by the lessee pursuant to subsection 5(e) hereof, the Secretary may, in order to offset such costs, adjust the royalties that would otherwise become due and payable thereafter under subsections 2(c) or 2(d) by allowing a credit against those royalties in such amount, and for such time, as he determines are warranted in the circumstances.

(v) It is expressly understood that, notwithstanding any other provision hereof, the lessor reserves the right to readjust the royalties prescribed in this subsection 2(c) as provided for in subsection 3(d) hereof.

(d) Minimum production. (1) Beginning with the sixth calendar year of the lease, except when the Secretary has directed or consented to a suspension of operations under Sec. 39 of the Act, to mine, or process by in situ methods, the leased deposits during that year to a royalty value of \$1 per acre or fraction thereof, and thereafter the royalty value shall increase \$1 per acre per year each succeeding year to and including the tenth year to a royalty value of \$5 per acre or fraction thereof.

(2) Or beginning the sixth calendar year, in lieu of any mining or in situ processing to pay

minimum royalty of $1 per acre or fraction thereof, and thereafter the minimum royalty shall increase $1 per acre per year each succeeding year to and including the tenth year to a minimum royalty of $5 per acre or fraction thereof.

(3) Beginning with the eleventh calendar year of the lease, except when the Secretary has directed or consented to a suspension of operations under Sec. 39 of the Act, to mine, or process by in situ methods, the leased deposits during that year at a minimum production rate of the equivalent of [3,500] tons of 2,000 pounds of oil shale containing 30 gallons of shale oil per ton per day, which is hereby established on the basis of an estimated recoverable reserve within the leased lands on the effective date of this lease of [2,100,000,000] tons of oil shale containing an average 30 gallons of shale oil per ton, and pay royalty thereon as prescribed in subsection 2(c) hereof, and thereafter the minimum production rate shall increase in a like amount of [3,500] tons of oil shale per day per year each succeeding year to and including the twentieth year to a rate of [35,000] tons of oil shale per day,

and the royalty payable during such succeeding years as prescribed in subsection 2(c) shall likewise increase in relation to the increase in the minimum production rate.

(4) Or beginning the eleventh calendar year, in lieu of any mining or in situ processing to pay minimum royalty of a value equivalent to the royalty value on a production rate of [3,500] tons of oil shale containing 30 gallons of shale oil per ton mined per day as prescribed in subsection 2(c) hereof, and thereafter the production rate for computing the minimum royalty shall increase in a like amount of [3,500] tons of oil shale per day per year each succeeding year to and including the twentieth year to a production rate of [35,000] tons of oil shale per day, and the minimum royalty payable during such succeeding years shall likewise increase in relation to the increase in the production rate and in the equivalent royalty payable thereon as prescribed in subsection 2(c).

(e) Payments. To make rental and bonus payments to the Manager of the appropriate Land

Office, except that when this lease becomes productive the rentals, bonus installments, if any, and royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Reports, Maps, Etc. (1) At such times and in such form as the lessor may prescribe, to furnish a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined or processed by in situ methods during the quarter, the character and quality thereof, amount of its products and by-products disposed of and price received therefor, and amount in storage or held for sale.

(2) To prepare and furnish at such times and in such form as the lessor may prescribe, maps, photographs, reports, statements and other documents required by the regulations in 30 CFR Part 231 and 43 CFR Part 23.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined or processed by in situ methods and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection and investigation. To permit at all reasonable times by any duly authorized officer of the Department: (1) inspection or investigation of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) copying and making extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office, within 90 days from the date of execution, any assignment or transfer made of this lease, or of any interest in this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument shall take effect on the first day of the month following approval by the Bureau of Land Management, or, if the assignee requests, on the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Lands disposed of with leased deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the leased deposits therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such deposits.

(k) Operations on the leased lands, protection of the environment and public health and safety, employee guarantees. (1) To exercise reasonable diligence, skill, and care in all operations on the leased lands.

(2) To conduct all operations on the leased lands in accordance with approved exploration or

mining plans as provided in the regulations in 30 CFR Part 231 and 43 CFR Part 23, modified, where necessary, to cover other than surface operations, and, in general, to conduct all such operations so as to prevent injury to life, health or property, to avoid, minimize, or repair damage to the environment, including land, water and air, to avoid, minimize, or correct hazards to the public health and safety, and to avoid wasting the mineral deposits which may be found in, upon or under such lands. It is understood and agreed that the regulations in 30 CFR Part 231 and 43 CFR Part 23 shall apply to any operations conducted under this lease whether underground or surface mining or in situ operations.

(3) To pay all wages due miners and other employees both above and below ground at least twice each month in lawful money of the United States; to accord all miners and other employees complete freedom of purchase; to restrict the workday to not more than 8 hours in any one day for underground workers, except in cases of emergency; and to employ no person under the age of 16 years in any mine

below the surface, unless the laws of the State in which the mine is situated prohibit the employment in a mine below the surface of persons of an age greater than 16 years, in which case the State laws shall control.

(l) Taxes. To pay, when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(m) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 25 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, except that,where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Department that he has made substantial investments for improvements on the land covered by the assignment.

(n) Delivery of premises in case of forfeiture. In case of forfeiture of this lease to deliver up to the lessor, in the condition required by the reclamation requirements of approved exploration or mining plans and other terms of applicable regulations, and subject to the provisions of Sec. 7 hereof, the leased lands, including permanent improvements and other property, whether fixtures or personalty, and all underground timbering, well casing, and such other supports and structures as are necessary for the preservation of any mines, other underground development works, or deposits.

(o) Extraction by in situ methods. Not to locate, where minerals are taken from the earth by in situ methods, any entry, well or opening for extraction within a producing formation within 500 feet of the boundary line of leased lands without the permission of, or unless directed by the lessor, nor shall induced fracturing extend to less than 100 feet from that boundary line.

(p) Nuclear stimulation. Not to utilize nuclear-explosive fracturing or stimulation in the extraction or processing of minerals subject to this lease, without the express, written consent of the Secretary of the Interior being first obtained.

(q) Bonus. (1) Except as provided in Paragraph (2) hereof, in addition to the payment made at the time of sale of this lease in the amount of [ ] dollars, which is the first installment on the bonus bid for the sale of this lease, to pay the lessor the amount of [ ] dollars due and owing on the bonus bid in 4 equal annual installments of [ ] dollars, such payments to be made on the first anniversary date of this lease and thereafter on each succeeding anniversary date to and including the fourth anniversary date.

(2) In the event the Secretary of the Interior should accept the surrender or relinquishment of this lease at any time prior to the third anniversary date of the lease, the lessee shall be released from the obligation to pay the fourth and fifth installments of the bonus which would have been otherwise due and owing on the third and fourth anniversary dates, respectively, of this lease.

(3) To maintain, in addition to the bonds maintained under subsections 2(a) and 5(e) hereof, the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with the

terms and conditions of this subsection 2(r) for the payment of the balance of the bonus due and owing to the lessor.

(r) Development Programs; diligence requirements. (1) Upon issuance of this lease, and in accordance with the approved preliminary development program incorporated in the terms of the offer, to proceed diligently to develop the leased deposits by approved methods and in such manner as to utilize all of the leased deposits that can be successfully processed hereunder.

(2) (i) To file with the mining supervisor on or before the third anniversary hereof a detailed development program, including a schedule of the planning, exploratory, development and production operations to be conducted thereunder, and a detailed description under 43 CFR Part 23 of the procedures to be followed to assure that the development program, and lease operations thereunder, will meet and conform to the environmental criteria, controls, and constraints incorporated in the lease, which have been formulated by the lessor for the express purpose of preserving and protecting the environment,

including land, water, air, and other natural resources within the area in which the leased premises are situated; and (ii) prior to commencing any of the said operations on or in the leased premises, to obtain approval of the detailed development program in accordance with the applicable regulations, and to proceed diligently to develop the leased deposits by approved methods and in such manner as to utilize all of the leased deposits that can be successfully processed hereunder.

(3) To file with the mining supervisor annual progress reports describing the operations actually conducted under the development program prescribed in Paragraph (2) above.

(4) To submit for approval in accordance with the applicable regulations a written statement of any proposed change in or supplement to the development plan prescribed in Paragraph (2) above, including any request for delay in scheduled performance, and the justification for the changes proposed. Any change or supplemental plan shall become effective only upon approval.

Sec. 3. The lessor expressly reserves the following rights, powers and authority:

(a) Easements and rights-of-way; investigations. (1) Upon such terms as it may determine to be just, the right to permit for joint or several use such easements or rights-of-way, including easements in tunnels, upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(2) The right to conduct geological and other investigations which do not interfere with or endanger operations under this lease.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the leased deposits therein, or to dispose of any surface resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. The full power and authority to promulgate and enforce all orders and regulations issued under the provisions of Sections 30 and 32 of the Act, as amended, necessary to insure the sale of the production of the leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms and conditions. The right to readjust royalties payable hereunder and other terms and conditions of this lease after the first 20-year period specified in Sec. 1 hereof, and thereafter after each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files either objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such readjusted terms and conditions.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, except such conditions as are required by the Act, as amended, but any such waiver shall extend only to the particular breach as waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. Relinquishment of lease. (a) Upon a satisfactory showing: (1) of compliance with the applicable regulations, and (2) that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. In no event shall the public interest be deemed to be impaired by a surrender or relinquishment of this lease prior to the third anniversary date hereof.

(b) A relinquishment must be filed, in duplicate, in the proper Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety, in accordance with the applicable regulations and the terms and conditions of this lease: (1) except as provided in subsection 2(r)(2) hereof, to make payment of all accrued bonus payments, rentals, and royalties; (2) to provide for the preservation of any mines, in situ productive works, underground development works, other permanent improvements or other property, whether fixtures or personalty, on the leased land; (3) to provide for the reclamation of lands and waters affected by exploration or mining operations under this lease; and (4) to comply with all the requirements of sec. 5 of this lease.

Sec. 5. Protection of the environment, nonmineral resources, and improvements, and reclamation of lands and waters. The lessee agrees:

(a) To meet all requirements formulated in accordance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, for the preservation and protection of the environment, including land, water, and air, for the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and the reclamation of lands and waters affected by exploration or mining operations, including in situ operations.

(b) In addition to meeting the requirements specified in paragraph (a) hereof, to conduct exploration or mining operations in compliance with all applicable Federal, State, and local water pollution control, water quality, air pollution control, and air quality standards in existence upon the effective date of this lease or thereafter promulgated.

(c) To comply with any exploration or mining plan, or amended, supplemental, or partial plan, approved in accordance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, the requirements of paragraph (b) hereof, and other terms and conditions of this lease, and to take such steps as may be specified in any such plan for the preservation and protection of the environment, the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and the reclamation of lands and waters affected by exploration or mining operations.

(d) To comply with the requirements for cessation or abandonment of operations under any exploration or mining plan, or amended, supplemental, or partial plan, approved in accordance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, the requirements of paragraph (b) hereof, and other terms and conditions of this lease, and to carry out and complete operations, including all reclamation requirements, in accordance with any such plan.

(e) (1) Upon approval of an exploration plan or mining plan, to file with the lessor and maintain, in addition to the bonds required under subsections 2(a) and 2(r) hereof, a bond in an amount of not less than $500 per acre of land estimated to be affected during the first 3-year period of exploration or mining operations, and thereafter during each succeeding 3-year period of exploration or mining operations, or in such amount as may be established at the time of approval of any exploration or mining plan, including amended, supplemental, or partial plans, whichever is greater, but in any event in an amount of not less than $2,000, which bond shall be conditioned upon the faithful compliance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, particularly 43 CFR 23.9, the terms and conditions of sections 5 and 11 of this lease, and any approved exploration or mining plan, or approved amended, supplemental, or partial plan, as the same relate to the preservation and protection of the environment, including land, water, and air, the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and the reclamation of lands and waters affected by exploration or mining operations.

(2) The amount of the bond required by paragraph (1) hereof may be increased or decreased upon approval of an amended, supplemental, or partial mining plan which includes an increase or decrease in the estimated number of acres to be affected during the 3-year period to be covered by the bond, but in no event shall the amount become less than $500 per acre of land estimated to be affected, nor less than $2,000 in total amount, during the 3-year period to be covered by the bond. The bond may be released as to leased lands affected by exploration or mining operations during the 3-year period covered by the bond, at such time as, and to the extent that it is determined by the lessor that such lands meet the reclamation requirements of the approved exploration or mining plan and that operations have been carried out and completed with respect to these lands in accordance with the approved plan.

(f) To take such reasonable steps and to conduct operations in such manner as may be needed to avoid, minimize, or repair damage to: (1) any forage and timber growth on Federal or non-Federal lands in the vicinity of the leased lands; (2) crops, including forage, timber, or improvements of a surface owner; or (3) improvements whether owned by the United States or by its permittees or lessees. The lessor must approve the steps to be taken and the restoration to be made in the event of the occurrence of damage described in this paragraph (f).

Sec. 6 Equal Opportunity Clause; certification of non-segregated facilities.

(1) Equal Opportunity Clause. During the performance of this contract the lessee agrees as follows: (i) The lessee will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The lessee will take affirmative action to insure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment,

upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the lessor setting forth the provisions of this Equal Opportunity clause.

(ii) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(iii) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the lessor, advising the labor union or workers' representative of the lessee's commitments under this Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(iv) The lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations and relevant orders of the Secretary of Labor.

(v) The lessee will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the Secretary of the Interior and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(vi) In the event of the lessee's noncompliance with the Equal Opportunity clause of this lease or with any of the said rules, regulations, or orders, this lease may be canceled, terminated or suspended in whole or in part and the lessee may be declared ineligible for further Federal Government contracts or leases in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(vii) The lessee will include the provisions of Paragraphs (i) through (vii) of this subsection 6 in every contract, subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each contractor, subcontractor or vendor. The lessee will take such action with respect to any contract, subcontract or purchase order as the Secretary may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, That in the event the lessee becomes involved in, or is threatened with, litigation with a contractor, subcontractor or vendor as a result of such direction by the Secretary, the lessee may request the lessor to enter into such litigation to protect the interests of the lessor.

(2) Certification of nonsegregated facilities. By entering into this lease, the lessee certifies that lessee does not and will not maintain or provide for lessee's employees any segregated facilities at any of lessee's establishments, and that lessee does not and will not permit lessee's employees to perform their services at any location, under lessee's control, where segregated facilities are maintained. The lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause in this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or

are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. Lessee further agrees that (except where lessee has obtained identical certifications from proposed contractors and subcontractors for specific time periods) lessee will obtain identical certifications from proposed contractors and subcontractors prior to the award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that lessee will retain such certifications in lessee's files; and that lessee will forward the following notice to such proposed contractors and subcontractors (except where the proposed contractor or subcontractor has submitted identical certifications for specific time periods): Notice to prospective contractors and subcontractors of requirement for certification of nonsegregated facilities. A Certification of Nonsegregated Facilities, as required by the May 9, 1967, order (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semi-annually, or annually).

Sec. 7. Removal of property on termination of lease. (a) Upon termination of this lease, by surrender or forfeiture, the lessor, his agent, licensee, or other lessee, shall have the exclusive right, at the lessor's election, to purchase at any time within 6 months thereafter, at the appraised value thereof, any or all structures, equipment, machinery, tools, appliances, and materials, whether fixtures or personalty, placed by the lessee in or on the land leased hereunder, other than all underground timbering and such other supports and structures as are necessary for the preservation of any mines or other underground development works, which shall be and remain a part of the realty without further consideration or compensation; the purchase price to be paid for such structures, equipment, machinery, tools, appliances, and materials shall be fixed by appraisal of three disinterested and competent persons (one to be designated by each party thereto and the third by the two so designated), and the valuation of the three or a majority of them shall be conclusive; pending such election to purchase within said period of 6 months, none of those structures or other property shall be moved from its normal position.

(b) At any time within a period of 90 days after election by the lessor not to purchase or upon expiration of said period of 6 months without election by the lessor, the lessee shall have the privilege of removing from the premises said structures and other property except said timbering and other supports and structures as are necessary for the preservation of any mines or other underground development works as aforesaid.

(c) Any structures, machinery, equipment, tools, appliances, and materials, subject to removal by the lessee as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions or other good and sufficient reason, at the election of the lessor, but the lessee shall remove any or all of such property on expiration of said 90-day period when so directed by the lessor.

Sec. 8. Remedies in case of default. If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or make default in the performance or observance of any of the provisions of this lease and such default shall continue for a period of 30 days, or such other period as may be specified under applicable regulations, after service of written notice thereof by the lessor, the lessor may suspend operations where authorized by the applicable regulations until such time as any required action is taken to correct noncompliance, or the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in

Sec. 31 of the Mineral Leasing Act, and for forfeiture of any performance bond required by the applicable regulations. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. The lessee shall not, however, be held responsible for damage or casualties occasioned by causes beyond the lessee's control.

Sec. 9. Heirs and successors in interest. Each obligation hereunder shall extend to and be binding upon, and every benefit shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 10. Unlawful interest. No member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States (41 U.S.C. § 22), as amended, and Sections 431, 432, and 433, Title 18 of the United States Code, relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

Sec. 11. There are attached hereto and specifically incorporated in and made a part of this lease stipulations of the general requirements which have been made known in writing to and accepted by the undersigned lessee and which the said lessee must meet for the protection of nonmineral resources during the conduct of exploration or mining operations and for the reclamation of lands or waters affected by exploration or mining operations.

THE UNITED STATES OF AMERICA

BY __________________________
(Authorized Officer)

____
(Title)

Witnesses to Signature of Lessee(s)

____
(Date)

__________________________ __________________________
(Signature of Lessee)

__________________________ __________________________
(Signature of Lessee)

__________________________ __________________________
(Signature of Lessee)

STIPULATIONS

For Proposed

OIL SHALE PROTOTYPE PROGRAM

Stipulations to be made a part
of any lease which may be issued
by the Department of the Interior
in connection with the proposed
Oil Shale Prototype Program

SECTION 1. GENERAL

(A) Applicability of Stipulations.

The terms, conditions, requirements and prohibitions imposed upon Lessee by these Stipulations are also imposed upon Lessee's agents, employees, contractors, and sub-contractors, and their employees. Failure or refusal of Lessee's agents, employees, contractors, sub-contractors, or their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the Lessee. Lessee shall require its agents, contractors, and sub-contractors to include these Stipulations in all contracts and sub-contracts which are entered into by any of them, together with a provision that the other contracting party, and its agents, employees, contractors and sub-contractors, and the employees of each of them, shall likewise be bound to comply with these Stipulations.

(B) Changes in Conditions.

These Stipulations are based on existing knowledge and technology. They may be revised or amended by mutual consent of the Mining Supervisor and the Lessee at any time to adjust to changed conditions or to correct an oversight. The Lessee, the Mining Supervisor, and the BLM District Manager shall meet at least once a year to review advances in technology and, in a mutual endeavor, weigh and decide upon the feasibility of revising or amending existing Stipulations.

The Lessor and the Lessee agree that, in this mutual endeavor to decide upon the feasibility of amending the existing Stipulations, they will act in good faith and in a sincere effort to make the Lessee's activities under the lease as free from environmental damage as is practicable. Toward this end, systems which require pollution control devices shall possess sufficient flexibility to adopt improved technology at practicable intervals and shall be constructed with the understanding that continued compliance with changing pollution control laws is required.

(C) Monitoring Program.

The Lessee shall prepare, as part of the exploration and mining plan, and, after approval of the plan, conduct an environmental monitoring program designed to provide (1) a continuing check on compliance with these Stipulations and all Federal, State, and local laws, (2) a factual basis for subsequent revision or amendment of these Stipulations pursuant to section 1(B) hereof, and (3) timely notice of detrimental effects and conditions which require correction.

(D) Emergency Decisions.

Any decisions or approvals of the Mining Supervisor required by these Stipulations to be in writing may in emergencies be issued orally, with written confirmation as soon thereafter as possible.

(E) Liability of Lessee.

(1) Lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with activities and operations conducted pursuant to this Lease,

except where such damage is caused by employees of the United States acting within the scope of their authority.

(2) The Lessee shall be liable to third parties in accordance with applicable laws for bodily injuries to or the death of any person arising from or connected with activities and operations under this Lease.

(F) Environmental Briefing.

During the life of this Lease, Lessee shall provide for briefings on environmental and other pertinent matters for supervisory personnel by such Federal and State employees as may be designated by the Mining Supervisor. The Lessee shall provide for such briefings upon the request of the Mining Supervisor, but the Mining Supervisor shall request only such briefings as may be reasonably necessary to effectuate the provisions of this Lease and Stipulations. Lessee shall make arrangements for the time, place and attendance at such briefings upon the request of the Mining Supervisor. Lessee shall bear all costs of such briefings other than salary, per diem, subsistence and travel costs of Federal and State employees.

(G) Construction Standards.

The general design of all buildings and structures shall comply with the latest edition of the Uniform Building Code (U.B.C.). Structural steel shall be designed in accordance with the latest edition of the American Institute of Steel Construction "Specifications for Design, Fabrication and Erection of structural Steel for Buildings." Reinforced concrete shall comply with the latest edition of the American Concrete Institute's "Building Code Requirements for Reinforced Concrete." Engineering works for impoundments shall conform to standard engineering practice sufficient to withstand the 100-year flood in the drainage in which installed.

(H) Housing and Welfare of Employees.

In the exercise of his right under section 1(a) of the Lease to construct buildings and other facilities for the housing and welfare of his employees, the Lessee shall at all times make certain that these facilities are situated, constructed, operated, and maintained in an orderly manner, satisfactory to the Mining Supervisor. While no general restriction is imposed upon the construction of facilities necessary to the employees' health and well-being, such construction shall be subject to the Mining Supervisor's approval and shall not unreasonably damage the environment of the leased lands.

(I) Posting of Stipulations and Plans.

The Lessee shall insure that copies of these Stipulations and any approved exploration and mining plans are available at the operating sites and for inspection by all on-the-ground operating personnel.

SECTION 2. ACCESS AND SERVICE FACILITIES

(A) Transportation Corridor Plans.

The Lessee shall provide corridor plans for roads, pipelines and utilities for approval by the Mining Supervisor. Each plan shall include probable major design features and plans for the protection of the environment, prevention of pollution, minimization of erosion, rehabilitation and revegetation of all disturbed areas not required in operation of the transportation system, both during and after construction. The Lessee shall, to the maximum extent practicable, make use of multi-use corridors for roads, pipelines and utilities.

(B) Regulation of Public Access.

After road construction is completed, the Lessee shall permit reasonable, free and unrestricted public access to and upon the road and rights-of-way for all lawful and proper purposes except in those areas closed to public access by the Lessee with the consent of the Mining Supervisor. The Lessee shall regulate public access and public vehicular traffic as required to facilitate operations and to protect the public and, to the extent reasonable, livestock and wildlife from hazards associated with construction. For this purpose the Lessee shall provide warnings, flagmen, barricades, and other safety measures as necessary. Whenever the Mining Supervisor shall determine that the Lessee's regulation of access and traffic is unreasonable, or that the Lessee's provision of safety measures is inadequate, he shall so inform the Lessee who shall immediately take corrective measures.

(C) Existing and Planned Roads and Trails.

Where feasible, the Lessee shall use existing roads and trails. Unless the Mining Supervisor shall direct otherwise, roads and trails shall be located, constructed, maintained, and closed according to the specifications of the Bureau of Land Management and shall include drainage structures where needed.

(D) Waterbars and Breaks.

The Lessee shall divert runoff from roads and uphill slopes by means of waterbars, waterbreaks, or culverts constructed in accordance with BLM specifications.

(E) Pipeline Construction Standards.

The Lessee shall follow the following standards (wherever they may be made applicable) in the design and construction of oil pipelines and the choice of materials for them, and, if these standards should ever be revised, supplemented, or replaced, shall follow the new standards in new construction:

(1) U.S.A. Standard Code (USA Standards Institute) for Pressure Piping, Liquid Petroleum Transportation Piping Systems (USAS B31.4-1966).

(2) U.S.A. Standard Code for Pressure Piping, Gas Transmission and Distribution Piping Systems (USAS B31.8-1968).

(3) American Society for Testing and Materials (ASTM) standards for the appropriate steel tubing as given in the latest Book of ASTM Standards, Part 1 or plastic pipe, Part 26.

(F) Pipeline Safety Standards.

The Lessee shall meet where applicable, the safety standards and reporting requirements set forth in:

(1) 49 CFR, Part 110, Carriers by Pipeline (Other than Natural Gas and Water).

(2) 49 CFR, Part 190, Interim Minimum Federal Safety Standards for the Transmission of Natural Gas and Other Gas by Pipeline.

(3) 49 CFR, Part 195, Transmission of Liquids by Pipeline.

(G) Shut-Off Valves.

The Lessee shall insure that oil transportation pipeline designs provide for automatic shut-off valves at each pumping or compressor station and such additional valves as may be necessary in view of:

(1) Terrain and drainage systems traversed;

(2) Population centers;

(3) Wildlife and fishery habitat;

(4) Public water supplies and significant water bodies;

(5) Hazardous geologic areas; and

(6) Scenic Values.

The Lessee shall install any additional valves required by the Mining Supervisor.

(H) Pipeline Corrosion.

With regard to oil transportation pipelines, the Lessee shall submit detailed plans to the Mining Supervisor for corrosion-resistant design and methods for early detection of pipeline corrosion. These shall include: (1) pipe material and welding techniques to be used and information on their particular suitability for the environment involved; (2) details on the external pipe protection to be provided (coating, wrapping, etc.), including information on variation of the coating process to cope with variations in environmental factors; (3) plans for cathodic protection including details of impressed ground sources and controls to insure continuous maintenance of adequate protection over the entire surface of the pipe; (4) details of plans for monitoring cathodic protection current including spacing of current monitors; and (5) provision for periodic surveys of troubls spots, regular preventive maintenance surveys, regular surveys for external and internal deterioration which may result in failure, and special provisions for abnormal potential patterns resulting from crossings with other pipelines or cables.

(I) Electric Transmission Facilities.

The Lessee shall design and construct telegraph, telephone, electric powerlines, distribution lines and other transmission facilities in accordance with the guidelines set forth in "Environmental Criteria for Electric Transmission Systems" (U.S.D.I., U.S.D.A., 1970), as now or in the future amended. Distribution lines shall be designed and constructed in accordance with REA Bulletin 61-10 (Powerline Contacts by Eagles and other Large Birds), as now or in the future amended.

(J) Natural Barriers.

Where a road or exploratory site cuts a natural barrier used for livestock control, the Lessee shall, at his own expense, close the opening by the use of fence meeting BLM standards.

(K) Specifications for Fences, Cattleguards.

Fences and cattleguards constructed by the Lessee shall meet established BLM specifications and standards.

(L) Crossings.

The Lessee shall take all steps necessary to make certain that roads constructed under this Lease do not prevent or unreasonably disrupt the use of existing roads, foot trails, pipelines, and other rights-of-way. This requirement shall include the construction of suitable overhead or underground crossings where necessary.

(M) Alternate Routes.

If during construction the Lessee's activities shall interfere with the free use of existing roads and trails used by persons, whether or not recorded, he shall provide such alternate roads and trails as the Mining Supervisor may determine to be needed.

(N) Off-Road Vehicle Use.

The Lessee shall use off-road vehicles in a manner consistent with applicable regulations.

SECTION 3. FIRE PREVENTION AND CONTROL

(A) Instructions of the Mining Supervisor.

(1) The Lessee shall comply with the instructions and directions of the Mining Supervisor concerning the use, prevention and suppression of fires, and shall make every reasonable effort to prevent, control and suppress any fire on land subject to the Lease. Uncontrolled fires must be immediately reported to the Mining Supervisor.

(2)(a) The Lessee shall not burn rubbish, trash or other flammable materials nor use explosives in such a manner as to scatter flammable materials on the lands, except as permitted by the Mining Supervisor.

(b) The Lessee shall construct fire lines or perform clearing when determined by the Mining Supervisor to be necessary for forest, brush and grass fire prevention.

(c) The Lessee shall comply with the National Fire Codes on handling transportation, storage, use and disposal of all flammable liquids, gases, and solids.

(d) The Lessee shall take all appropriate actions to prevent oil shale outcrop fires.

(B) Liability of Lessee.

The control and suppression of any fires on the leased lands (or on adjoining public lands which have spread from the leased lands) caused by the Lessee or his employees, contractors, subcontractors, or agents shall be at the expense of the Lessee. Upon the failure of the Lessee to control and suppress such fires in a manner satisfactory to him, the Mining Supervisor shall take such steps as are necessary to control and suppress the fire, either alone or in conjunction with other Federal, State, and local authorities, and the cost of such control and suppression shall be borne by the Lessee.

SECTION 4. FISH AND WILDLIFE

(A) Management Plan.

The Lessee shall submit for approval by the Mining Supervisor a detailed fish and wildlife management plan as part of the exploration and mining plan, which explains the steps the Lessee proposes to take to: (1) avoid or minimize damage to fish and wildlife habitat, including water supplies; (2) restore such habitat in the event it is unavoidably destroyed or damaged; (3) provide alternate habitats; and (4) provide controlled access to the public for the enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedule, performance standards, proposed accomplishments, and ways and means of eliminating or minimizing environmental impacts on fish and wildlife.

(B) Mitigation of Damage.

Wherever destruction or significant disturbance of fish and wildlife habitat is inevitable, the Lessee shall submit, for the Mining Supervisor's approval at least 60 days prior to the destruction or damage of the habitat, those measures which the Lessee proposes to take to comply with the requirement of 30 CFR 231.4(b) to avoid, minimize, or repair injury or destruction of fish and wildlife and their habitat. As a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged. Unless the Mining Supervisor shall indicate otherwise within 60 days after the submission of the proposed measures to him, the measures will be deemed approved and thereafter the Lessee will execute the proposed measures for the mitigation of the destruction or damage of the habitat.

(C) Big Game.

The Lessee shall construct big game drift fences when and where necessary to direct big game movements around or away from oil shale development areas.

(D) Hunting and Fishing Regulations.

The Lessee shall post in reasonable and conspicuous places notices informing its employees, agents, contractors, subcontractors and their employees of all applicable laws and regulations governing hunting, fishing and trapping.

SECTION 5. HEALTH AND SAFETY

(A) In General.

The Lessee shall take all measures necessary to protect the health and safety of all persons affected by its activities and operations and shall immediately abate any activity or condition which threatens the life of any person or which threatens him with bodily harm.

(B) Compliance with Federal Health and Safety Laws and Regulations.

The Lessee shall comply with the Federal Metal and Non-metallic Mine Safety Act of 1966 (30 U.S.C. §§ 721-740) and the Occupational Health and Safety Act of 1970 (29 U.S.C. §§ 651-678) and all health and safety standards promulgated pursuant thereto.

(C) Use of Explosives.

The Lessee shall insure that all blasting operations, including the purchase, handling, transportation, storege, use, and destruction of blasting agents are performed in conformance with Public Law 91-452, October 15, 1970 (18 U.S.C. §§ 841-848) and the regulations promulgated thereunder (26 CFR 181).

SECTION 6. HISTORIC AND SCIENTIFIC VALUES

(A) Cultural Investigations.

The Lessee shall, prior to construction or mining, conduct a thorough and professional investigation for objects of historic, or scientific interest, including Indian ruins, pictographs and other archeological remains. The Lessee shall report the results of these investigations to the Mining Supervisor before commencing construction and mining operations.

(B) Objects of Historic or Scientific Interest.

The Lessee shall not remove, injure, deface or alter any object of historic or scientific interest, including Indian ruins, pictographs and other archeological remains. Where a question exists as to whether or not an object is of scientific or historic interest, the Lessee shall immediately bring the matter to the attention of the Mining Supervisor for final determination.

SECTION 7. OIL AND HAZARDOUS MATERIALS

(A) Spill Contingency Plans.

The Lessee agrees to submit oil spill contingency plans to the Mining Supervisor with the detailed mining plan. The plans shall conform to this Stipulation and the National Oil and Hazardous Substances Pollution Contingency Plan, 36 FR 16215, August 20, 1971, and shall: (1) include provisions for oil spill control; (2) provide for immediate corrective action including oil spill control and restoration of the effected resource; (3) provide that the Mining Supervisor shall approve any materials or devices used for oil spill control and shall approve any disposal sites or techniques selected to handle oily matter; and (4) include separate and specific techniques and schedules for cleanup of oil spills on land, rivers and streams. As used in this Stipulation, oil spill control is defined as: (1) detection of the spill; (2) location of the spill; (3) confinement of the spill; and (4) cleanup of the spill.

If, during operations, any oil or other pollutant should be discharged, the control and removal, disposal and cleaning up of such oil or other pollutant, wherever found, shall be the responsibility of Lessee. Upon failure of Lessee to control, dispose of, or clean up such discharge, or to repair all damages resulting therefrom, the Mining Supervisor may take such measures as he deems necessary to control and clean up the discharge and restore the area, including, where appropriate, the aquatic environment and fish and wildlife habitats, at the full expense of the Lessee. Such action by the Mining Supervisor shall not relieve Lessee of any responsibility as provided herein.

(B) Reporting of Oil Discharges.

The Lessee shall give immediate notice of any oil spills or discharges to: (1) the Mining Supervisor and (2) such other Federal and State officials as are required by law to be given such notice. Any oral notice shall be confirmed by the Lessee in writing as soon as possible.

(C) Storage and Handling.

The Lessee shall store oil, petroleum products, industrial chemicals and similar toxic or volatile materials in durable containers and locate such materials so that any accidental spillage will not drain into water courses, lakes, reservoirs, or ground water. Unless otherwise approved by the Mining Supervisor, the Lessee shall store substantial quantities, (more than 500 gallons), of such materials in an area surrounded by impermeable containment structures. The volume of the containment structures shall be at least: (1) one-hundred fifty (150) percent of the total storage volume of storage tanks in the relevant area; plus (2) a volume sufficient for maximum trapped precipitation and run-off which might be impounded at the time of a spill.

(D) Pesticides and Herbicides.

The Lessee shall not use pesticides and herbicides without the approval of the Mining Supervisor. Pesticides and herbicides shall be considered treatments of last resort, to be used only when reasonable alternatives are not available and where their use is consistent with protection and enhancement of the environment. Where pesticides and herbicides are used, the type, amount, method of application, storage and disposal shall be in accordance with procedures prescribed by the Mining Supervisor.

SECTION 8. POLLUTION--AIR

(A) Air Quality.

The Lessee shall utilize and operate all facilities and devices in such a way as to eliminate or minimize air pollution. At all times during construction and operation, Lessee shall conduct its activities in accordance with all applicable air quality standards and related plans of implementation adopted pursuant to the Clean Air Act, as amended (40 U.S.C. §§ 1857-1857-1).

[Note: Each specific lease may contain additional standards to meet special conditions.]

(B) Dust.

The Lessee shall make every effort to minimize dust problems. Where necessary, sprinking, oiling, or other means of dust control shall be required on roads and trails. The Lessee shall conduct processing operations so as not to create environmental or health problems associated with dust.

(C) Burning.

The Lessee shall not burn waste, timber, or debris, where prohibited by the Mining Supervisor.

SECTION 9. POLLUTION--WATER

(A) Water Quality.

The Lessee shall utilize and operate all facilities and devices in such a way as to eliminate or minimize water pollution. At all times during construction and operation, Lessee shall conduct its activities in accordance with all applicable water quality standards and related plans of implementation.

[Note: Each specific lease may contain additional standards to meet special conditions.]

(B) Disturbance of Existing Waters.

All construction activities, exclusive of actual mining activities, that may cause the creation of new lakes, drainage of existing ponds, diversion of natural drainages, alteration of stream hydraulics, disturbance of areas of stream beds or degradation of land and water quality or adversely affect the environmental integrity of the area are prohibited unless approved in writing by the Mining Supervisor.

(C) Control of Waste Waters.

In areas where overburden, water, or waste from mines or processing plants might contain toxic or saline materials, the Lessee shall:

(1) Divert surface or groundwaters where practicable to prevent entry or reduce flow of water into and through workings;

(2) Insure that water that does not gain entry into the workings is diverted so as to eliminate the formation and drainage of toxic or saline water to streams;

(3) Dispose of refuse and spent shale from mining and processing in a manner which will eliminate the discharge of toxic drainage or saline water to surface or groundwater;

(4) Employ, upon termination of operations of any mine, all practicable mine-closing measures consistent with ecological principles and safety requirements in order to minimize or eliminate the formation and discharge of toxic or saline water drainage;

(5) Dispose of toxic and saline water in a manner that does not pollute surface or groundwaters;

(6) During mining operations, monitor spoil and refuse for the presence of materials likely to yield unacceptably alkaline, acidic, saline, or toxic solutes; and

(7) Not reinject water, except where authorized to do so by the Mining Supervisor.

(D) Cuts and Fills.

The Lessee shall not cut or fill near or in streams which will result in siltation or accumulation of debris unless approved in writing by the Mining Supervisor.

(E) Streams.

The location of crossings of perennial streams, lakes and rivers must be approved in writing by the Mining Supervisor. To control erosion, the Lessee shall maintain buffer strips at least 200 feet wide on each side of a stream in their natural and undisturbed state unless otherwise authorized in writing by the Mining Supervisor.

(F) Road Surfacing Material.

All road surfacing material used by the Lessee must be approved by the Mining Supervisor.

SECTION 10. POLLUTION--NOISE

In the absence of specific noise pollution standards, the Lessee shall keep noise at or below levels safe and acceptable for humans, as determined by the Mining Supervisor.

SECTION 11. REHABILITATION

(A) In General.

The Lessee shall, to the extent practicable, rehabilitate all affected lands to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing, adjacent undisturbed natural areas. Rehabilitation methods include, but are not limited to, the following: leveling, backfilling, covering the surface with topsoil, and revegetating the spoil banks and pit areas consistent with sound restoration methods. The Lessee shall leave reclaimed land in a usable, non-hazardous condition such that soil erosion and water pollution are avoided or minimized. The Lessee shall, to the extent practicable, conduct such backfilling, leveling and grading concurrently with the mining operations. Upon removal of property at termination of the Lease pursuant to Section 6 of the Lease, the Lessee shall, to the extent practicable, complete the restoration of affected lands to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing adjacent undisturbed natural areas.

(B) Management Plan.

The Lessee shall submit for approval by the Mining Supervisor an erosion control and surface rehabilitation plan as part of the exploration or mining plan. The initial plan shall be submitted not less than 60 days prior to start of mining site preparation and updated each year thereafter before March 15. The plan shall include, but not be limited to, detailed information on activities, areas, time schedules, standards, accomplishments, and methods of eliminating or minimizing oil shale development impacts. The Lessee shall base erosion control plans and procedures on a maximum 50-year precipitation rate characteristic of the area. If a 50-year rate is not available, the Lessee shall use data based on the longest period of reliable information. Procedures and plans shall consider flash flood effects, mud flows, mudslides, landslides, rock falls, and other similar types of material mass movements.

(C) Stabilization of Disturbed Areas.

The Lessee shall leave all disturbed areas in a stabilized condition. Stabilization practices shall include, as determined by the needs of specific sites: seeding; planting; mulching; and the placement of mat binders, soil binders, rock or gravel blankets or other such structures. Seeding and planting shall be repeated if prior attempts to revegetate are unsuccessful. All trees, snags, stumps or other vegetative material, not having commercial, ecological, wildlife, or construction value, shall be considered for mechanical chipping and spreading in a manner that will aid seeding establishment and soil stabilization.

(D) Surface Disturbance On-Site.

The Lessee shall correct surface disturbance which may induce soil movement or water pollution, or both, whether during or after construction or mining, in accordance with the surface rehabilitation plan.

(E) Areas of Unstable Soils.

The Lessee shall, where possible, avoid areas having soils that are susceptible to slides and slips, excessive settlement, severe erosion and soil creep during construction or operation. When such areas cannot be avoided the Lessee shall design construction to insure maximum stability. The Lessee shall make soil foundation investigations in conjunction with construction activities. The Lessee shall make such data available to the Mining Supervisor upon request.

(F) Materials.

The Lessee shall, when feasible, utilize waste rock from the mining operations for road beds, fills and other similar construction purposes. When not feasible, gravel and other construction materials shall be purchased in accordance with 43 CFR 3610, except that the sale of such materials from stream beds and upland soil areas shall be avoided unless otherwise approved by the Mining Supervisor.

(G) Slopes of Cut and Fill Areas.

To the extent consistent with good mining practice, the Lessee shall maintain all cut and fill slopes in a stable condition for the duration of the Lease.

(H) Impoundments.

The Lessee shall grade excavations made for permanent impoundment of water in such a manner as to establish safe access to the water for persons, livestock and wildlife.

(I) Flood Plains.

The Lessee shall not construct improvements or conduct operations in flood plains or stream drainages when it is reasonable to expect risk to human life, pollution damage, or destruction of the existing environment caused by flood damage, without the express permission of the Mining Supervisor and without providing for protection of any such improvements constructed.

(J) Land Reclamation.

The Lessee shall, unless otherwise directed by the Mining Supervisor, backfill, level, final grade, cover with topsoil and initiate revegetation of each segment of the operation area in accordance with the rehabilitation plan as soon as that segment is no longer needed, but not later than one year after completion of the particular operation unless an alternative schedule has been approved by the Mining Supervisor.

(K) Overburden.

The Lessee shall, unless otherwise directed by the Mining Supervisor, separate overburden material and stockpile it separately as to topsoil, subsoil, and rock material for later use as fill and as top dressing for rehabilitation of disturbed areas.

(L) Revegetation

The Lessee shall revegetate all portions of the leased lands which have been disturbed by his operations as soon as possible thereafter in order to minimize and, if possible, to prevent erosion and related problems. The Lessee shall restore the vegetation of disturbed areas (1) by reestablishing permanent vegetation of a quality at least equal to the pre-existing native vegetation, or (2) to a condition consistent with the use to which the land will be put after the end of the surface disturbance, or (3) to a condition equal to pre-existing land uses in the area; the choice of which of these three standards he must meet is at the discretion of the Lessee. Plans for revegetation, including species, density, and timing, must be submitted to the Mining Supervisor for approval. The Mining Supervisor may require any reasonable methods and types of revegetation, and, if he deems it desirable, may require the Lessee to fence areas to assist revegetation.

SECTION 12. SCENIC VALUES

(A) Scenic Considerations in General.

The Lessee shall, where possible, use the following standards in all designing, clearing, earthmoving, and construction:

(1) Contours compatible with the natural environment shall be used to avoid straight lines.

(2) Natural colors consistent with the local environment such as pastels or muted shades of brown, green, reds, or greys shall be used in painting of facilities installed on the lease. Bright or unnatural colors shall be avoided except for use in warning signs or signals.

(3) Small natural openings or the edges of larger openings in the natural environment shall be utilized in construction of facilities, or disturbing the land surface.

(4) During the time when the land is disturbed, the portion of land which is not under revegetation programs shall only be those areas required under the mining plan for mining, storage, processing, or disposal operations.

(5) Contouring of the disturbed areas for reclamation shall simulate natural opening or areas consistent with the surrounding topography.

(B) Consideration of Aesthetic Values.

The Lessee shall consider existing aesthetic values in all planning, construction, reclamation and mining operations. All operations, including, but not limited to, design and construction of roads, pipelines and transmission lines, shall, where practicable, be performed so as to minimize visual impact, make use of the natural topography, and to achieve harmony with the landscape.

(C) Protection of Landscape.

The Lessee shall design any structures and facilities built under this Lease so that they will, to the extent practicable, blend with the natural landscape.

(D) Signs.

The Lessee shall design and construct signs that are rustic in appearance and conform to BLM sign standards.

SECTION 13. VEGETATION

(A) In General.

(1) The Lessee shall reserve from cutting and removal all timber and other vegetative material outside the clearing boundaries and all blazed, painted or posted trees which are on or mark the clearing boundaries, with the exception of danger trees or snags designated as such by the Mining Supervisor.

(2) The Lessee shall insure that all trees, snags or other woody material cut in connection with clearing operations are felled into the right-of-way and away from live water courses.

(B) Timber.

The Lessee shall deal with timber in accordance with the following: clearing and grubbing limits shall be approximately 50 ft. outside of the edge of any cut or fill; where practicable, trees, snags, stumps or other woody material not having wildlife value or value to the Lessee shall be mechanically chipped and spread in a manner that will aid seeding establishment and soil stabilization; clearing boundaries shall be identified on the ground prior to clearing operations.

(C) Clearing and Stripping.

The Lessee may clear and strip only such land as is necessary for roadbed widths but not more than 65 feet from the centerline unless otherwise specified by the Mining Supervisor.

SECTION 14. WASTE DISPOSAL

(A) Mine Waste.

The Lessee shall backfill or reclaim excavated material and spent shale and shall compact it thoroughly by machinery to avoid or minimize erosion and toxic or other leaching which creates pollution problems. Slope faces must be revegatated in accordance with the rehabilitation plan.

(B) Other Disposal Areas.

The term "waste" as used in this subsection (B) means all waste other than mine waste. To the extent practicable, the Lessee shall collect, recycle or dispose of waste in sanitary land fills or other disposal areas, and shall use the best practicable portable or permanent waste disposal systems, as approved by the Mining Supervisor. The Lessee shall remove or otherwise dispose of all waste in a manner acceptable to the Mining Supervisor, and in accordance with all applicable standards and guidelines of the State, the United States Public Health Service and the Environmental Protection Agency.

(C) Disposal of Solid and Liquid Wastes.

The Lessee shall design and construct disposal systems for solid and liquid wastes so as to avoid landslides, control erosion by wind and water, and establish conditions conducive to vegetative growth in the disposal area. The Lessee shall select and prepare disposal sites for wastes so as to avoid downward percolation of leached products and other pollutants into aquifers.

(D) Impoundment of Water.

No disposal of mine waste, other waste, or the residue from any activity under this Lease shall be disposed of in a manner which could cause an impoundment of water unless plans for spillways and means of diversion and the prevention of both surface and underground water contamination have been prepared by the Lessee and approved by the Mining Supervisor, and the Lessee has complied with those plans.

OFF-TRACT STIPULATIONS

for Proposed

OIL SHALE PROTOTYPE PROGRAM

Stipulations to be made a part of any lease, permit, license, or other instrument which may be issued by the Department of the Interior in connection with the proposed Oil Shale Prototype other than an oil shale lease itself.

An oil shale lessee or any other party will have to make separate applications for rights-of-way for roads, power transmission lines, telephone and telegraph lines, and pipelines and for special land use permits and other rights to use land outside the tract subject to the oil shall lease for purposes connected directly or indirectly with oil shale development. The environmental stipulations which will be included in such leases, permits, licenses, or other instruments issued under the public land laws for the conduct of activities and operations in connection with an oil shale lease but not pursuant to the oil shale lease itself may vary somewhat with the type of lease, permit, license, or other instrument at issue.

However, the following stipulations will be included in such instruments wherever they may be applicable.

(1) All the environmental stipulations set forth above for inclusion in the oil shale lease with the substitution of the term "Authorized Officer" for "Mining Supervisor" wherever the latter term appears and with the following specific exceptions as to subsections:

(a) Section 1(A) - insert "(2)" before present text and add the Section 1(A)(1) below;

(b) Section 1(B) - the second sentence should begin: "The Lessee, the Mining Supervisor, and the Authorized Officer shall meet . . . " It should be noted that this is the only place in the off tract Stipulations where "Mining Supervisor" appears;

(c) Section 1(C) - delete ", as part of the exploration and mining plan,";

(d) Section 1(H) - delete "his right under section 1(a) of the Lease" and substitute "any right under his Lease";

(e) Section 1(I) - delete "and any approved exploration and mining plans";

(f) Section 4(B) - delete entirely, but see 2(e) below;

(g) Section 4(C) - delete entirely, but see 4(c) below;

(h) Section 5(B) - delete "the Federal Metal and Non-metallic Mine Safety Act of 1966 (30 U.S.C. && 721-740) and";

(i) Section 7(A) - delete the words "with the detailed mining plan" in the first sentence;

(j) Section 11(A) - delete "pursuant to Section 6 of the Lease" in the last sentence;

(k) Section 11(B) - delete "as part of the exploration or mining plan" in the first sentence; and

(l) Section 11(G) - delete "To the extent consistent with good mining practice" and "for the duration of the Lease".

(2) The following additional stipulations:

(a) Insert the following in subsection (A) of section 1:

(1) These Stipulations shall apply to all activities and operations which are conducted in connection

activities and operations under an oil shale lease, but which are themselves conducted under a different lease, permit, license, or other instrument issued under the public land laws of the United States. The word "Lessee" as used in these Stipulations shall mean the person, association, or corporation holding such a lease, permit, license, or other instrument which has been issued under the public land laws in connection with activities and operations under an oil shale lease, but which is distinct from an oil shale lease. The word "Authorized Officer" means the District Manager of the Bureau of Land Management or his representative or such other officer as may have been designated by the Secretary of the Interior to execute duties under the instrument.

(b) Add the following new subsection to Section 2:

( ) Public Improvements.

The Lessee shall protect existing telephone, telegraph and transmission lines, roads, trails, fences, ditches, and similar improvements during all activities and operations conducted pursuant to this Lease. The Lessee shall not obstruct any road or trail without the approval of the Authorized Officer. Damage caused by Lessee to public utilities and improvements shall be promptly repaired by the Lessee to a condition which is satisfactory to the Authorized Officer.

(c) Add the following new subsections to section 4:

(C) Big Game.

The Lessee shall conduct all operations under this Lease so as to assure free passage and movements of big game animals and protect wildlife from hazards. The Lessee shall construct big game drift fences when and where necessary to direct big game movements around or away from hazardous development areas.

( ) Fish Migration.

(1) The Lessee shall provide for uninterrupted and safe upstream or downstream passage of fish. The Lessee shall not erect or construct any artificial structure or stream channel change that causes a permanent blockage to movement of fish.

(2) Unless otherwise provided for by appropriate State or Federal authority, the Lessee shall perform culvert construction in water crossings by the use of procedures and standards designed to avoid interference with fish movements, including, but not limited to, the following:

(a) Water velocities at medium discharge shall not exceed two (2) feet per second in any part of the culvert.

(b) Installation shall whenever possible be at zero gradient with the bottom of the outlet six (6) inches below the natural steambed to prevent erosion at the downstream end of the culvert.

(c) Where outfall erosion is unavoidable, a stilling basin of dimensions sufficient to achieve settling shall be constructed at the outflow end of the culvert. The pool sides shall be stabilized by means of rip-rap or other appropriate method to prevent erosion.

(d) In order to reduce sedimentation, diversion of water around the work area in the streambed may be required during installation of a culvert.

(e) Abandoned water diversion structures shall be plugged and stabilized to prevent trapping or stranding of fish.

(f) Stream preservation and improvement structures shall be in accordance with BLM Manual 6760, as now or in the future amended.

( ) Fish Spawning Areas.

"Fish spawning areas" means the areas where fish deposit their eggs. The Lessee shall protect spawning areas from sediment from all sources of construction or mining activity. Where soil material is expected to be suspended in water as a result of construction or mining activities, the Lessee shall construct sediment settling basins or take other appropriate measures to permit the removal of silt before it reaches a stream or lake. Special requirements may be made by the Authorized Officer for each stream system to protect spawning areas. The Lessee shall repair all damage to fish spawning beds caused by construction or operation activities.

( ) Use of Explosives.

The Lessee shall not, without prior approval of the Authorized Officer, use explosives in areas designated by the Authorized Officer as closed to the use of explosives during the times specified in the notice of designation. This designation shall be made at the time of the issuance of the instrument granting the Lessee the right to use the area, and shall be made only to protect fish spawning or rearing areas, nesting areas, lambing grounds, fawning grounds, and strutting sites during periods of intense activity.

(d) Add the following new subsection to section 11:

( ) Surface Disturbance Off-Site.

The Lessee shall (1) eliminate or minimize off-site vegetative or surface disturbance to the extent that such elimination or minimization is consistent with practical construction operations, and (2) as soon as feasible, rehabilitate all disturbed areas to conform as nearly as practicable with the adjacent terrain and revegetate all areas adjacent to utility corridors or roads the surface of which has been disturbed.

(e) Insert the following new subsection (B) in Section 4:

(B) Mitigation of Damage.

Wherever destruction or significant disturbance of fish and wildlife habitat is inevitable, the Lessee shall submit, for the Authorized Officer's approval, those measures which the Lessee proposes to take to avoid, wherever possible, and, where avoidance is impossible, to minimize and repair injury or destruction of fish and wildlife and their habitat at least 60 days prior to the destruction or damage of the habitat. Unless the Authorized Officer shall incidate otherwise within 60 days after the submission of the proposed measures to him, the measures will be deemed approved and thereafter the Lessee will execute the proposed measures for the mitigation of the destruction or damage of the habitat.

Title 43—PUBLIC LANDS: INTERIOR

Subtitle A—Office of the Secretary of the Interior

[Circular No 2259]

PART 23—SURFACE EXPLORATION, MINING AND RECLAMATION OF LANDS

A new Part 23 is hereby added to Title 43 Code of Federal Regulations, to become effective upon publication in the FEDERAL REGISTER.

§ 23.1 Purpose.

It is the policy of this Department to encourage the development of the mineral resources under its jurisdiction where mining is authorized. However, the public interest requires that, with respect to the exploration for, and the surface mining of, such minerals, adequate measures be taken to avoid, minimize, or correct damage to the environment—land, water, and air—and to avoid, minimize, or correct hazards to the public health and safety. The regulations in this part prescribe procedures to that end.

§ 23.2 Scope.

(a) Except as provided in paragraphs (b) and (c) of this section, the regulations in this part provide for the protection and conservation of nonmineral resources during operations for the discovery, development, surface mining, and onsite processing of minerals under permits, leases, or contracts issued pursuant to: The Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181–287); the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351–359); the Materials Act of July 31, 1947, as amended (30 U.S.C. 601–604); and title 23, United States Code, section 317, relating to appropriation for highway purposes of lands owned by the United States.

(b) The regulations in this part do not cover the exploration for oil and gas or the issuance of leases, or operations thereunder, for oil and gas under the mineral leasing acts, which are covered by regulations in Subpart 3107 and Part 3120 of this title and 30 CFR Part 221; neither do they cover minerals underlying Indian tribal or allotted lands, which are subject to regulations in Title 25 CFR, nor minerals subject to the general mining laws (30 U.S.C. 21–54); nor minerals under the Materials Act which are under the jurisdiction of the Secretary of Agriculture (74 Stat. 205); nor minerals underlying lands, the surface of which is not owned by the U.S. Government.

(c) When more than one permit or contract is expected to be issued to dispose of materials in a particular deposit or tract of land, such as community pits or common use areas, no requirement for reclamation will be made in such permits or contracts and the burden of reclamation will be assumed by the Government. Where reclamation is not required because more than one permit or contract is expected to be issued, there shall be added to the sales price under each permit or contract a reasonable charge to defer the cost of reclamation. In computing such added charge, the authorized officer shall establish the estimated cost of reclamation upon completion of extractive operations for the deposit and the estimated total volume of material to be extracted. The added charge shall be a proportionate share of the estimated cost of reclamation in the same ratio as the material sold under the permit or contract bears to the total estimated volume of the deposit which is expected to be extracted.

(d) The regulations in this part shall apply only to permits, leases, or contracts issued subsequent to the date on which the regulations become effective.

§ 23.3 Definitions.

As used in the regulations in this part:

(a) "Mineral leasing acts" means the Mineral Leasing Act of February 25, 1920, as amended and supplemented (30 U.S.C. 181–287) and the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351–359);

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(b) "Materials Act" means the Act of July 31, 1947, as amended (30 U.S.C. 601-604);

(c) "Mining supervisor" means the Regional Mining Supervisor, or his authorized representative, of the Geological Survey authorized as provided in 30 CFR 211.3 and 231.2 to supervise operations on the land covered by a permit or lease;

(d) "District manager" means the manager of the district office or other authorized officer of the Bureau of Land Management having administrative jurisdiction of and responsibility for the land covered by a permit, lease, contract, application, or offer;

(e) "Overburden" means all the earth and other materials which lie above a natural deposit of minerals and such earth and other materials after removal from their natural state in the process of mining;

(f) "Area of land to be affected" or "area of land affected" means the area of land from which overburden is to be or has been removed and upon which the overburden or waste is to be or has been deposited, and includes all lands affected by the construction of new roads or the improvement or use of existing roads to gain access to an operation and for haulage;

(g) "Operation" means all of the premises, facilities, roads, and equipment used in the process of determining the location, composition or quality of a mineral deposit, or in developing, extracting, or onsite processing of a mineral deposit in a designated area;

(h) "Method of operation" means the method or manner by which a cut or open pit is made, the overburden is placed or handled, water is controlled or affected and other acts performed by the operator in the process of exploring or uncovering and removing or onsite processing of a mineral deposit;

(i) "Holder" or "operator" means the permittee, leasee, or contractor designated in a permit, lease, or contract;

(j) "Reclamation" means measures undertaken to bring about the necessary reconditioning or restoration of land or water that has been affected by exploration or mineral development, mining or onsite processing operations, and waste disposal, in ways which will prevent or control onsite and offsite damage to the environment.

§ 23.4 Application for permission to conduct exploration operations.

No person shall, in any manner or by any means which will cause the surface of lands to be disturbed, explore, test, or prospect for minerals (other than oil and gas) subject to disposition under the mineral leasing acts or the Materials Act without first filing an application for, and obtaining, a permit, lease or contract which authorizes such exploring, testing, or prospecting.

§ 23.5 Technical examination of prospective surface exploration and mining operations.

(a) (1) In connection with an application for a permit or lease under the mineral leasing acts or an application for a permit or an offer to make a contract under the Materials Act, the district manager shall make, or cause to be made, a technical examination of the prospective effects of the proposed exploration or surface mining operations upon the environment. The technical examination shall take into consideration the need for the preservation and protection of other resources, including recreational, scenic, historic, and ecological values; the control of erosion, flooding, and pollution of water; the isolation of toxic materials; the prevention of air pollution; the reclamation by revegetation, replacement of soil, or by other means, of lands affected by the exploration or mining operations; the prevention of slides; the protection of fish and wildlife and their habitat; and the prevention of hazards to public health and safety.

(2) A technical examination of an area should be made with the recognition that actual potential mining sites and mining operations vary widely with respect to topography, climate, surrounding land uses, proximity to densely used areas, and other environmental influences and that mining and reclamation requirements should provide sufficient flexibility to permit adjustment to local conditions.

(b) Based upon the technical examination, the district manager shall formulate the general requirements which the applicant must meet for the protection of nonmineral resources during the conduct of exploration or mining operations and for the reclamation of lands or waters affected by exploration or mining operations. The general requirements shall be made known in writing to the applicant before the issuance of a permit or lease or the making of a contract, and upon acceptance thereof by the applicant, shall be incorporated in the permit, lease, or contract. If an application or offer is made under the Mineral Leasing Act for Acquired Lands and if the lands are under the jurisdiction of an agency other than the Department of the Interior, the requirements must incorporate provisions prescribed by that agency. If the application or offer is made under the Mineral Leasing Act of February 25, 1920, or the Materials Act, and if the lands are under the jurisdiction of an agency other than the Department of the Interior, the district manager shall consult representatives of the agency administering the land and obtain their recommendations for provisions to be incorporated in the general requirements. If the district manager does not concur in the recommendations, the issues shall be referred for resolution to the Under Secretary of the Department of the Interior and the comparable officer of the agency submitting the recommendations. In the case of disagreement on the issues which are so referred, the Secretary of the Interior shall make a determination on the recommendations which shall be final and binding.

(c) In each instance in which an application or offer is made under the mineral leasing acts, the mining supervisor shall participate in the technical examination and in the formulation of the general requirements. If the lands covered by an application or offer are under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management, the district manager shall consult representatives of the bureau administering the land. If the lands covered by the application or offer are under the jurisdiction of an agency other than the Department of the Interior and that agency makes a technical examination of the type provided for in paragraph (a) of this section, district managers and mining supervisors are authorized to participate in that examination.

(d) Whenever it is determined that any part of the area described in an application or offer for a permit, lease, or contract is such that previous experience under similar conditions has shown that operations cannot feasibly be conducted by any known methods or measures to avoid—

(1) Rock or landslides which would be a hazard to human lives or endanger or destroy private or public property; or

(2) Substantial deposition of sediment and silt into streams, lakes, reservoirs; or

(3) A lowering of water quality below standards established by the appropriate State water pollution control agency, or by the Secretary of the Interior; or

(4) A lowering of the quality of waters whose quality exceeds that required by the established standards—unless and until it has been affirmatively demonstrated to the State water pollution control agency and to the Department of the Interior that such lowering of quality is necessary to economic and social development and will not preclude any assigned uses made of such waters; or

(5) The destruction of key wildlife habitat or important scenic, historical, or other natural or cultural features; the district manager may prohibit or otherwise restrict operations on such part of an area.

(e) If, on the basis of a technical examination, the district manager determines that there is a likelihood that there will be a lowering of water quality as described in paragraphs (d) (3) and (4) of this section caused by the operation, no lease or permit shall be issued or contract made until after consultation with the Federal Water Pollution Control Administration and a finding by the Administration that the proposed operation would not be in violation of the Federal Water Pollution Control Act, as amended (33 U.S.C. sec. 466 et seq.) or of Executive Order No. 11288 (31 F.R. 9261). Where a permit or lease is involved the district manager's determination shall be made in consultation with the mining supervisor.

(f) Each notice of a proposed appropriation of a materials site filed by the Department of Transportation under 23 U.S.C. 317 shall be transmitted to the proper district manager. The district manager shall cause a technical examination to be made as provided in paragraph (a) of this section and shall formulate the requirements which the State highway department or its nominee must meet. If the land covered by the proposed appropriation is under the jurisdiction of a bureau of the Department other than the Bureau of Land Management, the district manager shall consult representatives of the bureau administering the land. If the district manager determines, or, in an instance in which the land is administered by another bureau, a representative of that bureau determines that the proposed appropriation is contrary to the public interest or is inconsistent with the purposes for which such land or materials are reserved, the district manager shall promptly submit the matter to the Secretary of the Interior for his decision. In other instances, the district manager shall notify the Department of Transportation of the requirements and conditions which the State highway department or its nominee must meet.

§ 23.6 Basis for denial of a permit, lease, or contract.

An application or offer for a permit, lease, or contract to conduct exploratory or extractive operations may be denied any applicant or offeror who has forfeited a required bond because of failure to comply with an exploration or mining plan. However, a permit, lease, or contract may not be denied an applicant or offeror because of the forfeiture of a bond if the lands disturbed under his previous permit, lease, or contract have subsequently been reclaimed without cost to the Federal Government.

§ 23.7 Approval of exploration plan.

(a) Before commencing any surface disturbing operations to explore, test, or prospect for minerals covered by the mineral leasing acts the operator shall file with the mining supervisor a plan for the proposed exploration operations. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(b) Before commencing any surface disturbing operations to explore, test, or prospect for materials covered by the Materials Act the operator shall file with the district manager a plan for the proposed exploration operations.

(c) Depending upon the size and nature of the operation and the requirements established pursuant to § 23.5 the mining supervisor or the district manager may require that the exploration plan submitted by the operator include any or all of the following:

(1) A description of the area within which exploration is to be conducted;

(2) Two copies of a suitable map or aerial photograph showing topographic, cultural and drainage features;

(3) A statement of proposed exploration methods, i.e. drilling, trenching, etc., and the location of primary support roads and facilities;

(4) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife or other natural resources, and hazards to public health and safety both during and upon abandonment of exploration activities.

(d) The mining supervisor or the district manager shall promptly review the exploration plan submitted to him by the operator and shall indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to

§ 23.5, the provisions of the regulations in this part, and the terms of the permit.

(e) The operator shall comply with the provisions of an approved exploration plan. The mining supervisor and the district manager may, with respect to such a plan, exercise the authority provided by paragraphs (f) and (g) of § 23.8 respecting a mining plan.

§ 23.8 Approval of mining plan.

(a) (1) Before surface mining operations may commence under any permit or lease issued under the mineral leasing acts the operator must file a mining plan with the mining supervisor and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon mining supervisors with respect to mining plans pertaining to permits or leases issued under the mineral leasing acts. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(2) Before surface mining operations may commence under any permit issued or contract made under the Materials Act, the operator must file a mining plan with the district manager and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon district managers with respect to mining plans pertaining to permits issued or contracts made under the Materials Act.

(b) Depending on the size and nature of the operation and the requirements established pursuant to § 23.5, the mining supervisor or the district manager may require that the mining plan submitted by the operator include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Two copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit, lease, or contract, the name and location of major topographic and cultural features, and the drainage plan away from the area to be affected;

(3) A statement of proposed methods of operating, including a description of proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife, and hazards to public health and safety; and

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the holder's operation.

(c) In those instances in which the permit, lease, or contract requires the revegetation of an area of land to be affected the mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

(d) In those instances in which the permit, lease, or contract requires regrading and backfilling, the mining plan shall show the proposed methods and the timing of grading and backfilling of areas to be affected by the operation.

(e) The mining supervisor or the district manager shall review the mining plan submitted to him by the operator and shall promptly indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to § 23.5, the provisions of the regulations in this part and the terms of the permit, lease, or contract. The operator shall comply with the provisions of an approved mining plan.

(f) A mining plan may be changed by mutual consent of the mining supervisor or the district manager and the operator at any time to adjust to changed conditions or to correct any oversight. To obtain approval of a change or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed. The mining supervisor or the district manager shall promptly notify the operator that he consents to the proposed changes or supplement or, in the event he does not consent, he shall specify the modifications thereto under which the proposed changes or supplement would be acceptable. After mutual acceptance of a change of a plan the operator shall not depart therefrom without further approval.

(g) If circumstances warrant, or if development of a mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operations, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 23.9 Performance bond.

(a) (1) Upon approval of an exploration plan or mining plan, the operator shall be required to file a suitable performance bond of not less than $2,000 with satisfactory surety, payable to the Secretary of the Interior, and the bond shall be conditioned upon the faithful compliance with applicable regulations, the terms and conditions of the permit, lease, or contract, and the exploration or mining plan as approved, amended or supplemented. The bond shall be in an amount sufficient to satisfy the reclamation requirements of an approved exploration or mining plan, or an approved partial or supplemental plan. In determining the amount of the bond consideration shall be given to the character and nature of the reclamation requirements and the estimated costs of reclamation in the event that the operater forfeits his performance bond.

(2) In lieu of a performance bond an operator may elect to deposit cash or negotiable bonds of the U.S. Government. The cash deposit or the market value of such securities shall be equal at least to the required sum of the bond.

(b) A bond may be a nationwide or statewide bond which the operator has filed with the Department under the provisions of the applicable leasing regulations in Subchapter C of Chapter II of this title, if the terms and conditions thereof are sufficient to comply with the regulations in this part.

(c) The district manager shall set the amount of a bond and take the necessary action for an increase or for a complete or partial release of a bond. He shall take action with respect to bonds for leases or permits only after consultation with the mining supervisor.

§ 23.10 Reports: Inspection.

(a) (1) The holder of a permit or lease under the mineral leasing acts shall file the reports required by this section with the mining supervisor. The holder of a permit or a party to a contract under the Materials Act shall file such reports with the district manager.

(2) The provisions of this section confer authority and impose duties upon mining supervisors with respect to permits or leases issued under the mineral leasing acts and upon district managers with respect to permits issued or contracts made under the Materials Act.

(b) Operations report: Within 30 days after the end of each calendar year, or if operations cease before the end of a calendar year, within 30 days after the cessation of operations, the operator shall submit an operations report containing the following information:

(1) An identification of the permit, lease, or contract and the location of the operation;

(2) A description of the operations performed during the period of time for which the report is filed;

(3) An identification of the area of land affected by the operations and a description of the manner in which the land has been affected;

(4) A statement as to the number of acres disturbed by the operations and the number of acres which were reclaimed during the period of time;

(5) A description of the method utilized for reclamation and the results thereof;

(6) A statement and description of reclamation work remaining to be done.

(c) Grading and backfilling report: Upon completion of such grading and backfilling as may be required by an approved exploration or mining plan, the operator shall make a report thereon and request inspection for approval. Whenever it is determined by such inspection that backfilling and grading has been carried out in accordance with the established requirements and approved exploration or mining plan, the district manager shall issue a release of an appropriate amount of the performance bond for the area graded and backfilled. Appropriate amounts of the bond shall be retained to assure that satisfactory planting, if required, is carried out.

(d) Planting report: (1) Whenever planting is required by an approved exploration or mining plan, the operator shall file a report with the mining supervisor or district manager whenever such planting is completed. The report shall—

(i) Identify the permit, lease, or contract;

(ii) Show the type of planting or seeding, including mixtures and amounts;

(iii) Show the date of planting or seeding;

(iv) Identify or describe the areas of the lands which have been planted;

(v) Contain such other information as may be relevant.

(2) The mining supervisor or district manager, as soon as possible after the completion of the first full growing season, shall make an inspection and evaluation of the vegetative cover and planting to determine if a satisfactory growth has been established.

(3) If it is determined that a satisfactory vegetative cover has been established and is likely to continue to grow, any remaining portion of the performance bond may be released if all requirements have been met by the operator.

(e) Report of cessation or abandonment of operations: (1) Not less than 30 days prior to cessation or abandonment of operations, the operator shall report his intention to cease or abandon operations, together with a statement of the exact number of acres of land affected by his operations, the extent of reclamation accomplished and other relevant information.

(2) (i) Upon receipt of such report the mining supervisor or the district manager shall make an inspection to determine whether operations have been carried out and completed in accordance with the approved exploration or mining plan.

(ii) Whenever the lands in a permit, lease or contract issued under the mineral leasing acts or the Materials Act are under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management the mining supervisor or the district manager, as appropriate, shall obtain the concurrence of the authorized officer of such bureau that the operation has been carried out and completed in accordance with the approved exploration or mining plan with respect to the surface protection and reclamation aspects of such plan before releasing the performance bond.

(iii) Whenever the lands in a permit, lease or contract issued under the Mineral Leasing Act of 1920 or the Materials Act are under the jurisdiction of an agency other than the Department of the Interior, the mining supervisor or the district manager, as appropriate, shall consult representatives of the agency administering the lands and obtain their recommendations as to whether the operation has been carried out and completed in accordance with the approved exploration or mining plan, with respect to the surface protection and reclamation aspects of such plan before releasing the performance bond. If the mining supervisor or district manager, as appropriate, do not concur in the recommendations of the agency regarding compliance with the surface protection and reclamation aspects of the approved exploration or mining plan, the issues shall be referred for resolution to the Under Secretary of the Department of the Interior and the comparable officer of the agency submitting the recommendations. In the case of disagreement on issues which are so referred, the Secretary of the Interior shall make a determination which shall be final and binding. In cases in which the recommendations are not concurred in by the mining supervisor or district manager, the performance bond shall not be released until resolution of the issues or until a final determination by the Secretary of the Interior.

(iv) Whenever the lands in a permit or lease issued under the Mineral Leasing Act for Acquired Lands are under the jurisdiction of an agency other than the Department of the Interior, the mining supervisor or the district manager, as appropriate, shall obtain the concurrence of the authorized officer of such agency that the operation has been carried out and completed in accordance with the approved exploration or mining plan with respect to the surface protection and reclamation aspects of such plan before releasing the performance bond.

§ 23.11 Notice of noncompliance: Revocation.

(a) The provisions of this section confer authority and impose duties upon mining supervisors with respect to permits or leases issued under the mineral leasing acts and upon district managers with respect to permits issued or contracts made under the Materials Act. The mining supervisor shall consult with the district manager before taking any action under this section.

(b) The mining supervisor or district manager shall have the right to enter upon the lands under a permit, lease, or contract, at any reasonable time, for the purpose of inspection or investigation to determine whether the terms and conditions of the permit, lease, or contract, and the requirements of the exploration or mining plan have been complied with.

(c) If the mining supervisor or the district manager determines that an operator has failed to comply with the terms and conditions of a permit, lease, or contract, or with the requirements of an exploration or mining plan, or with the provisions of applicable regulations under this part the supervisor or manager shall serve a notice of noncompliance upon the operator by delivery in person to him or his agent or by certified or registered mail addressed to the operator at his last known address.

(d) A notice of noncompliance shall specify in what respects the operator has failed to comply with the terms and conditions of a permit, lease, or contract, or the requirements of an exploration or mining plan, or the provisions of applicable regulations, and shall specify the action which must be taken to correct the noncompliance and the time limits within which such action must be taken.

(e) Failure of the operator to take action in accordance with the notice of noncompliance shall be grounds for suspension by the mining supervisor or the district manager of operations or for the initiation of action for the cancellation of the permit, lease, or contract and for forfeiture of the performance bond required under § 23.9.

§ 23.12 Appeals.

(a) A person adversely affected by a decision or order of a district manager or of a mining supervisor made pursuant to the provisions of this part shall have a right of appeal to the Director of the Bureau of Land Management whenever the decision appealed from was rendered by a district manager, or to the Director of the Geological Survey if the decision or order appealed from was rendered by a mining supervisor, and the further right to appeal to the Secretary of the Interior from an adverse decision of either Director unless such decison was approved by the Secretary prior to promulgation.

(b) Appeals to Director, Bureau of Land Management, or to Director, Geological Survey, and appeals to the Secretary shall be made pursuant to procedures and requirements of Parts 1840 and 1850 of this title, except that for the purposes of an appeal taken from a decision or order of a mining supervisor made pursuant to this part:

(1) The term "Director" wherever it occurs in Part 1850 or 1850 of this title shall mean the Director of the Geological Survey.

(2) The term "Field Commissioner" shall include a person designated by the Director of the Geological Survey to hold a hearing.

(3) Whenever the provisions of Parts 1840 and 1850 of this title require that a document be filed in the Office of the Director, such documents shall be filed in the Office of the Director, Geological Survey (Address: Director, Geological Survey, Washington, D.C. 20240).

(c) In any case involving a permit, lease or contract for lands under the jurisdiction of an agency other than the Department of the Interior, or a bureau of the Department of the Interior other than the Bureau of Land Management, the officer rendering a decision or order shall, in the event of an appeal from such decision or order, designate the authorized officer of such agency as an adverse party on whom a copy of a notice of appeal and any statement of reasons, written arguments or briefs must be served.

(d) Hearings to present evidence on an issue of fact before a Field Commissioner designated by the appropriate Director shall be conducted pursuant to the requirements and procedures set forth in Part 1850 of this title.

§ 23.13 Consultation.

Whenever the lands included in a permit, lease, or contract are under the jurisdiction of an agency other than the Department of the Interior or under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management, the mining supervisor or the district manager, as appropriate, shall consult the authorized officer of such agency before taking any final action under §§ 23.7, 23.8, 23.10 (c) and (d) (2) and (3), and 23.11(c).

DAVID S. BLACK,
Under Secretary of the Interior.

JANUARY 15, 1969.

[F.R. Doc. 69-747; Filed, Jan. 17, 1969; 8:51 a.m.]

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PART III

DEPARTMENT OF THE INTERIOR

■

GEOLOGICAL SURVEY

■

Operating Regulations for Exploration, Development and Production

No. 106—Pt. III——1

Title 30—MINERAL RESOURCES

Chapter II—Geological Survey, Department of the Interior

PART 231—OPERATING REGULATIONS FOR EXPLORATION, DEVELOPMENT; AND PRODUCTION

On March 24, 1971, a notice and text of a proposed revision of the mining operating regulations, governing operations conducted under mineral permits and leases on public and acquired lands of the United States and Indian lands administered by the Department of the Interior, was published in the FEDERAL REGISTER (36 F.R. 5510–5515) for the following purposes:

(1) To update the existing regulations by deleting obsolete provisions and including requirements consistent with modern mining practices;

(2) To add provisions for the protection of the environment during exploratory and mining operations and for reclamation of lands disturbed by such operations;

(3) To revise the procedure for appeals from decisions of the Mining Supervisors; and

(4) To delete provisions pertaining to health and safety of miners since health and safety standards for metal and nonmetallic mines are now contained in 30 CFR Parts 55, 56, and 57.

Interested parties were given 60 days from the date of publication of the notice within which to submit written comments, suggestions, or objections with respect to the proposed revision. The period for submitting written comments, suggestions, or objections was subsequently extended to July 22, 1971, by a notice published in the FEDERAL REGISTER on June 19, 1971 (36 F.R. 11815). After consideration of the views presented, the following changes have been made in the proposed regulations:

1. In § 231.1, the term "oil shale" has been corrected to read "shale oil" when referring to the extraction of shale oil by in situ methods from oil shale.

2. Section 231.2 has been amended to eliminate the definition of "Chief, Branch of Mining Operations" and to change the definition of "Mining Supervisor." These amendments have been made to reflect the recently approved reorganization of the Conservation Division of the Geological Survey. (Departmental Manual Part 120, Chapter 4; Release No. 1373, December 8, 1971.) For the same reason, the title, "Chief, Branch of Mining Operations" has been deleted in paragraph (a) of § 231.3, and in paragraphs (c) (3) and (4) of that section, the title "Chief, Conservation Division of the Geological Survey" has been substituted for the title "Chief, Branch of Mining Operations."

3. In § 231.3, the provision in paragraph (d) authorizing the Mining Supervisor to consult with or solicit and receive advice of the Environmental Protection Agency pertaining to water pollution problems has been deleted since such matters are more appropriately the subject of a memorandum of understanding between this Department and the Environmental Protection Agency. For the same reason, the provisions in paragraph (e) of this section and in paragraph (d) of § 231.4 with respect to consultation by the Mining Supervisor with the Environmental Protection Agency have been deleted. Paragraph (e) of § 231.3 has been amended to provide that the Mining Supervisor in addition to making inspections to determine the adequacy of water pollution control measures shall also make inspections to determine the adequacy of air pollution control measures.

4. Section 231.4 has been changed to make it clear that a lessee's or permittee's obligation, under paragraph (b), pertaining to damage to the environment, surface improvements, and other values is to "avoid, minimize or repair" such damage, and that determination made by the mining supervisor under paragraph (b) will be subject to appeal. Paragraph (c) has been amended to provide that all operations under the regulations shall be consistent with both Federal and State water and air quality standards.

5. Section 231.10(a) has been changed to require that exploration and mining plans be submitted in quintuplicate rather than in triplicate. This change is necessary to assure that the mining supervisor receives sufficient copies of the plans to permit distribution to other interested agencies.

6. In § 231.10(b), which enumerates the items which the mining supervisor may require be included in an exploration plan, the first 17 words: "Depending on the size and nature of the operations and terms and conditions of the permit * * * ," have been deleted as unnecessary since the authority granted to the mining supervisor to require inclusion of the enumerated item is discretionary. For the same reason, the first 17 words, "Depending on the size and nature of the operation and the terms and conditions of the lease * * *" have been deleted from paragraph (c) of this section which enumerates the items which the mining supervisor may require be included in mining plans. Also, the title of paragraphs (b) and (c) have been changed from "Permits" and "Lease" respectively, to the more descriptive titles, "Exploration Plans" and "Mining Plans." The number of maps or aerial photographs that may be required with exploration and mining plans has been increased from two to five because of the need by the mining supervisor and other interested agencies for additional copies of these items.

7. The requirement of § 231.11 that copies of maps of underground workings and surface operations be submitted on "tracing cloth" has been changed to require that such maps be submitted on "reproducible material." Copies of maps on reproducible material will be adequate for the Mining Supervisor's needs. In the requirement that the accuracy of maps furnished to the Mining Supervisor be certified "by a professional engineer, professional land surveyor, or other qualified person", the word "professionally" has been added between the words "other" and "qualified" to make it clear that the accuracy of such maps shall be certified only by those who are professionally qualified to do so.

8. The requirement of § 231.20(a) that all drill holes be logged "by competent geologists or engineers" has been changed to require that drill holes be logged "under supervision of a competent geologist or engineer." The changed requirement is considered to afford adequate protection to the United States and is consistent with present drilling practices. Section 231.20(a) also has been amended to place a limitation of 1 year on the period an operator is required to retain the core from test holes for inspection since retention for a longer period puts an unnecessary burden on the operator.

9. Section 231.20(b) has been changed to make it clear that drill holes shall be "cemented and/or cased" when abandoned, unless other methods of abandonment are approved in advance by the Mining Supervisor.

10. Section 231.20(d) has been changed to make the requirement for equipping drilling equipment with blowout preventers when drilling on lands valuable or potentially valuable for geothermal resources applicable also when drilling on land valuable or potentially valuable for oil and gas since the danger of blowouts exists in both situations.

11. In the requirement of § 231.30 that operators observe the highest standards while conducting mining operations, the term "good practice following the highest standards" has been substituted for the term "the highest standards." Section 231.30, as originally proposed, amended former § 231.12 by substituting "highest standards" for the term "good practice." It was not the purpose of that change to place on an operator any additional obligations to those required in the former regulation. The present change is being made to make it clear that the requirement that an operator observe "good practice" means that he shall follow the highest standards prevailing in the mining industry.

12. Since pillars may not be the only acceptable method for protection of mine workings and overlying deposits, § 231.31 has been amended to authorize the Mining Supervisor to approve other methods for providing such protection.

13. Section 231.34 has been changed by adding the word "underground" in the first sentence to make it clear that this section, which provides for development of leased lands from a mine on adjoining lands, applies only to underground mines on adjoining lands and not to surface mines. The requirement of paragraph (c) for providing free access for inspection of connecting mines on privately owned or controlled lands "at all hours" has been changed to the more reasonable requirement that such access be provided at "any reasonable time."

14. The requirement of § 231.34 that structures within 100 feet of a mine opening be protected against fire has been changed to add the additional requirement that they be constructed of fire resistent material. This change will add a higher degree of safety and is consistent with a similar requirement in 30 CFR Part 57.

15. Section 231.73 *Enforcement of orders*, has been rewritten to require that the Mining Supervisor serve notice on the operator before suspending operations for failure to comply with regulations, terms, and conditions of the permit or lease, the requirements of approved plans, and instructions of the Supervisor. Such advance notice, however, would not be required if the violation threaten immediate, serious or irreparable harm to the environment, mine, or other resources.

16. Section 231.74 has been changed in several respects for the purpose of clarifying the procedure for appeals from orders of the Mining Supervisor. The section has been amended to provide that appeals from a decision of the Director, Geological Survey, or the Commissioner of Indian Affairs under 30 CFR Part 231, may be taken to the Board of Land Appeals in accordance with the Department hearings and appeals procedures in 43 CFR Part 4.

Other suggestions for changes in the proposed regulations were considered but were not adopted.

Effective date. The amended regulations are hereby adopted to take effect at the beginning of the 30th calendar day following the date of publication in the FEDERAL REGISTER.

Dated: May 26, 1972.

W. T. PECORA,
Acting Secretary of the Interior.

AUTHORITY: The provisions of this Part 231 issued under 35 Stat. 312; 35 Stat. 761, as amended; secs. 32, 6, 26, 41 Stat. 450, 753, 1248; secs. 1, 2, 3, 44 Stat. 301, as amended; secs. 6, 3, 44 Stat. 659, 710; secs. 1, 2, 3, 44 Stat. 1057; 47 Stat. 1467; 49 Stat. 1482, 1250, 1967, 2026; 52 Stat. 347; sec. 10, 53 Stat. 1196, as amended; 58 Stat. 273; sec. 10, 61 Stat. 915; sec. 3, 63 Stat. 683; 84 Stat. 811; 25 U.S.C. 398, 396a–f, 30 U.S.C 189, 271, 261, 293, 359. Interpret or apply secs. 5, 5, 44 Stat. 302, 1056, as amended; 58 Stat. 483–465; 5 U.S.C. 301, 16 U.S.C. 508b, 30 U.S.C. 169, 192c, 271, 261, 293, 359, 43 U.S.C. 367.

ADMINISTRATION OF REGULATIONS AND DEFINITIONS

§ 231.1 Scope and purpose.

(a) The regulations in this part shall govern operations for the discovery, testing, development, mining, and processing of potash, sodium, phosphate, sulphur, asphalt, and oil shale (except for operations for the extraction of shale oil by in situ retorting methods utilizing boreholes or wells) under leases or permits issued for public domain lands pursuant to the regulations in 43 CFR Group 3500. These regulations shall also apply to operations for the discovery, testing, development, mining, and processing of minerals (except coal, oil, and gas) in acquired lands under leases or permits issued pursuant to the regulations in 43 CFR Group 3500 and minerals (except coal, oil, and gas) in tribal and allotted Indian lands leased under the regulations in 25 CFR Parts 171, 172, 173, 174, and 176.

(b) The purpose of the regulations in this part is to promote orderly and efficient prospecting, exploration, testing, development, mining, and processing operations and production practices without waste or avoidable loss of minerals or damage to deposits; to promote the safety, health, and welfare of workmen; to encourage maximum recovery and use of all known mineral resources; to promote operating practices which will avoid, minimize, or correct damage to the environment—land, water and air—and avoid, minimize, or correct hazards to public health and safety; and to obtain a proper record and accounting of all minerals produced.

(c) When the regulations in this part relate to matters included in the regulations in 43 CFR Part 23—Surface Exploration, Mining, and Reclamation of Lands—pertaining to public domain and acquired lands, or 25 CFR Part 177—Surface Exploration, Mining, and Reclamation of Lands—pertaining to Indian lands, the regulations in this part shall be considered as supplemental to the regulations in those parts, and the regulations in those parts shall govern to the extent of any inconsistencies.

CROSS REFERENCE: See Part 211 of this chapter for regulations governing operations under coal permits and leases. See Part 221 of this chapter for regulations governing operations under oil and gas leases and operations for the extraction of shale oil by in situ retorting or other methods utilizing boreholes or wells.

§ 231.2 Definitions.

The terms used in this part shall have the following meanings:

(a) *Secretary*. The Secretary of the Interior.

(b) *Director*. The Director of the Geological Survey, Washington, D.C.

(c) *Mining supervisor*. A registered professional engineer; the representative of the Secretary under administrative direction of the Director through the Chief, Conservation Division, and appropriate Regional Manager, Conservation Division of the Geological Survey, authorized and empowered to regulate operations and to perform other duties prescribed in the regulations in this part, or any subordinate of the Mining Supervisor acting under his direction.

(d) *Lessee*. Any person or persons, partnership, association, corporation, or municipality to whom a mineral lease is issued subject to the regulations in this part, or an assignee of such lease under an approved assignment.

(e) *Permittee*. Any person or persons, partnership, association, corporation, or municipality to whom a mineral prospecting permit is issued subject to the regulations in this part, or an assignee of such permit under an approved assignment.

(f) *Leased lands, leased premises, or leased tract*. Any lands or deposits under a mineral lease and subject to the regulations in this part.

(g) *Permit lands*. Any lands or deposit under a mineral prospecting permit and subject to the regulations in this part.

(h) *Operator*. A lessee or permittee or one conducting operations on the leased or permit lands under the authority of the lessee or permittee.

(i) *Reclamation*. The measures undertaken to bring about the necessary reconditioning or restoration of land or water that has been affected by exploration, testing, mineral development, mining, onsite processing operations, or waste disposal, in ways which will prevent or control onsite and offsite damage to the environment.

§ 231.3 Responsibilities.

(a) Subject to the supervisory authority of the Secretary, the regulations in this part shall be administered by the Director through the Chief, Conservation Division, of the Geological Survey.

(b) The responsibility for health and safety inspections of mines subject to the regulations in this part is vested in the Bureau of Mines in accordance with section 4 of the Federal Metal and Nonmetallic Mine Safety Act (80 Stat. 772, 773; 30 U.S.C. 723) and the Health and Safety Standards contained in Parts 55, 56, and 57, Chapter I, of this title.

(c) The mining supervisor, individually, or through his subordinates is empowered to regulate prospecting, exploration, testing, development, mining, and processing operations under the regulations in this part. The duties of the mining supervisor or his subordinates include the following:

(1) *Inspections; supervision of operations to prevent waste or damage.* Examine frequently leased or permit lands where operations for the discovery, testing, development, mining, or processing of minerals are conducted or are to be conducted; inspect and regulate such operations, including operations at accessory plants, for the purpose of preventing waste of mineral substances or damage to formations and deposits containing them, or damage to other formations, deposits, or nonmineral resources affected by the operations, and insuring that the terms and conditions of the permit or lease and the requirements of the exploration or mining plans are being complied with.

(2) *Compliance with regulations, lease or permit terms, and approved plans.* Require operators to conduct their operations in compliance with the provisions of applicable regulations, the terms and conditions of the leases or permits, and the requirements of approved exploration or mining plans.

(3) *Reports on condition of lands and manner of operations; recommendations for protection of property.* Make reports to the Chief, Conservation Division of the Geological Survey, as to the general condition of lands under permit or lease and the manner in which operations are being conducted and orders or instructions are being complied with, and to submit information and recommendations for protecting the minerals, the mineral-bearing formations and the nonmineral resources.

(4) *Manner and form of records, reports, and notices.* Prescribe, subject to the aproval of the Chief, Conservation Division of the Geological Survey, the manner and form in which records of operations, reports, and notices shall be made.

(5) *Records of production; rentals and royalties.* Obtain and check the records of production of minerals; determine rental and royalty liability of lessees and permittees; collect and deposit rental and royalty payments; and maintain rental and royalty accounts.

(6) *Suspension of operations and production.* Act on applications for suspension of operations or production or both filed pursuant to 43 CFR 3503.3-2(e), and terminate such suspensions which have been granted; and transmit to the Bureau of Indian Affairs for appropriate action applications for suspension of operations or production or both under leases on Indian lands.

(7) *Cessation and abandonment of operations.* Upon receipt of a report of cessation or abandonment of operations, inspect and determine whether the terms and conditions of the permit or lease and the exploration or mining plans have been complied with; and determine and report to the agency having administrative jurisdiction over the lands when the lands have been properly conditioned for abandonment. The mining supervisor, in accordance with applicable regulations, will consult with, or obtain the concurrence of, the authorized officer of the agency having administrative jurisdiction over the lands with respect to compliance by the operator with the surface protection and reclamation requirements of the lease or permit and the exploration or mining plan.

(8) *Trespass involving removal of mineral deposits.* Report to the agency having administrative jurisdiction over the lands any trespass that involves removal of mineral deposits.

(d) Prior to the approval of an exploration or mining plan, the mining supervisor shall consult with the authorized officer of the agency having administrative jurisdiction over the lands with respect to the surface protection and reclamation aspects of the plan.

(e) The mining supervisor shall inspect exploratory and mining operations to determine the adequacy of water management and pollution control measures for the protection and control of the quality of surface and ground water resources and the adequacy of emission control measures for the protection and control of air quality.

(f) The mining supervisor shall issue such orders and instructions not in conflict with the laws of the State in which the leased or permit lands are situated as necessary to assure compliance with the purposes of the regulations in this part.

§ 231.4 General obligations of lessees and permittees.

(a) Operations for the discovery, testing, development, mining, or processing of minerals shall conform to the provisions of applicable regulations, the terms and conditions of the lease or permit, the requirements of approved exploration or mining plans, and the orders and instructions issued by the mining supervisor or his subordinates under the regulations in this part. Lessees and permittees shall take precautions to prevent waste and damage to mineral-bearing formations, and shall take such steps as may be needed to prevent injury to life or health and to provide for the health and welfare of employees.

(b) Lessees and permittees shall take such action as may be needed to avoid, minimize, or repair soil erosion; pollution of air; pollution of surface or ground water; damage to vegetative growth, crops, including privately owned forage, or timber; injury or destruction of fish and wildlife and their habitat; creation of unsafe or hazardous conditions; and damage to improvements, whether owned by the United States, its permittees, licensees or lessees, or by others; and damage to recreational, scenic, historical, and ecological values of the land. The surface of leased or permit lands shall be reclaimed in accordance with the terms and conditions prescribed in the lease or permit and the provisions of the approved exploration or mining plan. Where any question arises as to the necessity for or the adequacy of an action to meet the requirements of this paragraph, the determination of the mining supervisor shall be final, subject to the right of appeal as provided in § 231.74.

(c) All operations conducted under the regulations in this part must be consistent with Federal and State water and air quality standards.

(d) When the mining supervisor determines that a water pollution problem exists, the mining supervisor may require that a lessee or permittee maintain records of the use of water, quantity and quality of waste water produced, and the quantity and quality of waste water disposal, including mine drainage discharge, process wastes and associated wastes. In order to obtain this information, the lessee or permittee may be required to install a suitable monitoring system.

(e) Full reports of accidents, inundations, or fires shall be promptly mailed to the mining supervisor by the operator or his representative. Fatal accidents, accidents threatening damage to the mine, the lands, or the deposits, or accidents which could cause water pollution shall be reported promptly to the mining supervisor by telegram or telephone. The reports required by this section shall be in addition to those required by Parts 55, 56, or 57, Chapter I of this title or other applicable regulations.

(f) Lessees and permittees shall submit the reports required by 25 CFR Part 177; Part 200 of this chapter, and 43 CFR Part 23.

§ 231.5 Public inspection of records.

Geological and geophysical interpretations, maps, and data and commercial and financial information required to be submitted under this part shall not be available for public inspection without the consent of the permittee or lessee so long as the permittee or lessee furnishing such data, or his successors or assignees, continues to hold a permit or lease of the lands involved.

MAPS AND PLANS

§ 231.10 Operating plans.

(a) *General.* Before conducting any operations under a permit or lease, the operator shall submit, in quintuplicate, to the mining supervisor for approval an exploration or mining plan which shall show in detail the proposed exploration, prospecting, testing, development, or mining operations to be conducted. Exploration and mining plans shall be consistent with and responsive to the requirements of the lease or permit for the protection of nonmineral resources and for the reclamation of the surface of the lands affected by the operations. The mining supervisor shall consult with the other agencies involved, and shall promptly approve the plans or indicate what modifications of the plans are necessary to conform to the provisions of the applicable regulations and the terms and conditions of the permit or lease. No operations shall be conducted except under an approved plan.

(b) *Exploration plans.* The mining supervisor may require that an exploration plan include any or all of the following:

(1) A description of the area within which exploration is to be conducted;

(2) Five copies of a suitable map or aerial photograph showing topographic, cultural, and drainage features;

(3) A statement of proposed exploration methods, i.e., drilling, trenching, etc., and the location of primary support roads and facilities;

(4) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, pollution of air, damage to fish and wildlife or other natural resources, and hazards to public health and safety both during and upon abandonment of exploration activities.

(c) *Mining plans.* The mining supervisor may require that a mining plan include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Five copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit or lease, the name and location of major topographic and cultural features, and the drainage plan away from the area affected;

(3) A statement of proposed methods of operating, including a description of the surface or underground mining methods; the proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, pollution of air, damage to fish and wildlife or other natural resources, and hazards to public health and safety;

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the operations.

(d) *Revegetation; regrading; backfilling.* In those instances in which the permit or lease requires the revegetation of an area to be affected by operations the exploration or mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

If the permit or lease requires regrading and backfilling, the exploration or mining plan shall show the proposed methods and the timing of grading and backfilling of areas of lands affected by the operations.

(e) *Changes in plans.* Exploration and mining plans may be changed by mutual consent of the mining supervisor and the operator at any time to adjust to changed conditions or to correct an oversight. To obtain approval of a changed or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed.

(f) *Partial plan.* If circumstances warrant, or if development of an exploration or mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operations, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 231.11 Maps of underground workings and surface operations and equipment.

Maps of underground workings and surface operations shall be drawn to a scale acceptable to the mining supervisor. All maps shall be appropriately marked with reference to Government land marks or lines and elevations with reference to sea level. When required by the mining supervisor vertical projections and cross sections shall accompany plan views. Maps shall be based on accurate surveys made at least annually and as may be necessary at other times. Accurate copies of such maps on reproducible material or prints thereof shall be furnished the mining supervisor when and as required. The maps shall be posted to date and submitted to the mining supervisor at least once each year. The accuracy of maps furnished shall be certified by a professional engineer, professional land surveyor, or other professionally qualified person.

§ 231.12 Other maps.

(a) The operator shall prepare such maps of the leased lands as in the judgment of the mining supervisor are necessary to show the surface boundaries, improvements, and topography, including subsidence resulting from mining, and the geological conditions so far as determined from outcrops, drill holes, exploration or mining. All excavations in each separate bed or deposit shall be shown in such manner that the production of minerals for any royalty period can be accurately ascertained.

(b) In the event of the failure of the operator to furnish the maps required, the mining supervisor shall employ a competent mine surveyor to make a survey and maps of the mine, and the cost thereof shall be charged to and promptly paid by the operator.

(c) If any map submitted by an operator is believed to be incorrect, the mining supervisor may cause a survey to be made, and if the survey shows the map submitted by the operator to be substantially incorrect in whole or in part, the cost of making the survey and preparing the map shall be charged to and promptly paid by the operator.

BORE HOLES AND SAMPLES

§ 231.20 Core or test hole, cores, samples, cuttings, mill products.

(a) The operator shall submit promptly to the mining supervisor signed copies, in duplicate, of records of all core or test holes made on the leased or permit lands, the records to be in such form that the position and direction of the holes can be accurately located on a map. The records shall include a log of all strata penetrated and conditions encountered, such as water, quicksand, gas, or unusual conditions, and copies of analyses of all samples analyzed from strata penetrated shall be transmitted to the mining supervisor as soon as obtained or at such time as specified by the mining supervisor. All drill holes will be logged under supervision of a competent geologist or engineer, and the lessees will furnish to the mining supervisor a detailed lithologic log of each drill hole and all other in-hole surveys, such as electric logs, gamma ray neutron logs, sonic logs or any other logs produced. The core from test holes shall be retained by the operator for 1 year and shall be available for inspection at the convenience of the mining supervisor, and he shall be privileged to cut such cores and receive samples of such parts as he may deem advisable, or on request of the mining supervisor the operator shall furnish such samples of strata, drill cuttings, and mill products as may be required.

(b) Drill holes for development or holes for prospecting shall be abandoned to the satisfaction of the mining supervisor by cementing and/or casing or by other methods approved in advance by the mining supervisor and in a manner to protect the surface and not to endanger any present or future underground operation or any deposit of oil, gas, other mineral substances, or water strata.

(c) At the option of the mining supervisor or the operator drill holes may be converted to surveillance wells for the purpose of determining the effect of subsequent operations upon the quantity, quality, or pressure of ground water or mine gases.

(d) When drilling on lands valuable or potentially valuable for oil and gas or geothermal resources drilling equipment shall be equipped with blowout control devices acceptable to the mining supervisor before penetrating more than 100 feet of consolidated sediments unless a greater depth is approved in advance by the mining supervisor.

WELFARE AND SAFETY

§ 231.25 Sanitary, welfare, and safety arrangements.

The underground and surface sanitary, welfare, health, and safety arrangements shall be in accordance with the recommendations of the U.S. Public Health Service and the applicable standards in Parts 55, 56, and 57, Chapter I of this title.

CROSS REFERENCE: For regulations of the U.S. Public Health Service, Department of Health, Education, and Welfare, see 42 CFR Chapter I.

MINING METHODS

§ 231.30 Good practice to be observed.

The operator shall observe good practice following the highest standards in prospecting, exploration, testing, development, and mining, sinking wells, shafts, and winzes, driving drifts and tunnels, stoping, blasting, transporting ore and materials, hoisting, the use of explosives, timbering, pumping, and other activities on the leased or permit lands.

§ 231.31 Ultimate maximum recovery; information regarding mineral deposits.

(a) Mining operations shall be conducted in a manner to yield the ultimate maximum recovery of the mineral deposits, consistent with the protection and use of other natural resources and the protection and preservation of the environment—land, water, and air. All shafts, main exits, and passageways, as well as overlying beds or mineral deposits that at a future date may be of economic importance, shall be protected by adequate pillars in the deposit being worked or by such other means as approved by the mining supervisor.

(b) Information obtained regarding the mineral deposit being worked and other mineral deposits on the leased or permit lands shall be fully recorded and a copy of the record furnished to the mining supervisor.

§ 231.32 Pillars left for support.

Sufficient pillars shall be left in first mining to insure the ultimate maximum recovery of mineral deposits when the time arrives for the removal of pillars. Boundary pillars shall in no case be less than 50 feet thick unless otherwise specified in writing by the mining supervisor. Boundary and other main pillars shall be mined only with the written consent or by order of the mining supervisor or his authorized subordinates.

§ 231.33 Boundary pillars and isolated blocks.

(a) If the ore on adjacent lands subject to these regulations has been worked out beyond any boundary pillar, if the water level beyond the pillar is below the lessee's adjacent operations, and if no other hazards exist, the lessee shall, on the written demand of the mining supervisor, mine out and remove all available ore in such boundary pillar, both in the lands covered by the lease and in the adjoining premises, when the mining supervisor determines that it can be mined without undue hardship to the lessee.

(b) If the mining rights in adjoining premises are privately owned or controlled, an agreement may be made with the owners of such interests for the extraction of the ore in the boundary pillars.

(c) Narrow strips of ore between leased lands and the outcrop on other lands subject to these regulations and small blocks of ore adjacent to leased lands that would otherwise be isolated or lost may be mined under the provisions specified in paragraphs (a) and (b) of this section.

§ 231.34 Development on leased tract through adjoining mines as part of a mining unit.

A lessee may mine his leased tract from an adjoining underground mine on land privately owned or controlled or from adjacent leased lands, under the following conditions:

(a) A mine that is on the land privately owned or controlled shall conform to all sections in the regulations in this part.

(b) The only connections between the mine on land privately owned or controlled and the mine on leased land shall be the main haulageways, the ventilationways, and the escapeways. Substantial concrete frames and fireproof doors that may be closed in an emergency and opened from either side shall be installed in each such connection. Other connections through the boundary pillars shall not be made until both mines are about to be exhausted and abandoned. The mining supervisor may waive any of the requirements in this paragraph when, in his judgment, such a waiver would not conflict with the regulations in Part 57, Chapter I of this title and would not entail substantial loss of ore.

(c) Free access for inspection of said connecting mine on land privately owned or controlled shall be given at any reasonable time to the mining supervisor or other representative of the Secretary of the Interior.

(d) If a lessee operating on a lease through a mine on land privately owned or controlled does not maintain the mine in accordance with the operating regulations, operations on the leased land may be ordered stopped or departmental seals applied by the mining supervisor, and the operations on leased lands shall be stopped.

§ 231.35 Minerals soluble in water; brines; mineral taken in solution.

In mining or prospecting deposits of potassium or other minerals soluble in water, all wells, shafts, prospect holes, and other openings shall be adequately protected with neat cement or other suitable materials against the coursing or entrance of water; and the operator shall, on orders of the mining supervisor, backfill with rock or other suitable material to protect the roof from breakage when there is a danger of the entrance of water. On leased or permit lands containing brines, due precaution shall be exercised to prevent the deposits becoming diluted or contaminated by the mixture of water or valueless solution. Where minerals are taken from the earth in solution, such extraction shall not be within 500 feet of the boundary line of the leased lands without the written permission of the mining supervisor.

PROTECTION AGAINST MINE HAZARDS

§ 231.40 Surface openings.

(a) The operator shall substantially fill in, fence, protect or close all surface openings, subsidence holes, surface excavations or workings which are a hazard to people or animals. Such protective measures shall be maintained in a secure condition during the term of the permit or lease. Before abandonment of operations all openings, including water discharge points, shall be closed to the satisfaction of the mining supervisor.

(b) Reclamation or protection of surface areas no longer needed for operations should commence without delay. The mining supervisor shall designate such areas where restoration or protective measures, or both, must be taken.

§ 231.41 Abandonment of underground workings.

No underground workings or part thereof shall be permanently abandoned and rendered inaccessible without the advance and written approval of the mining supervisor.

§ 231.42 Flammable gas and dust.

Mines in which flammable gas is found or explosive dust produced shall be subject to the coal-mining operating regulations in Part 211 of this chapter. An "explosive dust" is a combustible solid in airborne dispersion capable of propagating flame when ignited.

§ 231.43 Fire protection.

All structures within 100 feet of any mine opening shall be protected against fire and constructed of fire resistant material. Flammable material shall not be stored within 100 feet of a mine exit. All shafts shall be fireproof, or adequate fire-control devices, satisfactory to the mining supervisor, shall be installed. All underground offices, stations, shops, magazines, and stores shall be so constructed, equipped, and maintained as to reduce the fire hazard to a minimum. Sufficient fire-fighting apparatus shall be maintained in working condition at the mine exits and at convenient points in the mine workings for fire emergencies. An adequate water supply shall be held in storage tanks or reservoirs for fire emergencies and shall be available for immediate use through connecting pipelines for either surface or underground fires.

MILLING; WASTE FROM MINING OR MILLING

§ 231.50 Milling.

It shall be the duty of the operator to conduct milling operations pursuant to the terms of the lease, the approved mining plan, and the regulations in this part and to use due diligence in the reduction, concentration, or separation of mineral substances by mechanical or chemical processes, by distillation, by evaporation, or other means so that the percentage of salts, concentrates, oil, or other mineral substances recovered shall be in accordance with approved practices.

§ 231.51 Disposal of waste.

The operator shall dispose of all wastes resulting from the mining, reduction, concentration, or separation of mineral substances in accordance with the terms of the lease, approved mining plan, the regulations in this part, and the directions of the mining supervisor.

PRODUCTION RECORDS AND AUDIT

§ 231.60 Books of account.

Operators shall maintain books in which will be kept a correct account of all ore and rock mined, of all ore put through the mill, of all mineral products produced, and of all ore and mineral products sold and to whom sold, the weight, assay value, moisture content, base price, dates, penalties, and price received, and the percentage of the mineral products recovered and lost shall be shown.

CROSS REFERENCE: See Part 200 of this chapter for reports required to be filed and the forms to be used.

§ 231.61 Royalty basis.

The sale price basis for the determination of the rates and amount of royalty shall not be less than the highest and best obtainable market price of the ore and mineral products, at the usual and customary place of disposing of them at the time of sale, and the right is reserved to the Secretary of the Interior to determine and declare such market price, if it is deemed necessary by him to do so for the protection of the interests of the lessor.

§ 231.62 Audits.

An audit of the lessee's accounts and books may be made annually or at such other times as may be directed by the mining supervisor, by certified public accountants, and at the expense of the lessee. The lessee shall furnish free of cost duplicate copies of such annual or other audits to the mining supervisor, within 30 days after the completion of each auditing.

INSPECTION, ISSUANCE OR ORDERS, AND ENFORCEMENT OF ORDERS

§ 231.70 Inspection of underground and surface conditions; surveying, estimating, and study.

Operators shall provide means at all reasonable hours, either day or night, for the mining supervisor or his representative to inspect or investigate the underground and surface conditions; to conduct surveys; to estimate the amount of ore or mineral product mined; to study the methods of prospecting, exploration, testing, development, processing, and handling that are followed; to determine the volumes, types, and composition of wastes generated, the adequacy of measures for minimizing the amount of such wastes, and the measures for treatment and disposal of such wastes; and to determine whether the terms and conditions of the permit or lease and the requirements of the exploration or mining plan have been complied with.

§ 231.71 Issuance of orders.

Before beginning operations the operator shall inform the mining supervisor in writing of the designation and post office address of the exploration or mining operation, the operator's temporary and permanent post office address, and the name and post office address of the superintendent or other agent who will be in charge of the operations and who will act as the local representative of the operator. The mining supervisor shall also be informed of each change thereafter in the address of the mine office or in the name or address of the local representative.

§ 231.72 Service of notices, instructions, and orders.

The operator shall be considered to have received all notices, instructions, and orders that are mailed to or posted at the mine or mine office, or mailed or handed to the superintendent, the mine foreman, the mine clerk, or higher officials connected with the mine, for transmittal to the operator or his local representative.

§ 231.73 Enforcement of orders.

(a) If the mining supervisor determines that an operator has failed to comply with the regulations in this part, other applicable departmental regulation, the terms and conditions of the permit or lease, the requirements of an approved exploration or mining plan, or with the mining supervisor's orders or instructions, and such noncompliance does not threaten immediate, serious, or irreparable damage to the environment, the mine or the deposit being mined, or other valuable mineral deposits or other resources, the mining supervisor shall serve a notice of noncompliance upon the operator by delivery in person to him or his agent or by certified or registered mail addressed to the operator at his last known address. Failure of the operator to take action in accordance with the notice of noncompliance shall be grounds for suspension by the mining supervisor of operations.

(b) A notice of noncompliance shall specify in what respects the operator has failed to comply with the provisions of applicable regulations, the terms and conditions of the permit or lease, the requirements of an approved exploration or mining plan or the orders and instructions of the mining supervisor, and shall specify the action which must be taken to correct the noncompliance and the time limits within which such action must be taken.

(c) If in the judgment of the mining supervisor such failure to comply with the regulations, the terms and conditions of the permit or lease, the requirements of approved exploration or mining plans, or with the mining supervisor's orders or instructions threatens immediate, serious, or irreparable damage to the environment, the mine or the deposit being mined, or other valuable mineral deposits or other resources, the mining supervisor is authorized, either in writing or orally with written confirmation, to suspend operations without prior notice.

§ 231.74 Appeals.

(a) A party adversely affected by an order of the mining supervisor made pursuant to the provisions of this part shall have a right to appeal to the Director and the further right to appeal to the Board of Land Appeals in the Office of Hearings and Appeals, Office of the Secretary, from an adverse decision of the Director, unless such decision was approved by the Secretary prior to promulgation.

(b) An appeal to the Director may be taken by filing a notice of appeal with the mining supervisor within 30 days from service of the mining supervisor's order. The notice of appeal shall incorporate or be accompanied by such written showing and argument on the facts and laws as the appellant may deem adequate to justify reversal or modification of the order. Within the same 30-day period, the appellant will be permitted to file with the mining supervisor additional statements of reasons and written arguments or briefs.

(c) The mining supervisor shall transmit the appeal and accompanying papers to the Director who will review the record and render such a decision in the case as he deems proper.

(d) Appeals to the Board of Land Appeals shall be made pursuant to procedures outlined in 43 CFR Part, 4, Department Hearings and Appeals Procedures.

(e) Oral argument in any case pending before the Director will be allowed on motion in the discretion of such officer and at a time to be fixed by him.

(f) The procedure for appeals under this part shall be followed for permits and leases on Indian land except that with respect to such permits and leases, the Commissioner of Indian Affairs will exercise the functions vested in the Director. A party adversely affected by a decision of the Commissioner of Indian Affairs under this part shall have a right of appeal to the Board of Land Appeals in the Office of Hearings and Appeals, Office of the Secretary, in accordance with the procedures provided in this section.

(g) With the exception of the time fixed for filing a notice of appeal, the time for filing any document in connection with an appeal may be extended by the officer to whom the appeal is taken. A request for an extension of time must be filed within the time allowed for the filing of the document and must be filed in the same office in which the document in connection with which the extension is requested must be filed.

CROSS REFERENCE: See 43 CFR 23.12 for appeals under 43 CFR Part 23—Surface Exploration, Mining, and Reclamation of Lands. See 25 CFR 177.11 for appeals under 25 CFR Part 177—Surface Exploration, Mining, and Reclamation of Lands.

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VI. Adverse Effects Which Cannot be Avoided

A. Effects on Land Use

1. Mining and Processing

Development of any of the proposed tracts would inevitably result in land changes, some of which would be temporary in nature and some of which could be permanent depending upon the methods of mining and processing that were employed.

In the temporary category, land surfaces would be disturbed in preparing sites for operational and supporting facilities. Such disturbance would endure only during the period of operations, after which land restoration, including revegetation, would be required. Estimates of the land areas that would be affected under the anticipated development options for each tract are given in Chapter III of this analysis.

Permanent land impacts would occur to the extent that spent shale and other solid wastes would be produced in mining and aboveground processing in excess of amounts that would ultimately be disposed of in mined out areas. Such excesses, which also are estimated for various development options in Section III, would necessarily remain as surface deposits. Thus, the topography and general appearance of the land used for permanent disposal would be altered as detailed in other sections of this analysis and summarized below.

B. Effects on Grazing

Grazing on each of the tracts would be expected to be unavoidably affected for specific periods during the operation of the lease. One loss that would occur for the duration of the lease would be due to the location of plant, storage, and related facilities and improvements, including roads. Another loss, which would be temporary, would be due to the necessary time lageneeded to complete disposal and revegetation. The magnitude of these two categories of losses would be dependent upon the size of the plant, storage, and related facilities and improvements, including roads, and the type of mining method employed. The effects estimated on each tract for the projected development are as follows:

1. Tract C-a

It is estimated that between 35-65 animal unit months (AUM's) per year of spring/summer cattle grazing would be lost by development on this tract. Normal livestock trailing through the site would be disrupted.

2. Tract C-b

Some 35-55 AUM's per year of spring/fall cattle grazing would be lost on this tract. The project site constitutes a winter use area for a few wild horses, therefore some disruption could occur.

3. Tract U-a and U-b

Some 40-70 AUM's per year of winter/spring sheep grazing would be lost on each project site.

4. Tract W-a and W-b

Some 65 AUM's per year of fall/winter/spring sheet use and summer/fall cattle use would be lost. The scarcity of available water for livestock could pose additional animal distribution problems during operations under the proposed program.

C. Effects on Hisotrical and Archaelogical Sites

Although there are no known historical or archaeological sites on the selected tracts, the area including the sites was formerly inhabitated by nomadic, hunting Indian tribes. Any disturbance of the surface, especially an open-pit mining operation, could disturb some unknown archaeological sites or artifacts. Conversely, such operations might also lead to archeological discoveries that may otherwise not be made.

D. Effects on Water Resources

Water requirements for oil shale mining and processing at the six selected lease sites would depend upon the type of mining, retorting, and shale-disposal processing employed in each case. A complete description of the possible impacts on the water resources of the six sites is given in Chapter IV of this document. That discusses the tract specific impacts that may occur as a result ofmining and processing variations. The water diverted for all uses would have an unavoidable impact on regional water supplies, because any storage diversion and net consumption of existing water resources would deplete natural streamflow. This in turn would increase the salinity concentraction of the Colorado River at Hoover Dam, (2 to 3 mg/1) or a maximum of about 0.5 percent for the full 250,000 barrel per day prototype operations. During the period between disturbance of the surface and revegetation, high intensity rains could cause accelerated soil erosion and channel cutting and could increase sedimentation in the stream beds.

The cumulative impact of this over time would be quantifiable by monitoring of the major rivers. High quality excess and/or waste water discharged into the streams could add to the erosion factor and sediment load.

Drainage and channels would probably be diverted because of mine facilities and waste disposal areas. The quantity of impact depends upon the type and intensity of mining operations and control measures used.

As oil shale development proceeds, increased population would put increased sanitary waste load on regional water supplies. Even with the best of treatment and disposal facilities this effect cannot be fully mitigated, and in this sense is adverse.

The disturbance of ground water by mining operations, or by water used to return spent shale underground for disposal, could have an adverse effect on subsurface water quality, ground-water movement, water levels, spring flow, and streamflow. Knowledge of aquifer characteristics, head relations, and chemical quality distribution in the aquifers in much of the region is inadequate and the extent of this impact cannot be predicted. Specific information developed during core drilling and on going research might reduce the risk of adverse impacts on aquifers. Close minitoring of the quality of water, and prompt action to change operations detrimental to water quality would be conducted to help mitigate adverse effects.

E. Effects on Air Quality and Noise

The primary sources of potential air pollution and noise pollution from oil shale processing arise from particulate matter from mining, crushing, process gases, and those that may be used in support operations such as on-site power generation and air contamination due to surface vehicles and traffic. These possibilities for air and noise contamination are adverse effects which can only be partially avoided; the residuals have been quantified in chapter IV of this volume.

F. Effect on Fish and Wildlife

1. General

Unavoidable impacts of both a localized and regional nature have already been discussed in Section V, Volume I of this Environmental Statement. The following discussion is directed to tract-specific unavoidable adverse impacts of the six proposed oil shale installations on fish and wildlife resources.

2. Colorado Tracts

a. Tract C-a

Development of this tract including the 16-miles of trail and presently unpaved road from the Piceance Creek Highway to the tract, would result in increased hunting pressures and other human uses in the tract vicinity with accompanying reductions of game populations. The most significant wildlife impact, as compared with impacts at other tracts, would be a loss of the semi-remote characteristicsa and hunting qualities on and in the vicinity of tract C-a, as a result of roads, pipelines, transmission lines, signs, vehicular traffic, etc. Human activities accompanying construction and operation would, over the life of the lease, have a net disturbance effect on wildlife in the tract vicinity. Some species, such as mountain lion, and peregrine or prairie falcon would be intolerant and portions of the tract vicinity would be lost to them as habitat.

If an air strip and air traffic were established on or near the tract, aerial disturbance of mule deer, wild horses, and other animals would occur. The extent of such disturbance would be dependent upon the volume and type of air traffic.

Surface mining would disturb approximately 1,400 acres of the 5120 acre tract over a 30 year period. Off-site disturbances would include 400 acres for utilities and access roads and an additional 4,850 acres which would be used as a processed shale and overburden disposal area in the Cathedral Bluffs- Douglas Creek drainage. The impact of food and cover loss upon wildlife populations from this disturbance would occur principally in the loss of production capacity for the developed areas, which in turn would be reflected in lower populations of animals. For example, removal of winter browse vegetation would result in a coresponding reduction in mule deer numbers. Off-tract construction of roads, and utility and oil transmission corridors would also result in at least temporary physical loss of some wildlife habitat. An estimated 175 to 225 acres of right-of-way surface, some of it wildlife habitat, would be initially disturbed by land use for roads, pipelines, electric transmission lines, etc. It is anticipated there could be some lowering of natural surface water features, with subsequent effects upon two natural springs on this tract. Drying of these springs and other surface waters would disrupt the natural plant-animal complex associated with each water feature, including the related distribution of big game, cattle, and wild horses.

Areas stripped of natural cover would become vulnerable to wind and water erosion, until stabilized through revegetation or other means. An estimated 6,650 acres of land surface on or in the vicinity of tract C-a, with erosion potential varying from very low to very high, would at one time or another be exposed.

Both on and off-tract construction and operation activities, road traffic, fences, other facilities, and increased human activities, on tract C-a could result in some blockage and rerouting of the traditional mule deer migration pattern.

It would be reasonable to expect a minor loss of hawks and other birds which would come in contact with overhead power distribution lines.

Vegetation adjacent to constructed dirt roads and trails would be regularly covered with vehicle-caused dust, causing a minor, but notable loss of wildlife food value. This loss would continue until washed off by subsequent rains.

In the unlikely event that an accidental oil loss were to occur through breakage of the product pipeline or error at the oil storage facilities, adverse impacts would result upon vegetation, wildlife, and fish habitat exposed to the loss.

If silt and toxic substances, such as contaminated mine drainage and oil, were released to surface waters as a result of either on-or off-tract construction and operation, exposed aquatic habitat would be adversely affected. Such aquatic habitat does not exist on tract C-a itself, but does exist downstream in trout ponds on Ryan Creek and in the White River. Species which would be affected include trout, suckers and shiners.

The unavoidable adverse impacts of urbanization which would occur with the program are discussed in Chapter V of Volume I of this Environmental Statement.

b. Tract C-b

Direct on-tract surface disturbance on this 5,114-acre tract would occur up to 1,000 acres, if disposal of all the spent shale is done on the surface. An additional 200 acres would be required for off-tract roads, an oil pipeline, a gas transmission line,etc. Off-tract spent shale disposal could involve an additional 1,000 acres.

Development of the tract would result in basically the same types of unavoidable adverse impacts on wildlife resources as those already described for tract C-a, although the magnitude of impacts would vary with respect to tract specific characteristics. These impacts would include: increased hunting pressures with subsequent reductions in game populations and some loss of the tract's remote hunting qualities; disturbance of behavior and activity patterns of wildlife; losses of both on- and off-tract habitat of some species not capable of adapting to the changed environment, such as mountain lion, peregrine and prarie falcon; aerial disturbance of mule deer and other animals in the event an air strip were constructed; both on- and off-tract reductions in wildlife food and cover with a corresponding reduction in animal populations; drying up of some natural surface water features, such as springs, seeps, etc., with a corresponding disruption of the associated plant-animal complex; a minor loss of birds, particularly hawks and other raptors, through contact with power distribution lines; the potential for accidental oil losses with adverse impacts upon vegetation and animals; and the potential for introduction of toxic substances and silt to the White River with accompanying adverse impacts upon aquatic biota.

3. Utah Tracts U-a and U-b

Oil shale development on and in the vicinity of these two Utah tracts would cause basically the same types of unavoidable adverse impacts as those already described in detail for Colorado Tract C-a. The impacts would, however, vary in magnitude because of area-specific characteristics of fish and wildlife and their habitat. Since the two tracts adjoin one another, their unaboidable adverse impacts on fish and wildlife resources are discussed together. Combined surface would be as much as 800 acres, if disposal of all spent shale is done on the surface. An additional 200 acres would be required for off-tract roads, buildings, utility corridors, etc.

Off-tract spent shale disposal could involve an additional 1,200 acres, in the event that silt and toxic substances, such as contaminated mine drainage and oil, were to reach the White River, and adverse impacts would occur on aquatic organisms and habitat. Along this section, the White River contains catfish, bullheads, suckers, and the rare and endangered species of squawfish, hump-backed sucker and boney-tailed chub. The unavoidable adverse impacts of associated urbanization which would occur with the program are discussed in Chapter V of Volume I of this Environmental Statement.

4. Wyoming Tracts W-a and W- b

Since the two Wyoming tracts adjoin one another, impacts of their development upon fish and wildlife resources will be discussed together. Oil shale development would cause basically the same types of unavoidable adverse impacts as those already described in detail for Colorado tract C-a. The impacts would, however, vary in magnitude because of area-specific characteristics of fish and wildlife and their habitat.

It is quite likely that an in situ processing system would be used on both of these tracts, with resulting surface disturbance of approximately 775 acres per tract. An additional 600 acres of surface are development would be required for buildings, utility corridors, roads, etc.

In the event that silt and toxic substances, such as contaminated mine drainage or oil, were to reach Vermillion Creek or the Green River, adverse impacts would occur on aquatic organisms and habitat. Vermillion Creek has populations of suckers and trout, while the Green River has been designated by the State as an outstanding trout water.

The unavoidable adverse impacts of associated urbanization, which would occur in Wyoming, are discussed in Chapter V of Volume I of this Environmental Statement.

G. Effects on Aesthetics, Recreation, and Cultural Values

Development of an oil shale mining-processing-waste-disposal complex will require some unavoidable and adverse effects which cannot be avoided. However, the degree of the effects will depend upon the objectivity, and skill of the engineers, natural and social scientists, environmentalists, politicians, and other people involved in the planning,design, and management of the proposed oil shale projects. The major and known unavoidable effects are discussed below.

New roads, trails, plant sites, waste disposal areas, utility and pipeline corridors will need to be built. All of these will be in addition to the changes in the landscape caused by open-pit mines, underground mining, or combinations of both. In addition to these alterations related directly to the mining process, new urban-like areas will need to be constructed; this will involve further distortion of the landscape.

Waste disposal areas would change the topography and would thereby alter the appearance of the land. Vegetative cover would be affected until revegetation operations began. These changes would be considered adverse in the sense that the area's present topography, semi-remote, wildlife and recreation opportunities, would be altered. The degree to which these topographical changes are adverse, however, is a value judgment difficult to quantify. With proper methods the scenic and recreational impact could be kept within acceptable limits.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A. Consumption of Mineral Resources

The leasing of the selected six tracts would permit development and extraction of the leasable minerals in the oil shale of the selected areas. The oil shale resources of the combined six tracts contain about 8 billion barrels of 30 gallon per ton oil shale. However, as little as one-third of the inground resource may be economically processed. The lease sales could result in eventual production of 3- to 6-billion barrels of shale oil, or only a fraction of one percent of the gross potential shale oil of the region.

When mining or processing the oil shale, other minerals would probably be extracted as byproducts. For example, small amounts of sulfur and nitrogen in the organic matter of the shale could be recovered. Sodium minerals (nahcolite and halite) could be extracted where they are in conjunction with the oil shale in recoverable amounts. Alumina from the mineral dawsonite present in some oil shales may also be extracted. Byproduct minerals not processed could be returned to waste piles or waste brines.

Oil shale not processed in the first development would be left in the ground or stored as an interim measure for some future secondary extraction process.

B. Changes in Land Use Patterns

1. Industrialization

When the leases on any of the six proposed tracts expire or when the oil shale resource has been exhausted there would be no reason to maintain the surface processing facilities. The lease regulations would require that the unused facilities be removed, and reclamation-revegetation completed so as to restore the tracts to conditions at least equivalent to those of original land use. Most lands adjacent to the leased Federal tracts are also Federal property, and there would therefore be no spill-over development on these lands without further leasing which will not be done pending a complete review of the actual environmental impacts.

2. Topographic Changes

Upon completion of the mining operation, surface processing facilities would be removed. There would be some permanent topographic changes caused by the mining operation that would occur on each tract, as described below.

a. Colorado Tract C-a

This tract is susceptible to surface mining, underground mining or in-situ production. If surface mining would be the method used, about 30 percent of the surface of the tract could be disturbed by mining over a 30 year period of time. New contouring could remove undesirable steep slope grades that existed in the original topography, and revegetation would provide protection against erosion.

Processed shale has a lower density than raw shale. Oil shale expands when it is processed so that all of the spent shale will not "fit" into the mine if the original elevations are to be maintained. The excess could be disposed of by filling canyon land immediately west of Cathedral Bluffs; beyond the boundary of the lease. Approximately 900 acres could be required for such disposal if backfilling were used. The processed shale would be deposited to provide a stable slope and would be revegetated.

If underground mining is used, 60 percent of the processed shale could be replaced in the mine. This would reduce caving within the mine, and reduce the potential for surface subsidence. The portion of the processed shale that cannot be returned could be disposed of in canyon lands, as in surface mining, and would require 740 acres. On-site, mine entry and ventilation shafts would be filled in and revegetated so as to cause no permanent topographic change.

An in-situ operation would cause little permanent surface disturbance unless subsidence occurred as the result of the underground fracturing and retorting.

All three methods of operation could cause a permanent underground disturbance on site. The refilled excavation from surface or underground mining would have a different density and porosity than it had prior to mining. In situ processing also would create different physical and hydrologic characteristics than that of the undisturbed oil shale formation; the effect on the environment cannot now be estimated.

b. Colorado Tract C-b

This tract could be developed by either in situ processing or underground mining with surface processing. In situ processing as stated under Tract C-a would cause little permanent surface disturbance unless subsidence occurred. Underground mining with replacement of 60 percent of the processed shale in the mine would leave 40 percent of the processed shale to be disposed in-part on-site. This could be done by disposal in the canyons (outlined in Chapter III of this volume.).

c. Utah Tracts U-a and U-b

These adjacent tracts could be developed by either in situ processing or underground mining with surface processing. In situ processing as stated under tract C-a would cause little permanent surface disturbance. Underground mining with replacement in the mine of 60 percent of the processed shale would leave 40 percent of the processed shale to be disposed of on-site. Assuming a

50,000 barrel per day productive capacity for the two sites, this disposal could be accomplished by filling those canyons delineated in Chapter III of this analysis.

d. Wyoming Tracts W-a and W-b

These tracts are most suitable for in-situ processing, which would cause little permanent surface disturbance unless subsidence occurred as the result of underground fracturing and retorting.

C. Commitment of Water Resources

Between 25,000 and 40,000 acre feet per year of water would be used in mining, crushing, retorting, and waste disposal on the six selected tracts, and to support the accompanying population. A large part of this water would be diverted from the Colorado, White, and Green Rivers and would not be available for other uses. Construction of dams and reservoirs to assure a dependable water supply would commit the water storage sites for an indefinite length of time.

Pumping to dewater mine areas in Colorado could establish cones of depression, which could, in turn, lead to encroachment of highly mineralized ground water into the lease areas. Dewatering the leached area in the Piceance Creek Basin could lead to compaction within the Green River Formation strata, and ultimately could cause local land subsidence, decrease in stream flow and drying up of springs, with a consequent adverse effect on animals and plants.

D. Changes in Fish and Wildlife Resources

Establishment and operation of a regional oil shale industry would result in two general sources of irreversible and irretrievable commitments of fish and wildlife and their habitat. The first source would be those commitments resulting from construction and operation activities at and in the vicinity of oil shale installations; while the second would be accompanying regional urban develomment.

Irreversible and irretrievable effects on fish and wildlife resources resulting from both sources would include: permanent losses of natural surface water features, such as springs and seeps; and their associated plant and animal complexes; losses of fish and wildlife production on and near the actual oil shale tract and at associated urban development areas; and a net loss of semi-remote hunting and fishing values. Urbanization associated with regional oil shale development also has the potential to adversely affect to some extent existing rare and endangered species populations of the region.

E. Recreation, Aesthetic and Cultural Values

The proposed oil shale projects would create an industrial complex within a relatively remote, natural environment. Certain scenic landscapes with their attending vegetation, water, and wildlife habitat which provide recreational opportunities would be lost for decades; others would be permanently altered. For example, the view from Kinney Rim in Wyoming and from the Cathedral Bluffs in Colorado would be affected by mine development and mine disposal. The present recreational features would be permanently changed or altered because of these activities. Recreational use on any tract would also be temporarily lost, including rockhounding and recreational opportunities to observe the habitat and members of certain wildlife species.

VIII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

A. Energy and Mineral Resources Gain

The direct energy gain from this proposed prototype program would approximate 250,000 barrels per day by 1981. Viewed within the context of increasing energy demands, this will not provide a significant short-term (under 10 years) impact on oil supplies. However, the establishment of a proven technology and support facilities are important to the Nation's long-term need for clean energy.

Certain of the oil-shale also are associated with dawsonite, an aluminum-bearing mineral, and nahcolite, a natural form of sodium bicarbonate. On Colorado Tract C-a about 500 ft. of the lowest shale zones contain dawsonite in varying amounts, and on Tract C-b approximately 300 ft. of lower zone shales have dawsonite. Bedded nahcolite is present on the northwest part of the lower zone on Tract C-b, and nahcolite pods exist on Tract C-a and on both of the Utah tracts.

Technology and economics for processing these shales for minerals recovery are still in the research stage. However, by the time sufficient quantities of oil shale are being extracted, it is reasonable to assume that processes for minerals recovery will have been developed. Alumina recovery would have significant national importance since the United States now is almost totally dependent on foreign sources for its supply of aluminum uses. Nahcolite could have significant local importance, i.e., on-site or in the Four Corners area, as a means of reducing sulfur oxides and other noxious components of industrial stack gases. However, laboratory tests have not yet been confirmed on a commercial scale.

B. Improvements in Technology

The short-term/long-term factors as related to improvements in technology are considered in Volume I, Section VI-B of this analysis. In summary, the proposed program, if implemented, could be expected to lead the way to long-term productivity and economic benefits throughout the entire oil-shale region. Improvements in technology would be expected to result in increasingly effective use of the resource and concurrently would result in a more adequate identification of oil shale environmental problems, and the development of improved methods for their control or mitigation during processing.

C. Water Resources

A direct relationship of environmental impact to time and rate ofoil shale production exists, i.e., adverse effects will increase proportionately. However, some problems may become disproportionately more acute with time and production rate. These include:

(a) Ground water withdrawal will lower water levels (and pumping levels) and be followed by a decrease in the quantity of spring and stream flow. Depressuring or dewatering the leached zone could also cause land surface subsidence.

(b) Ground water pumpage would change hydraulic gradients, particularly in Colorado, and cause mineralized water to move toward pumped wells and pits. The quality of water available for human and industrial use from wells in the vicinity of the tracts could be effected at some time measured in months or years after withdrawals begin depending on the local situation.

The development of these six leases, however, could provide a body of hydrologic knowledge with which better water utilization could be accomplished, and better pollution and technical control measures established for the ultimate development of the oil shale resource.

D. Fish and Wildlife Resources

Some limited additional disturbance from future oil shale independent oil, gas, or mineral development may be anticipated in the oil shale areas. However, in the absence of the proposed prototype oil shale development, it can be assumed that current levels of wildlife productivity, species distribution, and recreation use, would be maintained on the existing, continuing and sustained-yield basis.

As described in preceding sections, the prototype oil shale program and associated urban development would result in certain localized, as well as regional, adverse impacts on fish and wildlife resources. Although some impacts related to proposed oil shale processing activities would be unavoidable, many lend themselves to at least partial control. Therefore, with the program already implemented (see Volume I), the optimum relationship between oil shale development and maintenance of long-term wildlife productivity can be balanced. This program includes the combined cooperation among the government, industrial and private sectors in anticipation of adverse impacts, and subsequent implementation of those actions which would preclude, minimize, or mitigate these impacts.

E. Changes in Recreation Patterns and Aesthetics

The proposed oil shale program and the anticipated urban development could result in certain localized as well as Basin and regional changes on recreation and aesthetic resources.

The present project areas in the three-State-region, together with the related new urban service and utility corridors, will involve a limited percentage of recreation lands; however, the sum total anticipated will exert a considerable impact on the existing environment well beyond the designated boundaries.

Existing land use programs, on, and in the vicinity of all the proposed projects, involves coordinated management of urban as well as the natural resources (soil, water, mineral, forest and wildlife) to provide for quality recreational opportunities. Although some impacts related to the proposed projects would be unavoidable, many lend themselves to technological and regulatory management. The objective would be to maintain existing recreation resources with as little disturbance as possible, at the same time, develop needed urban oriented recreation facilities such as: golf courses, reservoirs, play grounds, swimming pools, etc. Therefore, the optimum relationship between program implementation and maintenance of long-term recreation resources will involve cooperation among the government, industrial and private sectors in anticipation of adverse impacts, implementation of needed research, and the development of the management programs needed to minimize or mitigate the adverse impacts. Such a program has been initiated, see Volume I, Chapter I.

F. Economic Development of Adjacent Regions

Although the initial construction phases related to the proposed leasing would involve some burdens on the seven county region, an integrated development could serve as a model for the evolution of a rural area to urban and partially industrialized socio-economic structure.

The development would provide a stable tax base over a long term for semi-isolated areas. The trend in depleting population, particularly in Colorado and Utah, could be offset by new training and additional job opportunities. Due to the population increase with a stabilized industry of this magnitude the communities could have social services and facilities which are now minimal or lacking.

IX. Alternatives to Selected Tracts

A. Introduction

The previous sections of this volume have discussed the implementation of the proposed prototype oil-shale leasing program based upon development, following competitive-bids leasing, on six recommended tracts (in Colorado, tracts designated C_a and C_b; in Utah, tracts designated U_a and U_b; and in Wyoming, tracts designated W_a and W_b). As already mentioned elsewhere in this volume, these six tracts were recommended by a selection committee of Federal and State experts and the recommended tracts were subsequently reviewed by the Department of the Interior. Although other tracts were examined, no tracts were considered for selection except those nominated. The six recommendations were made from a total of 23 nominations of 20 individual sites made by 15 companies. In the selection process of the tracts, it was necessary for the committee to thoroughly analyze each proposed site. Two additional tracts were also nominated by the State of Wyoming, thus bringing the total number of nominated sites to 25. After elimination of duplicate sites, 20 individual nominated sites remained.

The tract selections were based on an evaluation of such factors as the potential for progressive stimulation of technology, resource availability, potential recoverable resource, interest in the area, and sufficiency of data. Many factors were considered during the tract selection process, including ground water quantity and quality, shale thickness and grade amount of overburden, associated minerals, existing land uses, and competitive interest in various tracts shown by nominating companies. The potential development of each site was also considered for: Surface (open-pit) mining; underground mining and in-situ recovery.

This chapter discusses alternatives to the selected tracts. Discussed are general alternatives to the tracts and specific tract alternatives.

B. General Alternatives

1. Change in number of tracts

One alternative to the present selection of the three States, is to consider either the leasing of more tracts or the leasing of fewer tracts. This general alternative has several important implications examined below.

a. Selection of Fewer Tracts

The selection of fewer tracts for development under the prototype program would result in reduced environmental disturbances. This positive consideration, however, would also involve a reduction in the opportunity for competitive development. This lessening of competitive development would concentrate technical and management expertise and eventual economic gain in the hands of only a few companies. In addition, the number of different technologies which could be examined and the variation in geologic conditions and other environmental parameters that could be studied would be fewer.

b. Selection of more tracts

Selection of a greater number of tracts would permit even broader industry participation and the examination of more of the parameters affecting oil-shale development. This alternative could increase all of those advantages that arise from competitive development. Attendant with increased development, however, would be an increase in the potential for environmental disturbances.

2. Change in Location of Selected Tracts

Another alternative that might be considered is to accept other sites for the proposed development. The alternative site selections would necessarily involve a change in the levels of compromise factors that were used in the selection of the six proposed sites. That is, for example, technologic and economic consideration would be given less weight in the selection criteria and environmental considerations given greater weight. This kind of balance, however, could only be modified to a small degree in that, at some point, the economic incentive to proceed with development would be lost.

Alternative choices in the locales of the six sites might have been made but probably only at the expense of some compromise of the program as a whole. For example, in Wyoming the similarity of three nominations made the selection of two tracts uncomplicated. In Utah the two sites selected are amenable to either conventional or in-situ mining. Other nominations posed problems in the amount of reserves present, the depth of the deposits, etc. In Colorado one of the two sites selected is particularly amenable to surface mining, and the other to underground mining. Other nominations posed difficulties in such matters as excessive amounts of water in the shale strata, the absence of a lower shale zone, the presence of highly saline water in the leached zone, and potentially objectionable concentrations of halite.

3. Change in Size of Tracts

The 5,120-acre tract is the maximum size permitted for leasing by the Department of Interior under the present Leasing Act. New statuatory authority would be required if, as an alternative, larger tracts were to be offered for lease. It was felt that in this prototype leasing program the major objectives could be accomplished within the limitations of the 5,120-acre site.

Another alternative would be to offer leases smaller than 5,120 acres. However, it was felt that this might compromise the technological developments which were being undertaken, and also could result in less than a full-scale assessment of any environmental problems which might arise.

C. Specific Tract Alternatives

All of the 23 sites nominated by the 15 companies were nominated after considering existing resource information about the sites or with the additional information made available through informational core-drilling operations. These core-drillings were conducted under the authority of Special Land Use Permits issued by the Department of the Interior. Because these nominated sites are those about which most information is known to date, reasonable alternative tracts to the six tracts recommended are the remaining fourteen tracts.

The comparative geology, oil shale resources, and mining potential of the alternative tracts considered in this section are summarized in Table IX-1.

Comparative ground water data of the oil shale zones in the alternative tracts in Colorado is shown in Table IX-2. In the table, the conductivity is a rough measure of the salinity of the water, and the transmissivity is a rough measure of the water that can be pumped from the shale sequence.

Figures IX-1, IX-2, and IX-3, show all of the tracts nominated. the sections that follow include descriptions of the fourteen alternative tracts.

Table IX - 1 (3 pages) GEOLOGY, RESOURCE, AND MINING POTENTIAL--COLORADO

Site No.	Average over-burden (ft)	Dip	Faults	Oil-shale resource thickness 30-gallon shale: Mahogany zone	Oil-shale resource thickness 30-gallon shale: Lower zone	Thickness of zone with associated minerals	Open-pit mining	Underground mining	In-situ retorting
C-1	1100	NE at 200 ft/mi	None apparent	60 ft	440 ft	Several hundred feet of nahcolite- and dawsonite-bearing shale. Some halite.	Not desirable because of high overburden:ore ratio.	Limited potential because of less reserves in Mahogany zone than similar tracts.	Limited potential because contains only 2 thin zones of 30 GPT above leached zone.
C-2	700	SE at 150 to 600 ft/mi	NW trend-ing fault of small displace-ment.	Less than 15 ft	Less than 100 ft	Probably bedded nahcolite in southern 1/3 of tract and pods in remainder. Dawsonite in several hundred feet of section.	Feasible but overburden: ore ratio not favorable.	Possible but average grade of oil shale is low.	Favorable if re-source recovery is satisfactory.
C-3	500	E and NE at 300 to 500 ft/mi	None apparent	Less than 15 ft on west edge to more than 50 ft on east edge.	Less than 100 ft on west edge. Increase in thickness and value on east edge.	Probably bedded nahcolite in the eastern part. Several hundred feet of dawsonite.	Some potential because of moderate depth of overburden.	Feasible but other tracts contain greater mining thickness.	Favorable because of moderate over-burden and thick-ness of 30-40 GPT is sufficient.
C-6	1100	N at 50 ft/mi in north-ern part. NNW at 100 ft/mi in south-ern part.	None apparent	100 ft	500 ft	Several hundred feet contains nahcolite, some bedded. 700-800 ft contains dawsonite. Thick beds of halite occupy much of 300-ft interval underlying leached zone.	Not desirable because of high overburden:ore ratio.	Good	Satisfactory
C-9	1000	N at 100 ft/mi	None apparent	100-130 ft	Probably none in units thicker than 15 ft.	Essentially no nahcolite. Probably less than 100 ft of section contains dawsonite.	Uneconomic be-cause of high overburden:ore ratio.	Good for mining Mahogany zone and R-6 bed.	Feasible.

Site No.	Average over-burden (ft)	Dip	Faults	Oil-shale resource thickness 30-gallon shale		Thickness of zone with associated minerals	Open-pit mining	Underground mining	In-situ retorting
				Mahogany zone	Lower zone				
C-10	900	NE at 100 to 150 ft/mi	Probably a few of slight displacement in SW part of site	70 ft	700 ft	Nahcolite has all been leached, about 600 ft of section contains dawsonite.	Feasible because of overburden: ore ratio.	Favorable, but water may be a problem.	Favorable
C-11	1100	W at 150 ft/mi in east part. NE at 150 ft/mi in west part.	NW trending graben in SE¼. Probably small displacement.	150 ft	750 ft	Bedded nahcolite in about 500 ft of section. Dawsonite in more than 700 ft of section. Thick beds of halite in 300 ft underlying leached zone.	Feasible but less potential than other sites because of overburden depth.	Excellent because of thickness of minable beds.	Possible
C-12	300	SW at 200 to 400 ft/mi	None apparent	Less than 15 ft	Less than 15 ft	Probably very little nahcolite but probably several hundred feet contain dawsonite.	Limited potential because of thickness of oil shale.	Fair	Feasible
C-14	900	N at 200 ft/mi	None apparent	More than 100 ft	About 25 ft	Amount of nahcolite probably insignificant. Probably less than 100 ft contains dawsonite.	Same as C-9.	Same as C-9.	Feasible.
C-15	1000	N at 200 ft/mi	None apparent	More than 100 ft	About 25 ft	Same as C-14.	Same as C-9.	Same as C-9.	Feasible
C-16	1100	SE at 150 ft/mi	None apparent	About 90 ft	About 200 ft in southern part. About 750 ft in northern part.	Nahcolite present throughout site. Zone thicker in the northern part. About 500 ft of dawsonite in south and 600 ft in north.	Little potential becauae of overburden:ore ratio.	Favorable because of minable thickneas of oil-shale beds.	Good potential.

GEOLOGY, RESOURCE, AND MINING POTENTIAL--UTAH --Cont.

UTAH

Site No.	Average over-burden (ft)	Dip	Faults	Oil-shale resource thickness 30-gallon shale Mahogany zone	Gilsonite veins	Open-pit mining	Underground mining	In-situ retorting
U-1	850	N to NW at 2°	None apparent	About 40 ft	Several; one has a maximum width of 30 in.	Not desirable because of overburden:ore ratio.	Feasible	Feasible
U-3	2300	NW at 1° to 2°.	None apparent	About 25 ft	Several; one has a maximum width of 36 in.	Not suitable because of high overburden:ore ratio.	Feasible but unlikely because of thickness and grade of minable beds.	Feasible

WYOMING

Site No.	Average over-burden (ft)	Dip	Faults	Oil-shale resource thickness 20-gallon shale in Laney Member	Open-pit mining	Underground mining	In-situ retorting
W-3	600	NE at 9° to 30° dips increase to NE	A normal fault 1.5 mi long along W margin. Displacement less than 100 ft.	Totals 90 ft in two zones approximately equal in thickness.	Not desirable because of high overburden:ore ratio.	Favorable, but shale is low grade.	Favorable

Table IX-2--Water criteria rating of oil shale tracts in Colorado.

Conductivity	Rating	Transmissivity
0 - 999 µmhos/cm	1 (Rating)	0 - 999 gpd/ft
1,000 - 1,999	2	1,000 - 1,999
2,000 - 4,999	3	2,000 - 4,999
5,000 - 9,999	4	5,000 - 9,999
10,000 - 20,000	5	10,000 -15,000
> 20,000	6	≥ 15,000

Site No.	Upper Oil Shale Zone		Lower Oil Shale Zone	
	Conductivity	Transmissivity	Conductivity	Transmissivity
Colo.				
1	1	3	6	3
2	Estimated to be similar to Site #C-1			
3	Lost all circulation at 1,060 feet			
6	4	2	6	1
9	No data-Score estimated			
10	3	5	4	5
11	3	5	4	5
12	5	2 (est.)	6 (est.)	2 (est.)
14	Same as No. 9			
15	Same as No. 9			
16	1	3	3	1

Note: The terms electrical conductance and conductivity used in this paper refer to the measurement of specific conductance as listed on page 323 of the 13th edition of *Standard Methods* for the examination of water and wastewater, 1971.

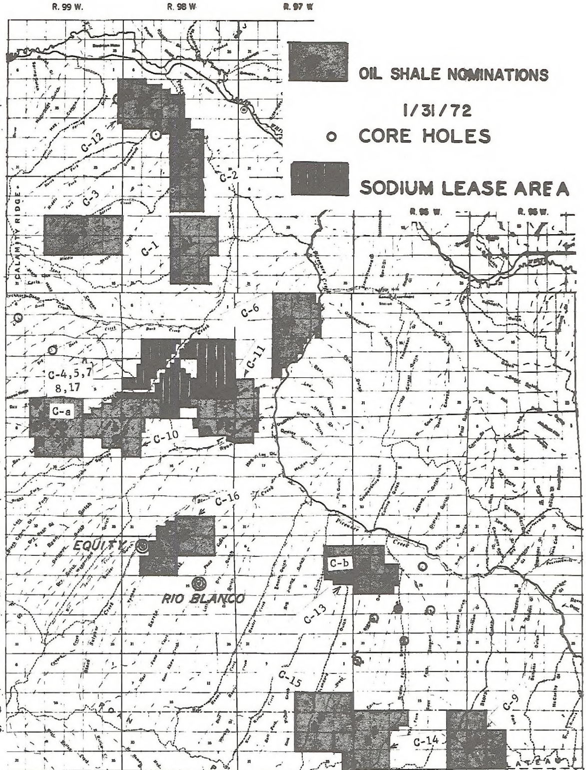

Figure IX-1. Oil Shale Nominations, Piceance Creek Basin, Colorado

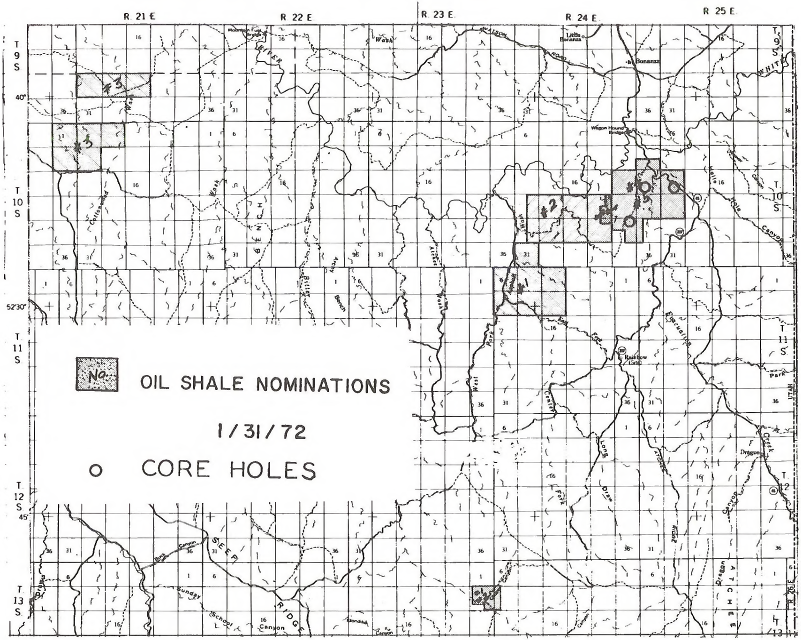

Figure IX-2. - Oil Shale Nominations, Uinta Basin, Utah

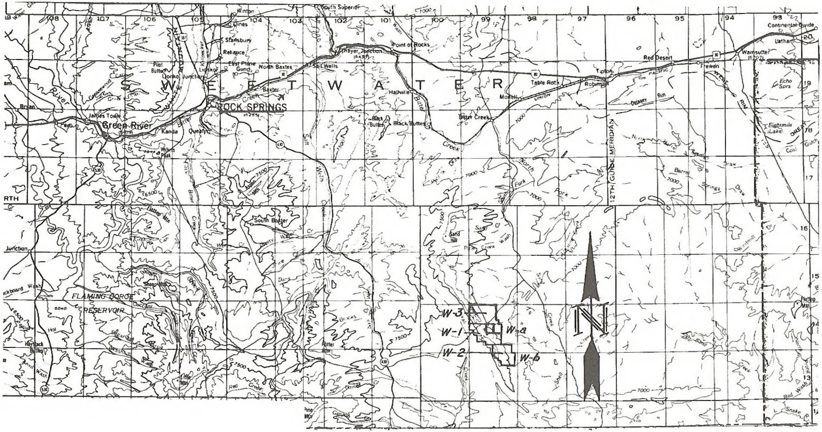

Figure IX - 3 - Oil Shale Nominations, Washakie Basin, Wyoming

1. Tract Alternatives in Colorado

a. Sites #C-1, C-6, and C-16

Sites #C-1, C-6, and C-16 contain thick rich oil shale in the mahogany zone and large resources of oil shale, nahcolite, and dawsonite in the lower oil shale zones. U.S. Bureau of Mines--AEC core hole No. 3 was drilled on Site #C-1 and a core hole was drilled on Site #C-6 on a special land-use permit prior to the nomination of the oil shale tracts. Resource information for Site #C-16 was derived from core holes drilled just west and 2 miles northeast of the site. Both Sites #C-1 and C-6 contain highly saline water in the leached zone and also contain halite in that part of the section underlying the leached zone. The northern part of Site #C-16 is probably underlain by saline water. Site #C-16 is about a mile north and a mile west of the proposed initial Rio Blanco gas stimulation test. All three of these tracts may lend themselves to underground mining or in-situ recovery, and each is discussed separately below.

(1) Colorado Site #C-1

(1) Colorado Site #C-1 Size and location.--A total of 5120 acres, more or less, consisting of the following lands: TIN, R98W (See Figure VIII-D)

Sections: 14 - All
15 - All
16 - E 1/2
21 - E 1/2
22 - All
23 - All
26 - W 1/2
27 - All
28 - E 1/2
33 - NE 1/4
34 - N 1/2
35 - NW 1/4

6th Principal Meridian, Rio Blanco County, Colorado.

Land Status--Entire site is public domain. PLO 4536 withdrawal AEC Experimental site covers the SW 1/4 Sec. 14, SE 1/4 Sec. 15, NE 1/4 Sec. 22 and NW 1/4 Sec. 23 Sec. 14 SW 1/4 SW 1/4 SW 1/4 is covered by a SLUP.

Mining Claim Conflicts.--Site has no mining claim conflicts.

Elevation.--Site elevation ranges from 6200' - 6700" above Mean Sea level.

Climate.--15" - 17" rainfall;
-40°F - +95°F temperature range;
45°F approximately mean temperature

Access.--The most direct access to the center of the site is from the Piceance Creek highway to Rio Blanco County road No. 122 thence to BLM road No. 1093. These are public roads with no excessive grades, and the lessee will be able to confine any road improvements to the existing routes.

Vegetative Types.--Pinon-juniper and sagebrush are the major vegetative types in this area. The sagebrush occurs in the drainage bottoms along with rabbit brush. At the lower elevations the bottoms have greasewood interspersed with the sagebrush. The pinon-juniper occurs on the slopes and ridges.

Geologic Features:

Alluvium.--% of Area - Less than 10%; composition - clay, silt, sand, maristone fragments; thickness - 0 to 100'.

Evacuation Creek Member of the Green River Formation.--% of Area - 100%; Composition - Mostly calcareous sandstone and siltstone with minor amounts of marlstone; Thickness - 700' to 1450'; Mineral Value - Some zones contain a high percent of analcime; extractable alumina may be present.

Parachute Creek Member of the Green River Formation.--% of Area - 100%; Composition - Mostly oil shale, minor amount of nahcolite, some halite, thin beds of analcime; Thickness - 1500'±

Mineral Value.--Mahogany Zone - Contains approximately 60 feet of oil shale in two zones 40 to 18 feet thick, averaging 30 gallons of oil with an in place resource of about 120 thousand barrels of oil per acre.

Lower Oil Shale.--Zones R-1 through R-6 - About 440' of section contains oil shale averaging 30 gals. of oil per ton with an in place resource of about 350 thousand bbls. of oil per acre. More than a 700 foot interval contains nahcolite and dawsonite of varying amounts. Several hundred feet of the section immediately underlying the Mahogany ledge that formerly contained nahcolite and possibly halite has been leached by underground water that now occupies the voids created by the leaching and is of poor quality. This highly saline aquifer probably inhibits the mining of a total of 60 feet of 30 gallon shale and several hundred feet of dawsonite rich shale. In addition the presence of thin beds of halite will discourage mining in an additional 100 or so feet of oil shale containing nahcolite and dawsonite immediately underlying the leached zone.

Geological.--Faults - None apparent; Strike - The rocks strike approximately N 45° W; Dip is to the NE at the rate of about 200 feet per mile.

Hydrology.--Two main criteria were used to evaluate the dewatering problems for the oil shale sites nominated for leasing: (1) the relative quantity of water, and (2) the degree of mineralization of the water. The index used to describe quantity was the transmissivity of the rocks above and below the Mahogany zone . The index used for quality of ground water was the electrical conductance of the water in these zones. Tables IX-2 show the rating given for different conductivities and transmissivities. Where specific data from test holes were not available at the site, the rating was estimated by inference from data at nearby test sites or from maps derived from the data. The hazard of ground water to development was indexed as the sum of the ratings for conductivity and transmissivity in both the zones above and below the Mahogany. Thus, the higher the sum (total score) the greater is the presumed water hazard.

A test hole in SW 1/4 SW 1/4 SW 1/4, Sec. 14, TIN, R98W, indicated that the upper zone contains water with an electrical conductance of 800 µmhos/cm and has a transmissivity of 4,200 gpd/ft.

The lower zone has a transmissivity of 2,000 gpd/ft and contains water with an electrical conductance of 25,000 µmhos/cm.

Watershed.--From a water yield standpoint these sites aren't large enough to appreciably influence the quantity of water in Piceance Creek or Yellow Creek.

It is assumed that if sites which cross the larger drainages are developed provisions will be made to maintain water flows from the affected drainage area into the two main streams.

Disposal of overburden and spent shale will not present an insurmountable problem on any site proposed for development. Techniques are available to allow filling drainageways, establishing vegetation on the fills and controlling the water table in these fills. Similar techniques can be used if waste materials are relocated in an excavated site.

Technology is also available to cope with forseeable erosion problems that might develop because of the mining operations and required access routes and utility corridors.

Mining Potential

Surface (open pit) Mining.--According to the Geologic Section about 1600 ft of oil shale (of which 500 ft. average 30 GPT) are overlain by an average of 1100 ft. of lower grade shale and waste. This is not considered to be an economic overburden to ore ratio for open pit mining in view of present economic considerations. Since the major reserves of oil shale and of associated minerals are in the lower zone below the leached zone, a pit that bottoms above the leached zone would be economically impossible.

Underground Mining.--The Geologic Section shows one 42 ft-thick oil shale zone which averages 30 GPT at a depth interval of 1272 ft to 1314 ft. This zone is separated from a lower 18 ft-thick zone of 30 GPT shale by 12 ft of lower grade shale. These beds are all in the Mahogany zone above the leached zone. This site does not constitute a desirable location for underground mining of the present stage of Basin development because the problems of pentrating the leached zone with large-diameter shafts and of large-scale mining below the leached zone are not known with respect to both time and costs. According to available hydrologic information, the leached zone contains very large amounts of saline water which would not only present a severe mining problem but could also be an environmental problem if disposed of on the surface.

The future possibilities of mining the oil shale and associated minerals in the lower zone cannot be ignored since they constitute the major part of the mineral reserves. Therefore, any mining plans must be so designated so that mining of the Mahogany zone will provide sufficient economic returns to permit development of methods for mining the lower zone. Since other nominated sites offer greater reserves in the Mahogany zone as well as in the lower zone, they are considered to be more attractive.

In Situ Recovery Methods.--The two relatively thin zones (42 ft and 18 ft) of 30 GPT shale at a depth interval of 1272 ft to 1344 ft and bottoming 80 ft above the leached zone make this site less desirable for in situ recovery methods than other nominations. It is assumed that an in situ method would not operate in the leached zones unless the water was removed. In situ methods in the lower zone presents a potential, but the extreme depth (over 1960 ft) would seem to limit research at this time because of greater costs.

Waste Disposal

Surface.--The potential for utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible in view of the moderate relief and the total area available.

Underground.--The potential for underground disposal of solid wastes is a direct function of the volume of waste. This volume, in turn, depends upon the retorting method used and whether only oil is extracted or whether both oil and associated minerals are extracted. If only oil is extracted, the underground space will not be sufficient to handle all of the waste. If both oil and associated minerals are extracted, the underground space may be sufficient. In any case, underground waste disposal will be delayed 3 to 5 years after mining begins since waste disposal areas must be developed without interfering with mine production. The initial surface of storage of waste (3 to 5 years) will remain until the end of underground production at which time space may be available for underground disposal.

Recapitulation.--This site does not offer the potential at this time of meeting the objectives of the Prototype Oil Shale Leasing Program.

Air and Water Quality Considerations

Surface Water Quality.--The site is close to the middle of the Yellow Creek drainage where surface water quality is deteriorating as the stream nears the White River.

Air Quality.--The site is in the low, middle basin and will probably be subject to night-time temperature inversions. Furthermore, because of the site's proximity to the White River it may become a source for pollutants carried toward Rangely by drainage winds.

Standards

Water.--Antidegradation standard plus Refuse Act Permit.
White River is A_1, B_2, C, D. (ph:6.5 - 8.5; DO; 5ppm)

Air.--Ambient (Sulfur, Part., CO, Photochem, Hydrocarb, NO_2)
Emission (Sulphur, Part., odor, visible)

Summary.--Standards are presently the same for all Colorado sites.

General Impact.--Assuming a potential for air, water, and solid waste emissions, this site offers problems in all three areas due, respectively, to the low mean altitude, the presence of poor quality water, and the nearness to public access or visibility. Revegetation would prove more difficult. Erosion should be lower but the nearness to perennial streams (Yellow Creek) makes seepage a potential problem. Resource utilization with economic methods appears uncertain at this point. North-facing slopes are subject to Freezing.

Transportation.--Existing roads are described under "F Access." Existing roads can be improved without major relocation; however, an oil shale industry may require a new road system.

Power Sources.--The nearest electric power is located along the Valley of Piceance Creek approximately 6 air miles east of the site. Routing the powerline along the same alignment as the roads will minimize surface damage and will not greatly increase the length of line.

This is a general service line, 7000V primary. High voltage transmission lines exist 12 miles north of the site. Telephone available 12 miles north or 6 miles east.

Land Use.--Present land use consists of livestock, grazing and wildlife habitat uses.

Vegetation and Soils

Soils.--The drainage bottoms are characterized by deep, light colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse
Amelanchier, Alnifalia
Purshia Tridentata
Cercocorpus Montanus
Sarcobatus Vermieulafus
Artemisia Tridentafa
Atriplex Spp.
Chrysothamnus Spp.

(2) Grasses
Oryzopsis Humenoides
Agropyron Spp.
Koelaira Spp.
Poa Spp.
Elymus Spp.
Stipa comata

(3) Trees
Pinus Edulis
Juniperus Spp.

Wildlife.--Mule deer numerous (winter), mountain lion, coyote, bobcat, chuckar, doves, rabbits, raptors, plus numerous small bird and mammal species.

Selection of site for test lease operation would result in localized loss of wildlife habitat; important deer winter range; disruption of game movements and hunter use, as well as the penetration by industry into a wildlife habitat.

The site and the surrounding area has been occupied by horses for winter range and the area has been tentatively selected as a designated horese range. The impact would be moderate if the site is selected.

Archeology.--None known or reported on site.

Recreation and Aesthetics.--Area is used primarily for hunting.

Livestock Grazing.--Cattle - spring and fall grazing; 200 head - 500 AUM's; one operator.

Improvements.--No significant improvements, other than a dirt road across the tract.

(2) Colorado Site #C-6

(2) Colorado Site #C-6.--Size and Location

Township 1 South, Range 97 West, Rio Blanco County, Colorado

Sec. 2:	S 1/2 Lot 3	Sec. 9:	All
	Lot 4	Sec. 10:	All
	S 1/2 NW 1/4	Sec. 11:	NW 1/4
	SW 1/4		E 1/2 SW 1/4
Sec. 3:	Lot 5		NW 1/4 SW 1/4
	Lot 6	Sec. 15:	NW 1/4
	Lot 7		N 1/2 SW 1/4
	Lot 8		SW 1/4 SW 1/4
	S 1/2 N 1/2	Sec. 22:	NW 1/4 NW 1/4
	S 1/2	Sec. 16:	All
Sec. 4:	Lot 5	Sec. 21:	NE 1/4 NE 1/4
	Lot 6		W 1/2 NE 1/4
	Lot 7		W 1/2
	Lot 8		
	S 1/2 N 1/2	Area: - 5108.1 acres.	
	S 1/2		

Land Status.--All public domain except Sec. 2: E 1/2 W 1/2 patented with Oil Shale reserved to the United States. Sec. 10: All except SE 1/4 SE 1/4 patented with no minerals reserved. Sec. 11: NW 1/4, N 1/2 SW 1/4 patented with no minerals reserved. Sec. 15: NW 1/4 NE 1/4, NE 1/4 SW 1/4, patented with no minerals reserved and NW 1/4 SW 1/4, SW 1/4 NW 1/4 which is patented with Oil and Gas reserved to the United States. Sec. 21: SW 1/4 NE 1/4, NE 1/4 NE 1/4 patented with no minerals reserved to the United States. Sec. 22: NW 1/4 NW 1/4 patented with no minerals reserved to the United States.

Mining Claim Conflicts.--All public domain in sections 15, 16 and 21 covered by post-1920 placer claims.

Elevation.--Site elevation ranges from 6100' - 6500' above sea level.

Climate.--15" - 17" rainfall; -40°F. + 95°F. temperature range and 45°F. approximately mean temperature.

Access.--The most direct route to the center of Site #C-6 is from Piceance Creek approximately 2 miles east of the site. An unimproved road provides access almost directly into the area from the Square S ranch in Piceance Creek and can be upgraded without a great deal of surface disturbance. Access through private land will have to be obtained.

Vegetative type.--This site is within the pinon-juniper type. There are areas of big sagebrush, located in drainages. Mountain browse is interspersed throughout the area. Wheatgrasses, big sage, service berry and bitterbrush are the primary forage species.

Geologic Features

Alluvium
- % of area - 10%-15%
- Composition - Clay, silt, sand and marlstone fragments.
- Thickness - 0-200'

Evacuation Creek Member of the Green River Formation
- % of area - 100%
- Composition - Mostly sandstone and siltstone with minor amounts of marlstone
- Thickness - 400' - 1,400'
- Mineral Value - Some units contain appreciable quantities of analcime; there may be some extractable alumina.

Parachute Creek Member of the Green River Formation
- % of area - 100%
- Composition - Mostly oil shale with minor amounts of bedded nahcolite and halite; thin analcime beds
  - Maghogany Zone - Contains about 100 feet of shale that averages 30 gallons of oil per ton in zones thicker than 15 feet. In-place shale-oil resource is approximately 200,000 bbls. per acre.
  - Lower oil shale zone (R-1 through R-6) - Contains about 500 feet of shale that averages 30 gallons of oil per ton in thick zones. In-place shale-oil resource is approximately 1,000,000 bbls. per acre. Bedded nahcolite and finely disseminated dawsonite in varying amounts are present in an oil-shale sequence more than 700 feet thick. A zone about 500 feet thick extending downward from the lower part of the Mahogany Zone formerly contained nahcolite and halite but ground water has leached these saline minerals and highly saline water occupies the voids created by leachings.

    Thick beds of halite occupy a great part of the 300-foot interval immediately underlying the leached zone. The leached zone and the zone containing a halite inhibits mining in as much as 150 feet of the 30-gallon shale and a thicker sequence of dawsonite-bearing shale.

Structure

Faults - None discovered in the site.

Strike - In the northern part of the site the oil shale trends to the east, and in the southern part it trends north-northeast.

Dip - The dip in the northern part is to the north at the rate of 50 feet per mile. The dip in the southern part is to the north-northwest at the rate of 100 feet per mile.

Hydrology

A test hole drilled in Sec. 9, T. 1 S., R. 97 W., indicated a transmissivity of 1,300 gpd/ft in the upper zone and an electrical conductance of the water of 5,000 μmhos/cm. In the lower zone the electrical conductance of the water was 27,000 μmhos/cm but the transmissivity was only 200 gpd/ft. A major disadvantage of this site is the large amount of sodium chloride, 8,650 mg/1, present in the lower zone.

Mining Potential

Surface (open-pit) Mining: Due to overburden depth in relation to shale thickness, open pit mining is not considered feasible for this site.

Underground Mining: This site is considered a very good one for underground mining of the Mahogany Zone, and a good site for experimentation to develop methods for mining shales and associated minerals below the Mahogany Zone. Unknown water problems may complicate early development of both shales and associated minerals.

In Situ Recovery Methods: This site is considered satisfactory for research on in situ methods of recovering oil and other minerals.

Waste Disposal:

Surface: Utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible.

Underground: It is reasonable to expect all available underground space will be used, as available, for storage of wastes. The volume of waste is in direct relation to the retorting method used and to whether oil alone is extracted or whether oil and associated minerals are extracted. In the first case, for oil alone, underground space will be insufficient; in the second case, the space may be sufficient. In either case, surface storage of large volumes of waste will be required.

Recapitulation: This site is considered as one that could meet the objectives of the Department of the Interior's Oil Shale Leasing Program.

Air & Water Quality Considerations

Surface Water Quality: Surface water on the site is essentially runoff of good quality.

Air Quality: Low, middle basin location places the site in an area of probable night-time temperature inversions.

Standards:

Water: Antidegradation standard plus Refuse Act Permit. White River is A_1, B_2, C, D. (pH: 6.5 - 8.5; DO: 5ppm)

Air: Ambient (Sulfur, Part., CO, Photochem, Hydrocarb, NO_2) Emission (Sulphur, Part., odor, visible).

Summary: Standards are presently the same for all Colorado sites.

General Impact:

Assuming a potential for air, water, and solid waste emissions, the site offers problems in all three areas due, respectively, to the low mean altitude, the presence of poor quality water, and the nearness to public access or visibility. Revegetation would prove more difficult. While erosion would be generally less, the proximity to a perennial stream makes seepage a potential problem. Erosion by flooding is a potential problem. Resource utilization is expected to be good. North-facing slopes are minimized and local access would have less impact that would access to certain other sites.

Transportation

Roads - Same as Site #C-1M
Pipelines - None

Power Sources

Electric power is available in Piceance Creek approximately 1.5 air miles southeast of the center of the site. The power line can be constructed with minimum surface damage, depending on the route chosen. Right of way for the powerline would also have to be obtained from State Game and Fish Division. Telephone is adjacent to this powerline.

Surface Resources.

Land Use - Same as for Site #C-1.
Vegetation & Soils - Same as for Site #C-1.
Watershed - Same as for Site #C-1.

Wildlife

Same as Site #C-1P except important deer migration routes transect this site.

Although situated adjacent to a surfaced highway, the site is affected by little agricultural or recreational disturbance.

Utilization of Site #C-6 for test lease operations would result in localized loss of moderately important wildlife habitat and hunter-use areas, as well as a disruption in game movements and recreational access. Although situated well within heart of Piceance Basin, the adverse factor of industrial penetration is moderated since the tract lies immediately adjacent to a surfaced highway currently carrying heavy vehicular traffic. Close proximity of tract to Piceance Creek may compound downstream fishery problems associated with sediment and dissolved solids.

This site is occupied by wild horses during the winter months. If none of the other sites were selected from the wild horse range,the impact would be moderate since the horses could move to the west and north for normal winter range.

Archeology and Paleontology - Same as Site #C-1.

Recreation & Aesthetics - Same as Site #C-1.

Livestock grazing

1. Present Use:
   One operator grazes cattle, spring-fall, 500 AUM's with 1,000 cattle.

2. Potential for artificial improvement of range limited by slopes and shallow soils.

Improvements: No significant improvements are on this site. The Square S AMP calls for a pasture fence through this area but the plan could undoubtedly be adjusted to allow moving the fence off of the site.

(3) Colorado Site #C-16

(3) Colorado Site #C-16 Size and location.--An area nominated for prospective oil shale leasing in the State of Colorado is:

Township 2 South, Range 98 West, 6th P.M. (Rio Blanco County, Colorado.)

Section 33: S1/2NE1/4; S1/2
Section 34: All
Section 35: All

Township 3 South, Range 98 West, 6th P.M. (Rio Blanco County, Colorado.)

Section 2: Lots 1, 2, 3, 4; S1/2 N1/2; S1/2
Section 3: Lots 1, 2, 3, 4: S1/2 N1/2; S1/2
Section 4: Lots 1, 2, 3, 4; S1/2 N1/2; S1/2
Section 5: S1/2NE1/4; SE1/4;
Section 8: All
Section 9: All

the above being 5,120 acres, more or less.

Land Status.--Entire site is public domain except for following parcels which are patented with at least oil shale reserved to the United States. T. 2 S., R. 98W., Sec. 33: NW 1/4 SW 1/4; Sec. 35: SE 1/4 SW 1/4, SE 1/4, SE 1/4 Ne 1/4; T. 3 S., R. 98W., Sec. 2: NW 1/4, W 1/2 SW 1/4, W 1/2 SW 1/4, SE 1/4 SE 1/4; Sec. 3: E 1/2 SE 1/4.

Mining Claim Conflicts.--Entire site is covered by 1 layer post-1920 placer mining claims except for following lands: T. 2 S., R. 98 W., Sec. 33: SW 1/4, S 1/2 NE 1/4; Sec. 35: S 1/2, SE 1/4 NE 1/4; T. 3 S., R. 98W., Sec. 2: E 1/2 SE 1/4, NW 1/4, W 1/2 SW 1/4; Sec. 3: SE 1/4; Sec. 5: S 1/2 NE 1/4.

Elevation.--Site elevation ranges from 6,500' - 7,200' above sea level.

Climate.--Same as Site #C-1

Access.--From a county maintained road in Black Sulphur Creek.

Vegetative Type.--Pinon-juniper at higher elevations, big sage-brush in drainage bottoms, with mountain browse interspersed throughout. Primary forage species are wheatgrasses, big sage, berry and bitterbrush.

Geologic Features

Alluvium

% of area - 5%-10%
Composition - Clay, silt, sand, and marlstone fragments
Thickness - 0-100'±

Evacuation Creek Member of the Green River Formation

% of area - 100%
Composition - Mostly sandstone and siltstone with minor amounts of marlstone
Thickness - 300'-900'
Mineral value - some zones contain appreciable quantities of analcime; extractable alumina may be present

Parachute Creek Member of the Green River Formation

% of area - 100%
Composition - Mostly oil shale, contains beds and pods of nahcolite and think beds of analcime
Thickness - 1,300' - 1,400'
Mineral Value

Mahogany zone - contains about 90 feet of shale averaging 30 gallons of oil per ton in units thicker than 15 feet with an in-place resource of about 180,000 barrels per acre.

Lower oil-shale zone (R-1 through R-6) - in the southern part of the tract the section contains about 200 feet of shale averaging 30 gallons of oil per ton in units thicker than 15 feet with an in-place resource of about 600,000 barrels per acre.

In the northern part of the tract about 750 feet of section contains shale that averages 30 gallons of oil per ton in zones thicker than 15 feet with an in-place resource of 1,500,000 barrels per acre. Nahcolite is present throughout the tract. Zones containing nahcolite are thicker and more numerous in the northern part of the site. About 500 feet of section contains dawsonite in the southern part of the site and this interval thickens to more than 600 feet in the northern part.

A sequence of shale starting in the lower part of the Mahogany zone and extending downward 500 to 600 feet formerly contained saline minerals that have now been leached by groundwater. The water, now highly saline, occupies the voids created by leaching. This probably inhibits mining in about 50% of the 30-gallon-shale resource.

Geologic Structure

Faults - None mapped in the site
Strike - The western end of a west-trending syncline bisects the site. The rocks in the north 1/2 strike northeast and in the south 1/2 strike northwest.
Dip - The dip is SE at the rate of 150 feet per mile in the northern part of the area and NE at the rate of 300 feet per mile in the southern part of the site.

Hydrology.--Hydrologic data are not available in this tract but are available from a test well drilled about one mile southward in Sec. 14, T. 3 S., R. 98 W. The electrical conductance of the ground water in the upper zone reached 800 µmhos/cm; the transmissivity was 4,660 gpd/ft. In the lower zone, the conductance was 4,000 umhos/cm but the transmissivity was only 200 gpd/ft. Both the conductance and the transmissivity probably are greater within Site #C-16.

Mining Potential

Surface (Open Pit) Mining.--The site is considered to have no potential for surface mining at this time.

Underground Mining.--The site is considered to be among the top 2-3 sites for underground mining among the total of 12 sites proposed for mining by one or more methods. It is assumed there are no water problems in and above the Mahogany zone but that there are considerable water problems of unknown extent in the leached zone.

In Situ Recovery Method.--The site has good potential for in situ recovery when and if satisfactory recovery of resource methods are developed.

Waste Disposal

Surface Mining.--The potential for utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible.

Underground Mining.--Disposal of solid wastes underground looks very favorable. Amounts so stored will depend on whether the associated minerals are extracted as well as the oil. In either case waste production from the first few years of operations will be placed on the surface and may remain there for the life of the operation.

Recapitulation.--This site presents a potential for meeting the objectives of the Department of the Interior, June 1971, Program Statement on Oil Shale Leasing.

The site is near the proposed Rio Blanco Test Site. This was considered in the above appraisal.

Air and Water Quality Considerations

Surface Water Quality.--Surface water in intermittent drainages of fair quality; that in perennial streams of fair to poor quality.

Air Quality.--Medium elevation similar to that of Site #C-10 where inversion conditions are less likely but where drainage winds may concentrate material.

Standards

Water.--"Antidegradation Standard" plus Refuse Act Permit. White River is A, B_2, C, D. (pH: 6.5 - 8.5; DO: 5ppm)

Air.--Ambient (sulfur, Part., CO, Photochem, Hydrocarb, NO_2) Emission (sulfur, part., odor, visible).

Summary.--Standards are presently the same for all Colorado sites.

General Impact.--Assuming that the potential for air, water, and solid waste emissions exists, the site offers problems of intermediate significance compared to other sites. Air and water problems are average; erosion and seepage potential are about the same average. Revegetation appears moderately easy, the site is some moderate distance from easy public access.

Transportation.--Roads - See Site #C-1M. Pipelines - none.

Power Sources.--Power, and telephone, available in Black Sulphur Creek at north edge of site.

Surface Resources

Land Use.--Present land use consists of livestock grazing, and wildlife habitat.

Vegetation and Soils

Soils.--The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants tolerant of these salts.

The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinon-juniper with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with understory of native grasses.

Plant species

Browse - Amelanchier. Alnifalia
Purshia Tridentata
Cercocorpus Montanus
Sarcobatus Vermieulafus
Artemisia Tridentata
Atriplex Spp.
Chrysothamnus Spp.

Grasses -Oryzopsis Hymenoides
Agropyron Spp.
Koelaira Spp.
Poa Spp.
Elymus Spp.
Stipa comata

Trees - Pinus Edulis
Juniperus Spp.

Condition.--Fair to good on vigor

Potential for revegetation.--Limited by shallow soils on ridges and slopes.

Watershed.--Same as Site #C-1.

Wildlife.--Same as Site #C-13.

Activities associated with year-long livestock operations constitute greatest influence on lands within tract boundaries. Sport harvests and general recreational use, although somewhat restrictive, results in considerable vehicular traffic.

Development of Site #C-16 for test lease operations would result in localized loss of wildlife habitat lying at the less critical upper limits of deer winter-use zone. The adverse impacts related to industrial penetration of remote wildlife range are quite severe, but of lesser significance than anticipated in Centeral Basin area where State Agency management for wildlife and recreational use is given high land-use priority.

Archeology and Paleontology.--None known or reported.

Recreation and Aesthetics.--Area is used primarily for hunting and major values are wildlife uses.

Livestock Grazing.--Part of one allotment grazing cattle in spring and fall. 1700 cattle - approximately 500 AUM's on site. Two (2) operators.

Improvements.--None of record.

b. Sites #C-2, C-3, and C-12

Sites #C-2, C-3, and C-12 contain oil shale that is marginal or submarginal in thickness or value and it is doubtful if a sufficient resource is available to sustain a 20-year commercial oil shale operation.

(1) Colorado Site #C-2

(1) Colorado Site - C-2

Size and Location (see Figure VIII-1).--A total of 5,120 acres, more or less, all located within Rio Blanco County, Colorado, and consisting of the following described lands:

T. 2 N., R. 98 W., 6th P.M.,

sec. 21: $E\frac{1}{2}$;
sec. 22: $W\frac{1}{2}$, $SE\frac{1}{4}$, $W\frac{1}{2}W\frac{1}{2}NE\frac{1}{4}$;
sec. 23: $W\frac{1}{2}SW\frac{1}{4}$;
sec. 26: $W\frac{1}{2}W\frac{1}{2}$
sec. 27: All;
sec. 28: $E\frac{1}{2}$;
sec. 33: $E\frac{1}{2}$;
sec. 34: All;
sec. 35: $W\frac{1}{2}W\frac{1}{2}$.

T. 1 N., R. 98 W., 6th P.M.,

sec. 2: $W\frac{1}{2}W\frac{1}{2}$;
sec. 3: All;
sec. 4: $E\frac{1}{2}$;
sec. 9: $NE\frac{1}{2}$, $N\frac{1}{2}SE\frac{1}{4}$;
Sec. 10: $N\frac{1}{2}$, $N\frac{1}{2}S\frac{1}{2}$;
Sec. 11: $W\frac{1}{2}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$.

Land Status: Site is entirely on public domain land. Site overlaps Site #C-12.

Mining Claim Conflicts

Site #C-2: Pre-1920 mining claims cover $E\frac{1}{2}$ sec. 21, T. 2 N., R. 98 W. Post-1920 mining claims cover all lands in T. 2 N., R. 98 W.

Elevation: Site elevation ranges from 5,000 ft. to 6,000 ft. above mean sea level.

Climate: Same as Site C-1.

Access: The present route to improved roads from the center of this site is down Barcus Creek for approximately 1.5 miles to the junction of Barcus Creek and Yellow Creek, then upstream along the Yellow Creek drainage for approximately 3.5 miles to the junction of BLM Road No. 1093 and County Road No. 122, then 4 miles east to Piceance Creek, a total of approximately 9 miles.

Vegetative Type: Same as Site C-1.

Geologic Features

Alluvium
% of area - Less than 10%
Composition - Clay, silt, sand, marlstone fragments.
Thickness - 0-100 ft.

Evacuation Creek Member of the Green River Formation
% of area - 90%
Composition - Mostly calcareous sandstone and siltstone with minor amounts of marlstone.
Thickness - 0-1,400 ft.
Mineral value - Some zones contain a high percent of analcime; extractable alumina may be present.

Parachute Creek Member of the Green River Formation
% of area - 100%
Composition - Mostly oil shale, minor amounts of nahcolite and sandstone, thin beds of analcime.
Thickness - 700-1,200 ft. (extrapolation from information outside the nominated tract)
Mineral Value - (Extrapolation from information outside the nominated tract)

Mahogany Zone - No interval thicker than 15 ft., averages 30 or more gallons of oil per ton. The mahogany zone contains small amounts of extractable alumina.

Lower Oil Shale Zones R-1 through R-6 - Less than 100 feet of shale in the lower zone averages more than 30 gallons of oil per ton. There is probably bedded nahcolite in the southern 1/3 of the tract and minor amounts of nahcolite in pods in the remainder of the tract.

Dawsonite is contained in varying amounts through several hundred feet of section. Probably no halite underlies the tract.

Geological Structures

Faults - A northwest trending normal fault of small displacement extends into the center of the site.

Strike - The axis of a northwest trending syncline comes into the south one-third of the site. The strike in most of the area is to the northwest.

Dip - The dip is southeast at a rate varying from 150 feet per mile in the southern two-thirds to more than 600 feet per mile in the north end.

Hydrology: No hydrologic data are available for this site. It is estimated to be similar to Site C-1.

Watershed: Same as Site C-1.

Mining Potential

Surface (open pit) Mining: The geologic section indicates an area of 0 ft. overburden so some open pit work is possible. Depth of average overburden (700 ft.) vs. ore thickness does not favor this mining method.

Underground Mining: This extraction method is possible and the 700 ft.+ average overburden is favorable for shaft sinking. However, average grade of shale is low and many other sites present more favorable conditions for underground mining.

In Situ Recovery: Overburden depth and, in general, shale thicknesses and grade make this a favorable site for in situ recovery from surface drill holes or combined underground-in situ method.

Waste Disposal

Surface: The potential for utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible in view of the moderate relief and the total area available.

Underground: The potential for underground disposal of solid wastes is a direct function of the volume. This volume, in turn, depends on retorting method and on whether only oil is extracted or whether oil and associated minerals are extracted. In the first case the underground space will be insufficient. In the second case space may be sufficient. In either case surface storage of large volumes of material will be required for the life of the project.

Recapitulation: This site does not offer the potential, at this time, of meeting the objectives of the June 1971 prototype Oil Shale Leasing Program.

Air and Water Quality Considerations

Surface Water Quality: Located near the lower reaches of the Yellow Creek drainage where surface water has high TDS.

Air Quality: The low, middle basin location places the site in an area of likely temperature inversions. Nearness to Yellow Creek and to White River places the site in a likely area to affect Rangely with drainage winds if emissions are not properly controlled.

Standards:
a. Water: "Antidegradation" standard plus Refuse Act Permit. White River is A_1, B_2, C, D. (ph; 6.5 - 8.5: DO:5ppm).
b. Air: (sulfur, part CO, photochem, hydrocarb, NO_2). Emission (Sulfur, part, odor, visible).

Summary: Standards are presently the same for all Colorado sites.

General Impact: Assuming a potential for air, water, and solid waste emissions, this site offers problems in all three areas due, respectively, to the low mean altitude, the presence of moderate quantities of poor quality water, and the nearness to the public access routes or visibility. Revegetation would be difficult. Erosion due to precipitation is low, but close proximity to major streams makes seepage a potential problem.

Transportation: Roads - same as Site C-1M - Alternative access can be provided by a road up Yellow Creek.

Power Sources: Natural gas 6 miles to the north.

The nearest power source for this site is along the valley of Piceance Creek northeast approximately 6 air miles over Blair Mesa. The construction of a power line on this route can cause considerable surface damage depending on methods used to construct the line.

Telephone 6 miles to the north.

Vegetation and Soils: Same as Site C-1.

Wildlife: Same as Site C-1 plus golden eagle nesting sites.

Archeology: Same as Site C-1.

Recreation and Aesthetics: Same as Site C-1.

Livestock grazing: Same as Site C-1.

Improvements: Same as Site C-1.

(2) Colorado Site #C-3

(2) Colorado Site C-3

Size and location: The lands described below are all within Rio Blanco County, Colorado, and total 5,120 acres, more or less:

T. 1 N., R. 99 W., 6th P.M.,

sec. 13: All;
sec. 14: All;
sec. 15: All;
sec. 16: All;
sec. 21: All;
sec. 22: All;
sec. 23: All;
sec. 24: All;

Status: Site is entirely on public domain land. Sec. 21, NE¼NW¼ is covered by power site reserve.

Mining Claim Conflicts: Site has no mining claim conflicts.

Elevation: Site elevation ranges from 6,500 ft. to 7,000 ft., above sea level.

Climate: Same as Site C-1.

Access: Access to Site C-3 will be confined to Barcus Creek drainage to minimize surface damage. The distance would be approximately 7 miles down Barcus Creek to the center of Site C-2, a total of 16 miles to Piceance Creek, using the same route outlined for Site C-2. Access through private land in Yellow Creek will have to be obtained. An alternative route is up the drainage of North or Middle Barcus Creek to the Calamity Ridge road and then to Colorado Highway 64 and Rangely. This will involve the construction of one mile of new road.

Vegetative Type: Same as Site C-1 plus western 1/3 of area is characterized by mountain browse type.

Geologic Features

Alluvium
% of area - Less than 10%
Composition - Clay, silt, sand, marlstone
Thickness - 0-100 ft.

Evacuation Creek Member of the Green River Formation
% of area - 80%
Composition - Mostly calcareous sandstone and siltstone with minor amounts of marlstone.
Thickness - 0-800 ft.
Mineral Value - Some zones contain a high percent of analcime; extractable alumina may be present.

Parachute Creek Member of the Green River Formation
% of area - 100%
Composition - Mostly oil shale with minor amounts of sandstone in the western part, very little nahcolite in the west one-half, increasing amounts in the east one-half, thin beds of analcime
Thickness - 1,200 ft. to 1,500 ft.
Mineral Value - Mahogany Zone - Less than 15 feet of 30 gallon shale in the west edge to more than 50 feet on the east edge.

Lower Oil Shale Zones R-1 through R-6 - Less than 100 feet of shale in the lower zone averages more than 30 gallons of oil per ton in the west part of the tract; shale thickens and values increase toward the eastern part of the tract. There is probably bedded nahcolite in the eastern part of the tract but not in the western part. Several hundred feet of oil shale contains dawsonite of varying quality.

Geological Structure

Faults - No faults noted in the area.

Strike - Mostly to the north and northwest.

Dip - To the east and northeast at rates varying from 500 feet to the mile on the west to 300 feet to the mile on the east.

Hydrology: A test well drilled in sec. 20, T. 1 N., R. 99 W., penetrated the Parachute Creek Member but few hydrologic data were collected. The well yielded 35 gpm to a depth of 1,060 feet where all circulation was lost. The water quality is probably superior to that of Site C-1.

Watershed: Same as Site C-1.

Mining Potential

Surface (open pit Mining): The relatively moderate (500 ft.) average depth of overburden indicates this site may provide some potential for open pit mining. This would be contingent upon additional exploration to determine if an ore colume of sufficient grade and thickness could be developed to support the operation. Value of associated minerals (not now available) would be quite important in any final decision.

Underground Mining: Resource data on this site indicate underground mining would be feasible at several horizons. In general, shale bed thickness does not provide as favorable mining thickness as do other sites in the basin.

In Situ Recovery: In situ or combined underground mining and in situ appears as a favorable production method. Overburden is not excessive and in general seam thickness of suitable grade shale is plentiful. If associated minerals cannot be recovered, the system may not be desirable from a resource viewpoint. Water does not seem to be a problem for in situ extraction.

Waste Disposal

Surface: Surface disposal of wastes will present the usual problem of stowing so as to prevent pollution. Surface area seems sufficient for long term disposal of expected solid wastes from mining and processing.

Underground: Potential for underground disposal of solid wastes is a direct function of the volume of waste. This volume in turn depends upon the retorting method used and whether only oil is extracted or whether both oil and associated minerals are extracted. In the first case, underground space will be insufficient; in the second case, underground space may be sufficient. In either case, some 3 to 5 years of surface storage may be required before mine development permits underground space use.

Recapitulation: This site offers a potential for surface, underground, and underground-in-situ extraction. The combined underground-in situ extraction seems to fit site conditions best. This site is not as favorable as other proposed sites for meeting the objectives of the June 1971 prototype Oil Shale Leasing Program.

Air and Water Quality Considerations

Surface Water Quality: Location near head of Barcus Gulch suggests relatively high quality surface water.

Air Quality: High elevation minimizes the possibilities of stagnation or inversion but north location has potential proximity problem with respect to Rangely (drainage) and Meeker (prevailing wind).

Standards:

Water: "Antidegradation" standard plus Refuse Act Permit. White River, some distance away, classified A, B_2, C. D. (ph: 6.5-8.5; DO:5ppm)

Air: Ambient (sulfur, part CO, photochem, hydrocarb, NO_2) Emission (sulfur, part., odor, visible)

Summary: Standards are presently the same for all Colorado sites.

General Impact: Assuming a potential for air, water, and solid waste emissions, this site offers problems, some of which are different in nature from those at the lower elevations. Air problems may be less, while water quality is generally good and small flows would be expected. Visibility would be low, except from the air (if surface-mined especially), erosion potential is higher, but revegetation ("rehabilitation") potential is better. Resource utilization appears fair. North-facing slopes are present and are subject to freezing. Access roads would appear to have a major impact.

Transportation: Roads: Same as Site C-1.

Power Sources

The nearest electric power source is at 84 Ranch approximately 8 air miles southwest of the site. If a road has to be built alongside the powerline during construction, the powerline could be erected along existing roads for a portion of the route.

Telephone 12 miles north via existing road.

Vegetation and Soils: Same as Site C-1.

Wildlife

Same as Site C-1, plus loss of benefits associated with recent range improvement program involving 700 acres of pinon-juniper chaining.

Archeology: Same as Site C-1.

Recreation and Aesthetics: Same as Site C-1.

Livestock Grazing: Cattle - 565 head - Summer 500 AUM's.

Improvements: Same as Site C-1.

(3) Colorado Site #C-12.

(3) Colorado Site - C-12

Size and Location

Range 99W, T2N
Sec. 12 E½E½
Sec. 13 E½E½
Sec. 24 NE¼NE¼

Range 98W, T2N
Sec. 7 All
Sec. 8 S½S¼N½NW¼NW¼
Sec. 9 SW¼S½SE¼
Sec. 10 SW¼SW¼
Sec. 15 W½W½
Sec. 16 All
Sec. 17 All
Sec. 18 All
Sec. 19 N½
Sec. 20 N½
Sec. 21 N½N½S½
Sec. 22 W½NW¼NW¼SW¼

Total 5,120 acres

Land Status: Entire site is public domain.

Mining Claim Conflicts: Entire site covered by post-1920 placer mining claims.

T. 2 N., R. 98W., Sec. 8: E½, 1 layer pre-1920 mining claims. Sec. 9: S½, 2 layers pre-1920 mining claims. Sec. 10: SW¼, 1 layer pre-1920 placer mining claims. Sec. 15: W½, 1 layer pre-1920 placer mining claims. Sec. 16: All, 1 or more layers pre-1920 placer mining claims. Sec. 17: E½, SW¼, 1 or more layers pre-1920 placer mining claims. Sec. 20: N½, 2 layers pre-1920 placer mining claims. Sec. 21: All, 1 or more layers pre-1920 placer mining claims.

Elevation: Site elevation ranges from 5700' - 6800' above mean sea level.

Climate: Same as Site C-1.

Access: Access to the center of this site is from State Highway #64 at the confluence of Yellow Creek and White River. Access will have to be obtained through private land. The present road lies along the west side of Yellow Creek drainage to the confluence of Greasewood Creek and Yellow Creek, then up the Greasewood Creek drainage, a total of approximately 4 miles. The present road location can be upgraded with little realignment.

Vegetative Type: Same as Site C-1.

Geologic Units

Alluvium
- % of Area - 15%
- Composition - Clay, silt, sand and marlstone fragments
- Thickness - 0 - 200'±

Evacuation Creek Member of the Green River Formation
- % of Area - 60%
- Composition - Mostly calcareous sandstone and siltstone with minor amounts of marlstone
- Thickness - 0 - 600'

Parachute Creek Member of the Green River Formation
- % of Area - 90%
- Composition - oil shale (mostly low grade), sandstone, siltstone, marlstone
- Thickness - 0 - 700'±
- Mineral Value -
  - Mahogany Zone - Probably contains no oil shale averaging 30 gallons of oil per ton in thicknesses greater than 15 feet.
  - Lower Oil Shale Zone R1 - through R-6 - From the outcrop it is apparent that this zone is thin and low grade, possibly contains no oil shale averaging 30 gallons per ton in zones thicker than 15 feet. Probably several hundred feet contains disseminated dawsonite of varying amounts and there is probably very little nahcolite.

Geologic Structure

Faults - None apparent

Strike - The rocks strike to the west or northwest

Dip - Dip is south or southwest at rates ranging from 200' per mile in the southwest to more than 400' per mile in the northeast.

Hydrology: A test hole was drilled in Sec. 20, T. 2 N., R. 98W. to a depth of 1,025 feet. The well is not known to have reached the lower zone. The electrical conductance of the water was 12,000 umhos/cm below a depth of 900 feet. No aquifer tests were made. It is estimated that the transmissivity may be fairly low; less than 5,000 gpd/ft.

Mining Potential

Surface (Open Pit) Mining

The Geologic Section indicates limited portions of the site may be mined by open pit methods. The thin shales do not provide the large tonnages usually associated with this mining method.

Underground Mining

Underground mining of the thin oil shale zones is possible.

In Situ Recovery Methods

The shallow cover and thickness and grade of the inferred oil shale zone indicate that either in situ recovery methods using surface wells, or an in situ-underground mining method, can be applied.

Waste Disposal

Surface Mining:

The potential for utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible in view of surface relief and total area available. Proximity of major drainage requires no release of waste materials.

Underground Mining:

The shallow (37' of 30 gal/ton shale potential) mining width and apparent lack of associated minerals will require considerable surface storage before underground storage is possible. Possibly 50 to 60 percent of processed shale waste might be placed underground.

Recapitulation: This site does not offer the potential of meeting the objectives of the prototype Oil Shale Leasing Program as summarized in the Department of Interior June 1971 Program Statement.

Air and Water Quality Considerations

Surface water quality: Quality at site expected to range from good in headwaters to very poor in lower reaches of perennial streams.

Air Quality: Low elevation makes site poor from standpoint of concentrating emissions under thermal inversions. Nearness to Rangely, combined with low elevation makes site a source of air pollution affecting town under drainage conditions.

Standards:

Water:

Antidegradation standard plus Refuse Act Permit. White River is A, B_2, C, D. (pH: 6.5-8.5 DO: 5ppm)

Air:

Ambient (Sulfur, Part., CO, Photochem, Hydrocarb, NO_2) Emission (Sulfur, Part., odor, visible)

Summary

Standards are presently the same for all Colorado sites.

General Impact: Assuming that operations at this site create a potential for air, water and solid waste emissions, the site offers significant problems caused by the low altitude, poor quality of the water and nearness to public transport routes. Revegetation would prove difficult though erosion would be low. Seepage to streams may be of concern. Resource utilization might be expected to be good, but is presently unknown. North-facing slopes subject to freezing at present.

Transportation

Roads: See Site C-1M

Pipelines: Natural gas pipeline 1 mile north.

Power Sources: Power source for this site is available at a power line along White River approximately 1.5 miles north of the center of the site. No difficulty, and little surface disturbance should occur in constructing a power line to the site. Telephone approximately 1.5 miles north.

Surface Resources

Land Use: Same as Site C-1.

Vegetation and Soils: Same as Site C-1.

Watershed: Same as Site C-1.

Wildlife

Same as Site C-1, plus golden eagle nesting sites and bald eagle winter-roost habitat. There is little current use of lands within vicinity of Site C-12 other than by recreationists or agricultural interests. Utilization of Site C-12 for test-lease operations would result in some localized loss of wildlife habitat, including eagle roose and nesting sites. The relative adverse impact of such development, however, would be minimized because of site location at outer boundary of the Piceance Basin. Industrial penetration of remote game range would not be a major factor since tract lies adjacent to a major surfaced highway.

The site is less likely to have adverse impact on the horse range. Access to site C-12 is short and direct to highway 64 and the area is on the extreme north end of the range and is not considered an integral part of the range.

Archeology: Same as Site C-1.

Recreation and Aesthetics: Same as Site C-1.

Livestock Grazing: Spring and Fall Cattle 365 - 500 AUM's.

Improvements: No significant Range Improvement Projects.

(c) Sites # C-9, C-14, and C-15

Sites # C-9, C-14, and C-15 contain thick oil shale in the mahogany zone but the lower oil shale zones are relatively lean. A number of years ago core holes were drilled on unpatented oil shale cliams on and adjacent to the sites.

(1) Colorado Site #C-9

(1) Colorado Site C-9

Size and Location

Township 4 South - Range 95 West
Section 19
Section 29
Section 30
Section 31
Section 32

Township 4 South - Range 96 West
Section 24
Section 25
Section 36

covering 5,127.14 acres in Garfield County, Colorado.

Status: All public domain except: T. 4 S., R 96 W., Sec 36: SE 1/4 patented Oil and Gas reserved to the United States. T. 4 S., R. 95 W., Sec. 31: SE 1/4 Withdrawal-Public Water Reserve.

Entire site is covered by a mineral entry Patent Application C-09072.

Mining Claim Conflicts: Entire site except for SE 1/4 Sec. 36, T. 4 S., R. 96 W., is covered by pre-1920 placer mining claims. With the exception above and Sec. 24 of the same township and Sec. 19, T. 4 S., R.95 W. the site is covered by post-1920 claims.

Elevation: Site elevation ranges from 7500' - 8300' above Mean sea level.

Climate: Generally same as Site C #1 except annual precipitation is 20" - 25" per year.

Access: Access to Site #C-9 is most readily available from Piceance Creek approximately 8.5 miles north of the center of site along the Sprague Gulch Road - BLM No. 1112. The road is unimproved but the alignment is fair and can be easily upgraded.

Vegetative type: Mountain browse.

Geologic features:

Alluvium
% of Area - 5%
Composition - Clay, sitl, sand and marlstone fragments
Thickness - 0-50'

Evacuation of Creek Member of the Green River Formation
% of Area - 90%
Composition - Mostly sandstone and siltstone with minor amounts of marlstone and low grade oil shale.

Thickness - 0-800'
Mineral Value - Some units contain appreciable quantities of analcime; there may be some extractable alumina.

Parachute Creek Member of the Green River Formation
% of Area - 100%
Composition - Mostly oil shale with some thin beds of sandstone and analcime and minor amounts of nahcolite.
Thickness - 1000' - 1200'
Mineral Value -
Mahogany Zone - The Mahogany Zone contains 100 to 130 feet of oil shale that averages 30 gallons of oil per ton in zones thicker than 15 feet, with an in place resource of 200-260 thousand bbls. of shale oil.

Lower Oil Shale Zones (R-1 through R-6) - The lower three R zones probably are not present and the remaining three are poorly developed. There probably isn't any shale averaging 30 gal. of oil per ton in units thicker than 15 feet. The amount of nahcolite is insignificant and probably less than 100 feet of shale contains dawsonite in insignificant quantities.

Geological Structure:

Faults - None apparent
Strike - Generally to the west
Dip - About 200 feet to the mile to the north

Hydrology: No hydrologic data are available for this tract. However, considering the relatively great distance of the site from the center of the basin where ground water is highly mineralized and the topographic position of the site, it is likely that quality of ground water is good and that the quantity of ground water in the upper zone is small (no consideration was given to the lower zone); the site must be given an excellent rating.

Mining Potential Including Data on Site #C-14 and #C-15.

Surface (open Pit) Mining: From the Geologic Section the Mahogany Zone ranges 30 GPT in thickness from 106 ft. to 127 ft. Overburden averages 900 ft. to 1000ft. Minimum waste: ore ratio is about 6:1, which is considered to be uneconomical.

Underground Mining: The 30 gallon shale in the Mahogany Zone ranges in thickness from 106 ft. to 127 ft. This could be mined by conventional room-and-pillar systems and standard mining equipment. The R-6 Zone, which contains about 25 ft. of 30 gallon shale is about 50 ft. below the Mahogany Zone. This may also be mined by conventional room-and-pillar systems, but will probably require different mining equipment because of the differences in thickness of the two beds.

Percent extraction per panel should be at least 60 percent and can be improved if back-filling is used and some pillars are mined.

Mines could be developed by adits or inclined shafts, depending upon the location.

In Situ: Mineability of the sites by in situ methods can only be evaluated in general terms because the method is still experimental. Recovery of the oil may be low. The thinness of the oil shale beds would also affect the economics of any in situ method.

Waste Disposal:

Surface: Potential for using portions of the surface (especially in the canyons) for long term disposal of solid wastes from mining and processing appear feasible.

Underground: Volume of processed shale is greater than the volume of mined shale. For this reason, not all of the shale that is mined and processed can be back-filled into the mining voids. The remaining shale must be disposed on the surface. A system of underground waste disposal wherein processed shale is back-filled into mined-out areas offers several advantages. First, less of the surface environment will be disturbed. Second, back-fill will help to stabilize the underground openings and reduce surface subsidence. Third, a certain percentage of the unmined shale left for support (barrier pillars, rib pillars, etc.) may be mined after the area has stabilized. This will increase the recovery of the mineral resources.

Recapitulation: Based on the foregoing evaluation, Sites #C-9, #C-14, or #C-15 each meets the objectives of the Proposed Prototype Oil Shale Leasing Program. Site #C-9 is more desirable than Sites #C-14 or #C-15 because it contains more of the mineral resource. Lease of any of these three sites will result in the early development of a commercial oil shale industry. However, development of technology for mining the deeper and richer oil shale beds in the center of the Piceance Creek Basin will not be achieved by lease of these sites as they do not contain the lower beds.

Air & Water Quality Considerations:

Surface Water Quality: Surface waters are essentially good quality runoff waters.

Air Quality: High elevation eliminates possibility of stagnation or inversion if gaseous emissions occur on site. The site is closest to Rifel, but prevailing winds should direct emissions to NE. If extensive operations started in the Parachute Creek Valley, drainage winds might affect Grand Valley.

Standards:

Water: "Antidegeneration" standard plus Refuse Act Permits White River classified A, B_2, C, D at considerable distance away (pH: 6.5 - 8.5; DO 5ppm)

Air: Ambient (Sulfur, Part. Co., Photochem Hydrocarb, NO_2)
Emission (Sulfur, Part., odor, visible)

Summary: Standards are presently the same for all Colorado sites.

General Impact:

Assuming a potential for air, water and solid waste emissions, this site offers problems in fewer areas than do certain other sites. The high elevation reduces the potential for air and water problems and the site is not readily visible, except by air. However, higher precipitation makes erosion more of a factor. The precipitation also enhances the opportunity for revegetation. Resource utilization appears good, while road access may have an impact (though less than access to sites in the center of the basin). Seepage and flooding would not be areas of primary concern. Importation of water might be necessary.

Transportation:

Roads - same as Site #C-1M.
Pipelines - None

Power Sources: Electric power is available from the power line in Piceance Creek and the power line-to the site could easily follow the same alignment as the road. Telephone is adjacent to this powerline.

Surface Resources:

Land Use - same as for Site #C-1.

Vegetation & Soils:

Soils are generally deeper, 20-36", than in the sites located northwest of this area. Soils are also darker and more fertile.

Plant species: Same as for Site #C-1 <u>except</u> no Pinus, Juniperus or Purshia on this site.

Plant composition: Same as for Site #C-1.

Condition: Same as for Site #C-1.

Susceptibility;to revegetation: Same as for Site #C-1.

Watershed - Same as for Site #, C-1.

Wildlife Including Data on Sites #C14 and #C-15.

Spring, summer and fall deer range; recieves some utilization as elk winter range.

Deer, elk, bear, coyote, mountain lion, bobcat, blue grouse, sage grouse, rabbits, raptors, as well as numerous small bird and mammal species.

Sites situated in relatively remote wildlife range area; subject to little agricultural or recreational disturbance. Considerable ranch maintenance and livestock traffic prevails, however, restrictive access somewhat limits game harvest or general recreational use by the public. Development of Sites #C=9, #C-14, or #C=15 for test-lease operations would entail onlv a limited degree of industrial penetration within the valuable and relatively undisturbed Piceance Basin wildlife range. These sites lie near the southeastern edge of the topographic Basin at elevations well above the more critical deer winter-use zone. Sites are not subject to priority management for wildlife, and currently receive limited recreational use because of restrictive public access provisions.

Archeology: Same as for Site #C-1.

Recreation & Aesthetics: Same as for Site #C=1.

Livestock Grazing:

Cattle and sheep graze this site suring the summer months. During the spring and fall months the livestock are offsite to the north.

4,077 cattle and 4,124 sheep are licensed to graze within the areas covered by these sites. Approximately 600 AUM's are produced on this site.

Improvements: None of any significance.

(2) Colorado Site #C-14

(2) Colorado Site #C=14

Size and Location:

T. 4 S., R. 96 W., 6th P.M., Garfield County
Sec. 19: Lots 1,2,3,4, E 1/2 NW 1/4 E 1/2/ SW 1/4
Sec. 20: All
Sec: 21: N 1/2 SW 1/4 N 1/2 SE 1/4
Sec. 29: All
Sec. 30: Lots 3, 4, 5, 6 E 1/2 W 1/2 E 1/2
Sec. 31: Lots 1, 2, 3, 4 E 1/2 W 1/2 E 1/2
Sec. 32: All
T. 4 S., R. 97 W., 6th P.M.
Sec. 25: All
Sec. 36: E 1/2
Total: 5,120 acres

Status: All public domain except T. 4 S., R. 96 W., patented with at least oil shale reserved to the United States; all of sec. 29 except S 1/2, NE 1/4, S 1/2 NW 1/4, NE 1/4 NW 1/4; sec. 30, SE 1/4, E 1/] SW 1/4; sec. 31, N 1/2 NE 1/4, NE 1/4 NW 1/4; sec. 32, E 1/2, NE 1/4. T. 4 S., R. 97 W., sec 25, NW 1/4, NW 1/4 NE 1/4, patented with at least oil shale reserved to the United States.

Mining Claim Conflicts: Entire site is covered by one or more layers of pre-1920 placer mining claims.

One layer post-1920 placer mining claims cover sec. 19, sec. 20, and N 1/2 sec. 21, T. 4 S., R. 96 W.
Sec. 25, S 1/2; sec. 36, E 1/2

Elevation: Site elevation ranges from 7,500-8,200 feet above mean sea level.

Climate: Same as Site #C-9.

Access: This site can be served by the same road as Site #C-13. BLM Road No. 1112 will extend south on the ridge between Scandard and West Stewart Gulches; then new routes can be constructed east or west in the lease areas.

Vegetative Type: Same as Site #C-9.

Geologic Features: Same as Site #C-9.

Geologic Structure: Same as Site #C-9.

Hydrology: Same as Site #C-9.

Mining Potential: Same as #C-9.

Air and Water Quality Considerations:

Water Quality: surface same as Site #C-9.
Air Quality: same as Site #C-9.
Standards:

Water: "Antidegradation" standard plus Refuse Act Permits
White River classified A, B_2, C, D, at considerable distance away (pH: 6.5-8.5; DO 5 ppm).
Air: Ambient (Sulfur, Part., Col, Photochem. Hydrocarb. NO_2). Emission (Sulfur, Part., odor, visible).

Summary: Standards are presently the same for all Colorado sites.

General Impact: Same as Site #C-9.

Transportation:

Roads -- Same as Site C-1M.
Pipelines -- None.

Power Sources: Same as Site #C-9.

Surface Resources: Same as Site #C-9.

Wildlife: Same as Site #C-9.

Archeology and Paleontology: Same as Site #C-9.

Recreation and Aesthetics: Same as Site #C-9.

Livestock Grazing: Same as Site #C-9.

Improvements: Same as Site #C-9.

(3) Colorado Site #C-15

(3) Colorado Site #C-15

Size and Location

An area nominated for prospective oil-shale leasing in the State of Colorado is:

T. 4.S., R. 97 W., 6th P.M. (Garfield County, Colo.)
Sec. 13: All
Sec. 14: All
Sec. 15: All
Sec. 22: All
Sec. 23: All
Sec. 24: All
Sec. 26: All
Sec. 27: All

The above being 5,120 acres, more or less.

Land Status: All public domain except for following parcel which is patented with at least oil shale reserved to the United States: Sec. 13, W 1/2 NW 1/4; sec. 14, E 1/2 E1/2, W 1/2 SE 1/4, SW 1/4 NE 1/4, SE 1/4 SW 1/4; sec. 23, W 1/2 NE 1/4, SE 1/4 NW 1/4, NE 1/4 SW 1/4; sec. 24, S 1/2, S 1/2 NE 1/4; sec. 25, NW 1/4, NW 1/4 NE 1/4, Sec. 26, SE 1/4 NE 1/4.

Mining Claim Conflicts: Sec.13, E 1/2 E 1/2 E 1/2; sec. 22, all; sec. 23, all; sec. 24, all; sec. 26, all; sec. 27, all covered by one layer pre-1920 placer mining claims. Sec. 13, E 1/2, E 1/2 W 1/2; sec. 14, W 1/2. W 1/2, NE 1/4 SW 1/4, E 1/2 NW 1/4, NW 1/4 NE 1/4; sec. 15, all; sec. 22, all; sec. 26, S 1/2, NW 1/4; sec. 27, all covered by one layer post-1920 placer mining claims.

Elevation: Same as Site #C-9.

Climate: Same as Site #C-9.

Access: Same as Site #C-9.

Vegetative Type: Same as Site #C-9.

Geoligic Features: Same as Site #C-9.

Structure: Same as Site #C-9.

Hydrology: Same as Site #C-9.

Mining Potential: Same as Site #C-9.

Air and Water Quality Considerations:

Water Quality: Surface same as Site #C-9.
Air Quality: Same as Site #C-9.
Standards:

Water: "Antidegeneration standard plus Refuse Act Permits White River classified A, B_2, C, D, at considerable distance away (pH: 6.5-8.5; DO 5 ppm).
Air: Ambient (sulfur, Part. Co., Photochem. Hydrocarb. NO_2).
Emission (sulfur, Part. odor, visible).

Summary: Standards are presently the same for all Colorado sites.

General Impact: Same as Site #C-9.

Transportation: Same as Site #C-9.

Power Sources: Same as Site #C-9.

Surface Resources: Same as Site #C-9.

Wildlife: Same as Site #C-9.

Archeology and Paleontology: Same as Site #C-9.

Recreation and Aesthetics: Same as Site #C-9.

Livestick Grazing: Same as Site #C-9.

Improvements: Same as Site #C-9.

(d) Site #C-10

Site #C-10 probably contains oil shale as thick and rich as that that underlies Site #C-11 and also contains large resources of dawsonite in the lower oil shale zones. A core hole drilled on the site on a special land-use permit issued in connection with this leasing program showed that all of the nahcolite is leached and saline water is present throughout essentially all of the rich oil shale zones.

(d) Colorado Site #C-10

d. Colorado Site #C-10

Size and Location

The following compact and contiguous tract of land is hereby nominated for oil shale leasing by the U.S. Govt.

In R99W, T1S, 6th Prime Meridian, Colorado:

SE 1/4 SE 1/4	Section 25
SE 1/4	Section 35
S 1/2 SW 1/4	Section 35
S 1/2	Section 36
S 1/2 NW 1/4	Section 36
NE 1/4	Section 36

In R99W, T2S, 6th P. M., Colorado:

All	Section 1
All	Section 2
N 1/2	Section 12

In R98W, T1S, 6th P. M., Colorado:

All	Section 31
All	Section 32

In R98W, T2S, 6th P. M., Colorado:

W 1/2 NW 1/4	Section 5
NW 1/2 SW 1/4	Section 5
All	Section 6
All	Section 7

The total acreage: 5126.06 acres

Status: All public domain except T. 1 S., R. 98 W., Sec, 31: S 1/2 SE 1/4, NE 1/4 SE 1/4, SE 1/4 NE 1/4 patented with Oil Shale reserved to the United States. Sec. 32: N 1/2 NW 1/4, SW 1/4 NW 1/4, NW 1/4 SW 1/4, patented with Oil Shale reserved to the United States. T. 2 S., R. 98 W., Sec. 6: W 1/2 SW 1/4 patented with all minerals reserved to the United States. Sec. 7: W 1/2 NW 1/4, patented with all minerals reserved to the United States. T. 2 S., R. 99 W., Sec. 1: SE 1/4 SE 1/4 patented with Oil Shale reserved to the United States. Sec. 12: NE 1/4 patented with Oil Shale reserved to the United States.

Mining Claim Conflicts: Site #C-10: T. 2 S., R. 99 W., Sec. 1: N 1/2, SW 1/4; Sec. 2: All; T. 1 S., R. 98 W., Sec. 31 & 32 all covered by post-1920 placer claims.

Elevation: 6500'-7000' above sea level.

Climate: Same as Site #C-1.

Access: The most direct route to the center of this site is from 84 Ranch along Stakes Springs Draw drainage for approximately 2 miles, The route from 84 Ranch through Ryan Gulch into Piceance Creek is county road. The total distance to Piceance Creek is approximately 11 miles. All present roads could be easily upgraded in their present alignment.

Vegetative Type: Pinon, Juniper and Sage brush.

Geologic Features:

Alluvium
- % of area- 5%-10%
- Composition - clay, silt, sand and marlstone fragments
- Thickness - 0-150 ft.

Evacuation Creek Member of the Green River Formation
- % of area - 100%
- Composition - Mostly calcareous sandstone and siltstone with minor amounts of marlstone.
- Thickness - 500 ft. to 1050 ft.
- Mineral Value - Some zones contain a high percent of alacime; extractable alumina may be present.

Parachute Creek Member of the Green River Formation
- % of area - 100%
- Composition - Mostly oil shale, some thin sandstone and analcime beds, very small amounts of nahcolite.
- Thickness - 1500 ft. ±
- Mineral Value -
  - Mahogany Zone - Contains approximately 70 feet of shale averaging 30 gallons of oil in units thicker than 15 feet with an in place resource of 140,000 bbls. per acre.
  - Lower Oil shale zone R-1 through R-6 - About 700 feet of oil-shale average 30 gallons of oil per ton in units thicker than 15 feet with an in place resource of 1,400,000 bbls. per acre. About 600 ft. of section contains finely disseminated dawsonite in varying amounts. About 800-900 ft. of section that formerly contained saline minerals has been leached by ground water and the voids created by

the leaching are now filled with moderately saline water, This will possible inhibit mining in the lower zone.

Geologic Structure:

Faults - possible a few normal faults of slight displacement in the southwest part of the site.
Strike - generally to the northwest.
Dip - generally to the northeast at the rate of 100-150 feet per mile.

Hydrology: Water data are available from a test hole drilled in Sec. 12, T. 2 S., R. 99 W. In the upper zone, the electrical conductance of the water is 2,200 umhos/cm and the transmissivity is 12,000 gpd/ft. In the lower zone the conductance reached 5,000 umhos/cm and the transmissivity 10,000 gpd/ft. The presence of large amounts of brackish water can pose severe problems of dewatering and disposal.

Mining P6tential:

Surface (open pit) Mining: About 700 feet of 30 gal/ton shale is in the interval between the surface and about 1600 feet of depth. This stripping can be attractive if the potential value of Dawsonite is added to that of oil from shale, This will require mining of the leached zone where water problems are not completely known, but may be of a serious nature.

Underground Mining: The 70 ft. thick, 30 gal/ton sequence in the mahogany zone lying above the leached zone is the prime target for early underground mining. Depth below surface is very favorable for underground mining and for research to determine if mining in the leached zone can be accomplished. At this location there is about 620 feet of 30 gal/ton shale in the leached zone that should be a prime target for future use. According to available hydrologic information, the leached zone contains large amounts of saline water which may present a mining and environmental problem.

The future possibilities of mining the oil shale and associated minerals in the lower zone cannot be ignored since this constitutes the major part of the mineral reserves.

In Situ Recovery Methods: The depth of cover (600' average) with a 70-ft. thick bed of 30 gal/ton shale at about this depth makes this a favorable site IF in situ recovery is considered only in the mahogany bed. The additional depth (total 950' average) to other major shale beds which lie in the leached zone may also make the site attractive for research on in situ recovery in the leached zone.

Waste Disposal:

Surface: The potential for utilization of part of the surface for long term disposal of solid wastes from mining and processing appears feasible.

Underground: The potential for underground disposal of solid wastes is a direct function of the volume of waste. This volume, in turn, depends upon the retorting method used and whether only oil or whether both oil and associated minerals are extracted. If only oil is extracted underground, space will be insufficient; if both oil and associated minerals are extracted, space may be sufficient. In any case, surface storage for the first 3 to 5 years of operation must be stored on the surface pending mine development. Much of this material may remain for the life of the operation.

Recapitulation:

This site is considered to offer excellent opportunities for all three types of mining, that is, surface, underground and in situ.

Surface mining will present the best condition for total or near total resource recovery. Underground mining provides a reasonably sure method for around 50% resource recovery depending on solution of water and other problems. In situ or underground-in situ may be developed; however, resource recovery using this system cannot be evaluated at this time.

Air and Water Quality Considerations:

Surface Water Quality: Surface water is of fair quality.

Air Quality: Moderate elevation suggests that stagnation or inversion-concentration may be less significant. But position along flank of basin may subject discharges to concentration by nighttime drainage winds.

Standards:

Water: "Antidegradation" standard plus Refuse Act Permit. White River is A,B_2, C, D. (pH: 6.5-8.5; DO: 5ppm)

Air: Ambient (sulfur, Part. CO, Photochem, Hydrocarb, NO_2)
Emission (Sulfur, Part., odor, visible)

Summary: Standards are presently the same for all Colorado sites.

General Impact:

Assuming a potential for air, water, and solid waste emissions, the site offers problems intermediate in severity compared to other sites. The location indicates lesser air and water problems but extensive ground water may cause problems. Visibility should be low (except from the air). Erosion and revegetation ease would be moderate. Seepage is a potential problem. Resource utilization may be good, though water may pose a mining problem. North facing slopes, subject to freezing, are at a minimum.

Transportation:

Roads: Same as Site #C-1.
Pipelines: Cascade 16 " natural gas line cuts the south portion of the area.

Power Sources:

Electric power is available on the site. Telephone is located 4 miles southeast.

Surface Resources:

Land Use: Same as Site #C-1.
Vegetation and Soils: Same as Site #C-1.
Watershed: Same as Site #C-1.

Wildlife:

Very important mule deer winter-range area, lying within prime elevational zone. Deer, mountain lion, coyote, wild horses, bobcat, sage grouse, raptors, doves, rabbits and numerous small bird and mammal species - primary value is deer winter range.

Site is remote from population centers and is subject to little adverse impact from industrial processes or activities.

Utilization of Site #C-10 for test-lease operations will result in the localized loss of very important deer winter-range habitat, a serious disruption of major game·migration and hunter use corridors, and an undesirable penetration by industry into the heart of a wildlife habitat area primarily managed by a State Agency for the benefit of wildlife uses.

Archeology: Same as Site #C-1.

Recreation: Same as Site #C-1.

Livestock Grazing: Same as Site #C-4.

Improvements: Same as Site #C-4.

(e) Site #C-11

Site #C-11 was evaluated by two core holes drilled in conjunction with the 1968 oil-shale leasing program. The site has the greatest in-place resource of oil shale, nahcolite, and dawsonite of any of the nominated sites. Either underground mining or in-situ retorting may be the resource recovery method. The leached zone underlying the site contains highly saline water, approximately twice as saline as sea water. Beneath the leached zone a thick zone contains halite interbedded with nahcolite and oil shale.

(e) Colorado Site #C-11

(e) Colorado Site #C-11

Size and Location:

TOWNSHIP 1 SOUTH, RANGE 97 WEST
Section 29: W 1/2 SW 1/4
Section 30: Lots 1, 2, 3, and 4,
E 1/2 W 1/2, E 1/2
Section 31: Lots 1, 2,3, and 4,
E 1/2 W 1/2, E 1/2
Section 32: W 1/2 W 1/2

TOWNSHIP 1 SOUTH, RANGE 98 WEST
Section 34: NE 1/4
Section 35: All
Section 36: All

TOWNSHIP 2 SOUTH, RANGE 97 WEST
Section 5: Lot 4, SW 1/4 NW 1/4, NW 1/4 SW 1/4
Section 6: Lots 1 through 7 inclusive,
SE 1/4 NW 1/4, S 1/2 NE 1/4, E 1/2 SW 1/4,
SE 1/4
Section 7: Lot 1, NE 1/4 NW 1/4, N 1/2 NE 1/4

TOWNSHIP 2 SOUTH, RANGE 98 WEST
Section 1: Lots 5 through 20 inclusive
Section 2: Lots 5 through 20 inclusive
Section 3: Lots 5 and 6
Section 12: Lots 1 and 2

TOTAL ACREAGE 5,118.08

Status: Entire site is public domain. T. 2 S., R. 98 W.,
Sec. 1: Lot 10 covered by Public Water Reserve 107.
Sec. 2: Lot 15 covered by Public Water Reserve 107.

Mining Claim Conflicts: T. 1 s., R. 97 W., Sec. 29: W 1/2 SW 1/4, Sec. 30: All; T. 1 S., R. 98 W., Sec. 34: NE 1/4, covered by post 1920 mining claims.

Elevation: Site elevation ranges from 6200' - 6700' above mean sea level.

Climate: Same as Site #C-1.

Access: Access is readily available through a county road along the drainage of Ryan Gulch for approximately 2 miles. A mile of new road will have to be constructed to allow access to the center of the site.

Vegetative Type: This site is within the pinon-juniper type. There are areas of big sagebrush located in drainages. Mountain browse is interspersed throughout the area. Wheatgrasses, big sage, service berry and bitterbrush are the primary forage species.

Geologic Features:

Alluvium
- % of Area - 10%-15%
- Composition - Clay, Silt, Sand and Marlstone Fragments
- Thickness - 0-200 ft.±

Evacuation Creek Member of the Green River Formation
- % of Area- 100%
- Composition - Mostly sandstone and siltstone with minor amounts of marlstone and low-grade oil shale.
- Thickness - 500 ft. - 1100 ft.
- Mineral Value - Some zones contain appreciable quantities of analcime; extractable alumina may be present.

Parachute Creek Member of the Green River Formation
- % of Area - 100 %
- Composition - Mostly oil shale, some sandstone and siltstone beds and thin beds of analcime, contains beds of halite and nahcolite.
- Thickness - 1500 ft. ±
- Mineral Value
  - Mahogany Zone - Contains about 150 feet of shale averaging 30 gallons of oil per ton in units thicker than 15 feet, with an in-place resource of of about 300,00 bbls. per acre.
  - Lower oil shale R-1 through R-6 - Contains about 750 feet of shale averaging 30 gallons of oil per ton in units thicker than 15 feet with an in-place resource of 1,500,000 bbls. per acre. Bedded nahcolite is present in about 500 feet of section and dawsontie is present in more than 700 feet of section. Ground water has leached salts from more than 300 feet of section downward from the lower part pf the Mahogany zone. Highly saline water occupies the voids created by the leaching. Thick beds of halite are interspersed with oil shale and nahcolite in the 300 -foot interval immediately underlying the leached zone. The leached zone and the

zone containing halite probably will inhibit mining in as much as 180 feet of 30-gallon shale and a thicker zone of dawsonite-bearing shale.

Geologic Structures:

Faults - A graben with relatively small displacement trending northwest is in the SE 1/4 of the site.
Strike - The rocks trend north in the eastern part of the site and northwest in the western part.
Dip - The dip is west in the eastern part of the site at the rate of 150 feet per mile and is northwest in the western part at the rate of 150 feet per mile.

Hydrology: No hydrologic data are available for this area. It is estimated that conditions may be similar to those in Site #C-10, but water quality in the lower zone might be poorer.

Mining Potential:

Surface (open pit) Mining: The Geologic Section indicates low potential for open pit mining. Overburden average depth is about 1,100 feet. Because of lower grade beds it will require about a 2:1 stripping ratio to a depth of 2500 ft. From this will be obtained about 820 vertical feet of 30 gal/ton shale while about 1680 vertical feet of waste or lower grade shales will have to be removed. If this mining system were used, it is expected near 100% of associated minerals will be recovered, adding to the value of the resource. Mining in and under the leached zone will be required and handling the possible larger quantities of water will add to the mining problem and total costs as well as presenting environmental problems.

Underground Mining: The sequence of about 150 of 30 gal. shale in the Mahogany zone lying above the leached zone will be a prime target for early development. In fact, this 150 ft. thickness can present mining problems and reduced resource recovery because of the need to leave enough pillar support so that the surface above the mine will not subside. In any event, the average 1100 ft. vertical depth to the Mahogeny zone is compatible for shaft mining. There appears to be sufficient good grade shale in and below the leached zone to warrant study and research to solve the problems of deeper mining, especially since it is this zone that contains the associated minerals which may be quite valuable.

In Situ Recovery: The depth of cover (1100 ft. average) and 150 ft. thickness of 30 gal/ton shale in the Mahogeny zone makes this a possible site for in situ recovery of oil or underground mining-in situ recovery site. Any in situ recovery of deeper beds will have to take the aquifer in the leached zone into consideration and thus may be more difficult and expensive.

Waste Disposal:

Surface: The potential for utilization of part of the surface for long-term disposal of solid wastes from mining and processing appears feasible.

Underground: The potential for disposal of wastes underground is a direct function of the volume of waste. The volume, in turn, depends upon retort method and whether only oil or oil and associated minerals are extracted. In the first case, space will be sufficient; in the second case, space may be sufficient. In any case, surface storage for the first three to five years of operation must remain on the surface pending availability of mine space. Much of this material may require surface storage for the life of the operation.

Recapitulation: This site is considered to offer a fair opportunity for surface mining, an excellent opportunity for underground mining and an unknown opportunity for in situ recovery or for underground mining-in situ recovery. Resource recovery could be near 100% for surface (open pit) mining. About 50% for underground mining if water in leached zone problem can be solved, and to an unknown extent by in situ or a combination of in situ and other methods. The recovery of associated minerals by in situ is unknown.

Air & Water Quality Considerations

Surface Water Quality: By virtue of the site location in the middle of the basin, surface water is of moderately poor quality.

Air Quality: Low mean elevation places the site in an area of probable night-time temperature inversions. Drainage winds downslope along Piceance Creek may cause problems.

Standards:

Water: Antidegradation standard plus Refuse Act Permit. White River is A, B_2, C, D. (pH: 6.5-8.5; DO: 5 ppm)

Air: Ambient, (sulfur, Part., CO, Photochem, Hydrocarb, NO_2) Emission (sulfur, Part., odor, visible)

Summary: Standards are presently the same for all Colorado sites.

General Impact:

Assuming a potential for air, water, and solid waste, emissions, this site offers problems in all three areas due respectively, to the low mean altitude, the presence of poor quality water, and the proximity to access routes or visibility. Revegetation would prove more difficult. Erosion should be lower but the nearness to a perennial stream makes seepage a potential problem. Resource utilization appears only fair with foreseeable technology. North facing slopes are minimal. Flooding potential is moderate to low.

Transportation

Roads - A county maintained graded road crosses the southern part of the site. A paved road along Piceance Creek is one mile east of the site.

Pipelines: The same gas pipeline that traverses Site #C-10 passes through the south portion of this site.

Power Sources: Electric power is available in Piceance Creek approximately 2 miles east of the center of the site. The only surface disturbance anticipated outside the lease area will be the construction of a power line. Telephone is adjacent to this power line.

Surface Resources

Land Use: Same as for Site #C-1.
Vegetation & Soils: Same as for Site #C-1.
Watershed: Same as for Site #C-1.

Wildlife:

Same as Site #C-10; in addition has active golden eagle nest site.

Site situated abreast heavily travelled road utilized all year long by stockmen and recreationists; seasonally by sportsmen; and frequently by representatives of mining or petroleum companies having an interest in extensive land areas throughout the Cathedral Bluffs units.

Utilization of Site #C-11 for test-lease operations would result in the localized loss of deer winter-range habitat, some alteration of mule deer migration patterns and the creation of additional access by industry into an important wildlife habitat area, presently managed by the Colorado Game, Fish and Parks Division for the benefit of wildlife populations and hunters.

This site receives horse use during the winter months. If none of the other sites were selected from the wild horse range, the impact would be moderate since the horses could move to the west and north for normal winter range. The short access route from Piceance Creek would make this site preferable to all sites, except C- 12, from those sites that lie within the horse range.

Archeology: Same as Site #C-1.

Recreation and Aesthetics: Same as Site #C-1

Livestock Grazing

Present Use: One operator grazes cattle, spring-fall, 500 AUM's with 1,000 cattle.

Potential for artificial improvement of range limited by slopes and shallow soils.

Improvements: This site contains a well which is the water source for a planned extensive pipeline system to provide water for livestock, wildlife, and human consumption associated with hunter camps.

(a) Utah Site #U-1

2. Tract Alternatives in Utah

Nominated sites in Utah that were recommended by the selection committee were Utah site #2 (nomination designation, U-a) and Utah sites #4 and #5 (nomination designation, U-b). The remaining Utah sites, site #1 and site #3 would be alternatives to the two nominated sites.

a. <u>Utah Site #U-1</u>

Site #U-1 contains a moderately thick sequence of rich oil shale in the mahogany zone; however, there is insufficient resource underlying the site to sustain an industry for 20 years.

Size and Location:

A total of 5,120 acres, more or less, consisting of the following lands in Uintah County:

T. 11 S., R. 24 E.
Sec. 4: All
Sec. 5: All
Sec. 6: All
Sec. 7: All
Sec. 8: All
Sec. 9: All

T. 10 S., R. 24 E.
Sec. 31: All

*T. 13 S., R. 24 E.
Sec. 7: W½W½

*T. 13 S., R. 23 E.
Sec. 12: NE¼, E½NW½, E½W½NW¼; E½NW¼SW¼, NE¼SW¼, NW¼SE¼, E½SE¼, E½SW¼SE¼

*This southern portion of the site (approximately 500 acres) was excluded from evaluation since it is not adjacent to the major site acreage and the distance between the two areas is considered to be too far for efficient operation, and therefore, was considered not feasible.

Land Status:

All public domain except for the following:

T. 11 S., R. 24 E.
Sec. 4: S½SW¼, NW¼SW¼; Patended no minerals reserved.
Sec. 6: Approximately 49 acres patented lode claim in S½SE¼, NW¼SE¼, SE¼SW¼, N½SW¼; Lot 8, 46.43 acres Public Water Reserve.
Sec. 7: Approximately 49 acres patented lode claim in NE¼NE¼, S½NW¼, NE¼SW¼, NW¼SE¼, E½SE¼; Lot 7, 26.86 acres Public Water Reserve.
Sec. 8: Approximately 52 acres patented lode claim in N½NW¼, SE¼NW¼, E½NE¼, SE¼NE¼, NE¼SE¼, S½SW¼.
Sec. 9: Approximately 32 acres patented lode claim in NW¼SW¼, E½SW¼, SW¼SE¼.

Utah State Selection applications cover all of Site U-1 except 120 acres in SW¼ Sec. 4.

Mining Claim Conflicts:

T. 10 S., R. 24 E.
Sec. 31: Completely covered by both pre-1920 and post-1920 placer claims.

T. 11 S., R. 24 E.
Sec. 4: N½ and) Completely covered by one or more
Sec. 9: N½) layers of post-1920 placer claims.

Major portions of the remaining lands in T. 11 S., R. 24 E. are covered by lode claims.

Elevation: Site elevation ranges from 5,200 to 5,900 feet above sea level.

Climate: 10"-11" rainfall; -25°F to $+105^{\circ}$F temperature range. Precipitation is fairly equally divided between winter snow and summer rain. Prevailing winds are from the southwest. The site is subject to occasional severe summer thunderstorms and local flash floods.

Access: Asphalt Wash Road, an unimproved BLM road, extends from Rainbow Road in sec. 1, T. 12 S., R. 23 E., to the White River, and runs in a north-south direction through the west side of the Site. A truck tráil also cuts through the southwest corner of the Site.

Vegetative Type: Approximately 80% of the Site is in the Pinion-Juniper vegetative type. The drainage bottoms are predominantly greasewood type; about 10% of the total area. The remaining 10% is sagebrush-bunchgrass type.

Geologic Features: The oil shales of primary interest occur in the Mahogany zone. A sequence about 85 feet thick in the Mahogany zone averages about 25 gallons per ton. Within this unit about 50 feet averages 30 gallons of oil per ton. The overburden above the Mahogany zone ranges from 550 feet to 1,225 feet (the average is approximately 850 feet) and the nearest outcrop of the Mahogany zone is about 3 miles to the southeast. Several gilsonite veins outcrop on the site. One vein has a maximum width of approximately 30 inches and the other veins are appreciably narrower. The site probably contains an insignificant amount of nahcolite in very thin lenses and pods in a stratigraphic sequence 300 to 500 feet above the Mahogany zone.

Geologic Structure: Strike of the rocks is to the east or northeast and dip to the north or northwest at the rate of 2°. No significant faults are in the area but the Green River Formation is broken by a system of closely spaced joints.

Hydrology: Wells tapping the Green River Formation in Utah commonly yield less water than those in Colorado. The water quality is highly variable. Insufficient data are available to rate the Utah site by the criteria used for those in Colorado.

In Sec. 6, T. 11 S., R. 24 E., a well drilled to a depth of 5,950 feet completely penetrated the Green River Formation at a depth of 2,677 feet. Quality-of-water data from a sample of unknown depth indicate total dissolved solids of 1180 mg/l. The test hole has since been converted to a water well.

A well drilled in Sec. 8, T. 11 S., R. 24 W. was reported to yield 21 gpm from the Green River Formation at depths from 1,210 to 1,230 feet.

Mining Potential:

Surface (open-pit mining)

According to the geologic section, 85 feet of 25 GPT shale is overlain by 550-1,225 feet of waste. This overburden/ore ratio of from 6.5/1 to 14.4/1 is not considered to be economic for surface mining. Within this 25-gallon-per-ton sequence is 50 feet of 30 gallons per ton.

Underground Mining

Shaft mining with a conventional room-and-pillar system and standard mining equipment is feasible.

In situ Methods

In situ recovery methods using underground entries and/or surface drill holes for access and chemical explosives to fracture the rock are feasible. Whether or not an 85-foot thickness of oil shale can be efficiently mined by this method can only be determined by experiment.

Waste Disposal

Surface

Adequate area is available for long-term storage of solid waste from mining and processing.

Underground

There will not be enough space for underground storage of all of the processed shale.

Recapitulation

This site meets the objectives of the prototype Oil-Shale Leasing Program.

Air and Water Quality Considerations:

Surface water quality:

Area drains into the White River. The White River (near Watson, Utah) has essentially the same quality as it does upstream near Rangely, though DO and pH are better; chlorides are worse.

Air quality:

Prevailing winds are southwesterly and, therefore, gaseous emissions would be transported toward Rangely, Colo.

Standards

Water: "Antidegradation" statement applies. White River classified "CW" in area (pH 6.5 to 8.5; DO 5.5 ppm).

Air: Ambient (sulfur, part. CO., photochem, Hydrocarb; NO_2). Emission (Sulfur, Part., visible).

Summary: Standards are presently the same for all Utah sites.

Transportation:

Roads

Existing roads are described under "F. Access." Existing roads can be improved without major relocation; however, an oil-shale industry may require a new road system.

Pipelines

A major oil pipeline connecting the Rangely and Red Wash field to Salt Lake City is located about 6 miles north of the Site. A major gas line runes along Seep Ridge about 10 miles west of the Site.

Power Source: Existing power lines to Red Wash, Bonanza and the water pumps at the White River bridge are probably inadequate for an oil-shale plant in addition to their present load. A major substation is located near Jensen, Utah, about 35 miles north of the Site.

Surface Resources:

Land Use

Present land use consists of livestock grazing, wildlife habitat, recreation and gas production.

Vegetation and Soils

Soil types: Soils in this area are light colored, sodic, saline or sandy and highly erodable. The gradient and stability varies from very steep side slopes with stability problems to a moderately rolling topography with fairly stable soil characteristics. Soils of the upper slopes are shallow and immature with a thin A horizon.

In the lower reaches of the stream valleys the soils are principally loamy, very fine and sand formed by alluvial deposits and outwash from the upper slopes.

Plant species:

The pinon-juniper type consists of about 75% trees and shrubs with a bunchgrass and forb understory (15% and 10% respectively).

The mixed desert shrub type consists of low-growing, salt-tolerant shrubs about 25%, bunch grasses 50%, and forbs 25%.

The greasewood types are generally dense stands of greasewood with very few other shrubs and little understory. Plant composition is typically approximately 90% shrubs, 6% grass, and 4% forbs.

The sagebrush types are typically about 60% brush, 30% grass, and 10% forbs. Big sage and curly grass (Hilaria species) are the predominant species.

Conditions

The site is marginal for Pinon and Juniper. Pinon is a very small percent of the stand and is found only on the better areas. Juniper is low growing with very slow growth rate. Soil erosion is estimated at 0.38 to 0.45 acre feet/square mile.

Susceptibility to revegetation

Revegetation of disturbed areas and waste piles will be difficult because of limited topsoil and limited precipitation.

Watershed: The chemical and physical characteristics of the soils are conducive to high rates of runoff and surface erosion. Because of the erosion path that has become established over much of the site and the stable condition of the vegetation, erosion rates are moderate. Drainage bottoms do not have an erosion pavement and increased water volumes resulting in accelerated erosion.

Surface disturbance will result in increased erosion.

Wildlife: The Site supports a small resident mule deer herd. Other wildlife species using the Site include cottontail rabbits, chukar partridge, coyotes, bobcats, mountain lions, bear (occasional), golden eagle, prairie falcon, march hawk, sparrow hawk, redtail hawk, and coopers hawk and numerous small birds.

Utilization of the tract for test lease operations will result in a penetration by industry into a wildlife are relatively remote from populated areas. It will result in the localized loss of wildlife habitat as well as a disruption of game movements.

Archealogy: There are no known archaeological or historical features on the site.

Recreation and Aesthetics:

Present use: Present recreational use is principally hunting and sightseeing. Recreational visitor days are estimated at 50 per year. There are no developed recreation facilities on the Site.

Potential: Potential for increased hunting use is limited because of physical characteristics.

Aesthetics: The sharply cut, deep canyons, numerous buttes and spires, red and white rock formations, and dark-green juniper trees form semi-desert landscape.

Livestock Grazing: The site is grazed by a band of 3,500 sheep for approximately 15 days in the winter or early spring and by another band of 1,800 sheep for approximately 30 days during the same period.

There is little potential for improving grazing except by improved management practices which could result in 10%-20% forage increase over time.

Improvements: There are 3 water wells in the Site that flow into ponds providing valuable wildlife and livestock water.

b. Utah Site #U-3

Site #U-3 is separated into two parts by state land. A number of years ago a core hole was drilled on the state land to evaluate the oil shale for a proposed nuclear fracturing, in-situ recovery experiment. Assays of the core indicate that the mahogany zone is comparable in thickness and value to the mahogany zone underlying Site #U-2. Therefore sufficient resource is available to sustain an oil shale industry for 20 years; however, the mahogany zone is deeply buried and the only proposed method of recovery was by nuclear fracturing and in-situ retorting.

(b) Utah Site # U-3

Size and Location:

T. 9 S., R. 21 E
Sec. 28: All
Sec. 29: All
Sec. 30: All

T. 10 S., R. 21 E.
Sec. 5: All
Sec. 6: All
Sec. 7: All

T. 10 S., R. 20 E.
Sec. 1: All
Sec. 12: All

5,120 acres.

Land Status: The entire site is public domain.

Mining Claim Conflicts: There are no post-1920 placer claims on this site. The only pre-1920 placer claims lie on the portion of the site within T. 9 S., R. 21 E. These are the Kuhnhill Oil Nos. 5-16 of unknown ownership.

Elevation: Site elevation ranges from 4,800-5,200 feet above sea level.

Climate: Same as Site #U-1.

Access: The improved unsurfaced county road rurring from Ouray to P.R. Spring passes through the southwest corner of the site. A few unimproved truck trails extend into the site.

Vegetative Type: The south portion is almost entirely mixed desert type. The north portion is mixed desert shrub with minor areas of sagebrush type (approximately 20%).

Geologic Features: This site is located about 7 miles southeast of Ouray, Utah, in the east-central part of the Uinta Basin. The oil shales of primary interest occur in the Mahogany zone. Overburden above the Mahogany zone ranges from 2,000-2,550 feet and the average is approximately 2,300 feet. The nearest outcrop of the Mahogany zone is about 15 miles to the south. Several gilsonite veins crop out in the site and the widest of these has a width of about 36 inches. The amount of nahcolite in the site is probably minor. It occurs as thin lenses and pods in a sequence 300-600 feet above the Mahogany zone.

Structure: Essentially the same as Site #U-1.

Hydrology: Best hydrologic data below the Mahogany zone come from a test well drilled in Sec. 36, T. 9 S., R. 20 E. A drill stem test of the interval from 2,729-2,809 feet, and 2,901-2,929 feet showed a yield of 8 gpm, an electrical conductance of 82,000 umhos/cm, and a transmissivity of about 10 gpd/ft. A test of the interval from 3,115-3,154 feet indicates a yield of 16 gpm, an electrical conductance of 48,000 umhos/cm and a transmissivity of 18 gpd/ft. The conductance of the water is unusually high but the amount of water present seems to be negligible.

Mining Potential:

Surface: This site is not considered suitable for surface mining because of 2,000 feet or more of overburden and relatively narrow (63 ft) bed of 25 gal/ton shale.

Underground: Underground mining cannot be ruled out as an exploitation method, but this possibility is considered remote at this time because of the same overburden (2,000 ft or more) depth and shale thickness and grade 63 ft of 25 gal/ton that seems to eliminate surface mining as an exploitation method.

In Situ: In situ appears to present some possibility as an extraction method. Depth of shales below surface may present economic and operationsl problems for most known and demonstrated in situ methods.

Waste Disposal:

Surface: Limited availability of surface topography information indicates some surface storage of mined waste is feasible if suitable precautions aremade to protect drainage areas.

Underground: The probability of underground mining being done on this site at this time is remote since overburden depth of over 2,000 feet and rather limited (63 ft) thickness of 25 gal/ton shale impose questionable economic conditions.

Recapitulation: This site seems best suited to recovery of shale oil by in situ methods.

Air and Water Quality Considerations:

Surface Water Quality: Near this site, the quality of the White River has deteriorated with significant increases in salinity, sulfate, and dissolved solids from that at Rangely, Colo.

Air Quality: The area is not well-known from the air quality standpoint. The relatively isolated location suggests less impact on populated areas caused by prevailing winds but the proximity to the Ute Indian Reservation could negate this advantage.

Standards:

Water: "Antidegradation" statement applies. White River classified "CW" in area (pH 6.5-8.5; DO 5.5 ppm).

Air: Ambient (sulfur, part, CO., photochem, Hydrocarb.; NO_2). Emission (sulfur, Part., visible).

Summary: Standards are presently the same for all Utah sites.

Transportation:

Roads: Existing roads are described under "F. Access." Existing roads can be improved without major relocation; however, development of the site for shale-oil recovery would probably involve consideration of a new road system.

Pipelines: Same as Site #U-1. Seepridge Gas Line passes near SW corner of this site.

Power Source: Same as Site #U-1.

Surface Resources:) Same as for Site #U-1 with the following
Wildlife:) exceptions:
Archaeology:)
Recreation and)
Aesthetics:)
Livestock Grazing:)
Improvements:)

Vegetation and Soils: Soils on Site #U-3 contain considerably more clay than those on Site #U-1. Mixed desert shrub types on this site are predominantly saltbush. The stands are sparse and include a fair amount of matt saltbush and prickly pear cactus in addition to the species enumerated for Site #U-1.

Wildlife: Prairie dogs are present on Site #U-3. Mule deer use is light; mostly restricted to White River Canyon and Cottonwood Wash.

Recreation: Recreation use is estimated to be 75 visitor days per year.

Livestock Grazing: Approximately 4,700 sheep graze this site in the winter for a total of 20 days.

Improvements: Three small stock water reservoirs, several gas wells, and gas lines.

3. Tract Alternatives in Wyoming

Site #W-1 is the only site in Wyoming nominated by industry for an oil shale lease. Assays from a core hole drilled on the site by the U.S. Bureau of Mines prior to the leasing program indicate that a mineable thickness of oil shale 90 feet in two zones averages about 20 gallons of oil per ton in contrast to the 30-gallon average of mineable thicknesses underlying the selected sites in Colorado and Utah. Two oil shale zones 10 to 20 feet thick yield 25 gallons per ton. These relatively low-grade oil shales will probably only lend themselves to in-situ recovery of the shale oil.

Only a very limited amount of information is available about the oil shale resources of Wyoming. Only a few informational coreholes have been drilled and detailed resource knowledge is skimpy accordingly.

Site #W-2 is adjacent to W-1 on the south, and Site #W-3 is adjacent to #W-1 on the north. Both of these sites were nominated by the State of Wyoming and because of their proximity to Site #W-1 are assumed to have essentially the same resource potential and other characteristics as #W-1. Site #W-2 is fault free; however, a small fault cuts the oil shale outcrop on the west side of Site #W-3; therefore #W-2 was selected as the second site for lease.

a. Wyoming Sites No. W-1, W-2, and W-3

Size and Location:

Site No. W-3, Sweetwater County

T. 14 N., R. 99 W., 6th P.M.
Sec. 3: Lots 3, 4, S½NW¼,SW¼
Sec. 4: All
Sec. 5: All
Sec. 6: All
Sec. 7: All
Sec. 8: All
Sec. 9: All
Sec. 10: W½, SW¼SE¼
Sec. 15: All

Total -- 5,141.70 acres

Lane Status:

Site #W-3: All public domain except NW¼SE¼Sec. 9, which is patented (1093975) without mineral reservation.

Mining Claim Conflicts:

Site #W-3: All of Secs. 3, 10, and 15 are covered by one or more post-1920 claims; there are no pre-1920 claims on the site.

Elevation: The elevation of the ridge line at the crest of Kinney Rim near the western edge of Site #W-3 ranges from approximately 8,000 feet to approximately 8,200 feet. The elevation of the lower eastern side of the three contiguous sites ranges from approximately 7,100 feet to approximately 7,300 feet. Elevation of the slope below the Kinney Rim at the west edge of the sites is as low as 7,200 feet.

Climate: The climate of all three sites is semiarid with 10-12 inches average annual precipitation - 55°F to 107°F temperature range. Summer daily high temperatures generally range from the low 70's to the mid 80's. The mean winter temperature is about 20°F above zero.

Access: A bladed unsurfaced road extending from State Highway 430 about 14 miles west of Site #W-3 to the Eversole Ranch about 8 miles northeast from the sites passes through the northern portion of Site #W-1. This road is considered seasonal, as drifting snow precludes use at times during winter months.

Additional access is provided by an unsurfaced county road extending south from Interstate Highway 80 approximately 36 miles through Bitter Creek to the Eversole Ranch.

An unsurfaced road extends north from Powder Wash, in Moffat County, Colo., and connects with the road between Bitter Creek and the Eversole Ranch.

Vegetative Type: Desert shrub vegetative types are typical of the sites; however, small portions of the sites are covered by mountain shrub vegetative types.

Geologic Features: The nearest assayed core hole (U.S.B.M. Washakie Basin Corehole 1, located in the SW¼ Sec. 17, T. 14 N., R. 99 W.) showed two sequences of oil shale in the Laney Shale Member, ranging between 40 and 50 feet in thickness that had an average yield of about 20 gallons per ton. In the core hole, these oil-shale zones were in the interval between 346 and 542 feet. Collectively these two sequences, totaling 90 feet, contain shales that may yield 600 million barrels of oil on each site. The corehole penetrated two units 13 and 18 feet thick of 25 gallon per ton shale--that might yield 284,000 gallons of oil on each tract.

Geologic Structure: Beds located on these sites all strike northwest. Northeast dips increase in a northeast direction across the sites from about 9 to nearly 30 degrees.

Overburden is as follows:

Stratigraphic Unit	Overburden Maximum	Overburden Average	Overburden Minimum
Top of oil-shale part of the Laney Member	2,400	600	0
Top of Cathedral Bluffs Tongue	2,900	1,100	0
Top of Wilkins Peak Member	4,900	2,200	900
Top of Tipton Shale Member	5,200	2,500	1,200
Top of Luman Tongue	5,600	2,900	1,600
Top of main body of Wasatch Formation	5,900	3,200	1,900

Hydrology: The few hydrologic data available for these sites indicate the following:

Water occurs above, below, and probably in the oil shale.

Ten wells testing the Laney Shale have yielded amounts of water ranging from 0 to 200 gpm. Groundwater is under artesian pressure in the vicinity of the oil shale.

The water from a well in the Laney about a township north of the sites contained 450 ppm dissolved solids.

Mining Potentials:

Surface: Potential for an open-cut operation does not appear favorable since the overburden on the oil-shale part of the Laney averages 600 feet and oil shale of minable thickness only averages 20 gallons of oil per ton.

Underground: Underground mining by inclined or vertical shaft appears to be a feasible mining method for this deposit. Vertical separation of the two zones indicates both can be mined without unusual problems. Since zone thicknesses are essentially the same, all mining equipment should be interchangeable. The low-grade (20 gallon per ton) oil shale may present economic barriers by underground mining. The thinner zones of 25 gallon per ton shale probably could not be economically mined at present.

In Situ: The relatively shallow depth of the deposit plus its moderate grade of 20 gal/ton shale indicate that production by some in situ method may be the best chance for economic success.

Waste Disposal: Surface area available for the limited spent shale disposal required for this proposal appear to present minimal environmental problems.

Recapitulation: While the potential for economic production from these tracts is considered sub-marginal, they might meet the objectives of the Proposed Prototype Oil-Shale Leasing Program.

Air and Water Quality Considerations:

Surface Water Quality: The nearest recorded data was taken from Vermillion Creek near the confluence with Green River, about 25 miles to the southwest. These data indicate high content of total dissolved solids (1231 to 1710 ppm), chloride (50-269 ppm), sulfate (5.3-276 ppm), and carbonate (131-392 ppm).

Air Quality: Ambient air is relatively free of contaminants. Prevailing winds are from the west-southwest. Velocities average approximately 12 miles per hour.

Standards:

Water: "Antidegradation" standard applies to tributaries immediately receiving water-borne wastes from all Wyoming sites. Vermillion Creek is specifically addressed in Wyoming's standards. Controllable discharges of "salinity" (TDS, SO_4 and Cl) must be controlled.

Air: Ambient: (SO_x, Part. Co, Photochem. O_x, Hydrocarb., NO_2 Plus H_2S, Fl, odors). Emission (Part., NO_2, H_2SO_4, H_2S, odors, visibility, fugitive dust).

Summary: Standards are the same for all Wyoming Sites.

General Impact:

Springs along the eastern edge of the site will be affected by the operations. The sites join each other making a larger or more noticeable impact than if the sites were separated. Air quality should be affected equally by all sites.

Transportation:

Roads: Existing roads are described under "F. Access." Existing roads can be improved without major relocation; however, development of the sites for shale-oil recovery would probably involve consideration of a new, more efficient road system.

Pipelines: No oil pipelines are located on or near the subject sites. A 20 inch gas pipeline that connects with other gas lines near Rock Springs is located approximately 10 miles south of the sites.

Power Sources: A major power source, the Jim Bridger plant, is under construction approximately 40 miles north of the sites. This plant is scheduled for completion September 1976, and will have three 500-megawatt units.

A second possible power source is the Hayden plant located some 90 miles southeast in Colorado.

Surface Resources:

Land Use: Present land use consists of livestock grazing, wildlife habitat, and recreation.

Vegetation and Soil:

Soil Type: The majority of the soils in the area fall within the friable, grayish-brown loams. These soils are typically brownish gray in color and generally are underlain by free lime at a depth of 5-12 inches. The depth of the weathered layer varies from 6-50 inches but is generally quite shallow.

Plant Species:

Desert-shrub type: consists of low-growing, salt-tolerant shrubs such as salt bush, shadscale, and bug sage on the lower, drier areas and big sage with mixed-grass understory on the higher-moister areas.

Mountain-shrub type: plants consist primarily of shrub juniper, sagebrush, mountain mahogany, bitter brush, and service berry with a mixed-grass understory.

Conditions:

The east-sloping portions of the sites have a fair vegetative cover and little or no accelerated erosion occurs. Because of the thin soil mantle and frequency of high intensity summer storms, any reduction of vegetative cover will result in accelerated erosion and serious loss of top soil.

The west slopes have a sparse vegetative cover and are in a severe erosion classification. The steeper slopes have no topsoil and very sparse vegetation; consequently, most precipitation runs off carrying soil particles to the lower, flatter slopes. Any disturbance will increase the rate of erosion.

Susceptibility to Revegetation: Revegetation of waste piles and disturbed areas will be difficult because of the limited top soil and limited amount of precipitation.

Watershed:

The sites drain into Alkali Creek west of Kinney Rim and Shell Creek east of Kinney Rim. Both creeks are ephemeral streams tributary to Vermillion Creek. The average annual yield from Shell Creek is estimated at 4,260 acre feet. There is no yield data available for Alkali Creek.

The Shell Creek watershed is in fairly good condition. Erosion classification is "slight" or "stable" for 72,067 acres out of 91,830 total acres. The condition of Alkali Creek watershed is also considered fairly good; however, classification figures are not available.

Wildlife:

Species Using Site: A variety of wildlife species are supported by the desert-shrub and mountain-shrub vegetative types found on these sites. Species using the sites include antelope, mule deer, sage grouse, cottontail rabbit, coyote, bobcat, dove, eagle, and various raptors and song birds. The area of potential impact is habitat for elk, blue grouse, ruffled grouse, chukar partridge, mountain lion and water fowl as well as the aforementioned species.

Wild horses use the area throughout the year. Actual use of the sites is thought to be quite limited although small bands of horses have been noted in the site area by the Wyoming Game and Fish Commission while conducting aerial wildlife surveys.

Critical Habitat: The sites are situated in a winter-range area for antelope, mule deer, and sage grouse. Wild horses make use of the general area during the winter months.

Disruptive Influences: Existing oil and gas leases blanket entire tract. Activities associated with exploration for oil, gas, and mineral resources constitute major non-agricultural or nonrecreational land-use impact.

Summary Remarks: Utilization of the tracts for test least operations will result in a penetration by industry into a wildlife range area that is remote from existing population centers. It will result in the localized loss of wildlife habitat, as well as a disruption of game movements.

Archeology:

Structures and/or related forms of antiquity are unknown on the subject sites. However, Indian cultures are known to exist from the unearthing of fire-pot areas near the sites. Folsom and Yuma cultures have been unearthed in the area.

Fossils are abundant in the general area. Turritella agate is found in quantity on the Laney Rim on the north side of Washakie Basin. Fossil mammal remains are found in formations overlying, underlying, and intertonguing with the Green River Formation, but none are reported from the site.

Recreation and Aesthetics:

Present Use: Present recreational use of the sites includes hunting, rock collecting and sightseeing. The amount of recreational use of the sites is not known.

Livestock Grazing:

Sheep graze the area during late fall, winter, and early spring. Cattle and domestic horses also graze the area during summer and fall. Grazing capacity of the three sites is estimated at approximately 1,900 AUM's.

One livestock operator is presently licensed to graze in this area.

Scarcity of water for proper livestock distribution is the major grazing problem in the area. Potential for improving grazing conditions is considered very limited except through water development.

Improvements:

One reservoir and several springs are located on the sites. These are critical livestock water sources.