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FINAL
Mobil-Pacific Oil Shale Environmental Impact Statement

Volume I - Text

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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Prepared by:

Bureau of Land Management
U.S. Department of the Interior

with the assistance of:

Dames & Moore

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Prepared by:

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Kannon Richards

State Director
Colorado State Office

IN REPLY REFER TO:

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
GRAND JUNCTION DISTRICT
764 HORIZON DRIVE
GRAND JUNCTION, COLORADO 81501

NOTICE

This is the Final Environmental Impact Statement (FEIS) for two separate private oil shale developments in Garfield County and Mesa County, Colorado. The projects are the Parachute Shale Oil (Mobil) Project and the Pacific Shale (Pacific) Project.

The FEIS is a complete reprint of the Draft EIS with appropriate changes in the text due to public and other government agency review comments. The FEIS also incorporates, in Appendix A and B, copies of the Draft EIS review comments and BLM's response to those comments.

The FEIS is part of the decision-making process, but does not in itself represent or reflect a decision on the proposed action. A BLM Record Of Decision (ROD) outlining the decision and rationale will be prepared after a 30-day public review period on the FEIS has expired. The filing of the FEIS with the Environmental Protection Agency will initiate the 30-day review period.

Comments on this FEIS will be accepted for 30-days at the following address:

Mobil-Pacific EIS Team Leader
BLM, 764 Horizon Drive
Grand Junction, CO 81501

Wright Sheldon
District Manager

MOBIL-PACIFIC OIL SHALE

ENVIRONMENTAL IMPACT STATEMENT

( ) DRAFT FINAL (X)

Lead Agency

U.S. Department of the Interior, Bureau of Land Management

Cooperating Agencies

U.S. National Park Service
U.S. Army Corps of Engineers
U.S. Forest Service
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
U.S. Department of Energy

Abstract

This EIS assesses the environmental impacts of two oil shale projects proposed for west-central Colorado, the Parachute Shale Oil Project (Mobil Project) and the Pacific Shale Project (Pacific Project). Both projects will involve underground mining, surface shale oil retorting, surface disposal of retorted shale, shale oil upgrading facilities, product pipeline connections to proposed distribution systems, utilities, access roads, and water supply systems. Alternatives to the Proposed Actions consist of variations of basic components and No Action. This EIS focuses on issues and concerns identified during the scoping process; scoping emphasized socioeconomics and water resource issues.

EIS Contact

Comments on this EIS should be directed to:

Robert Kline
Bureau of Land Management
764 Horizon Drive
Grand Junction, CO 81501

Date Statement Made Available for U.S. Environmental Protection Agency and the Public:

Draft Statement: March 8, 1984

Final Statement: November 30, 1984

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1 Purpose and Need

This Environmental Impact Statement (EIS) has been prepared by the U.S. Department of Interior Bureau of Land Management (BLM) for two separate private oil shale developments at the southern edge of the Piceance Basin in Garfield County, Colorado. The two projects are Mobil Oil Corporation's proposed Parachute Shale Oil Project and the Pacific Shale Project proposed by a joint venture of Sohio Shale Oil Company, Superior Oil Company, and Cliffs Oil Shale Corporation (see Figure 1.0-1 for general locations).

Mobil Oil Corporation ("Mobil") proposes to develop a 100,000-barrel-per-calendar-day shale oil project north of the town of Parachute. It would involve underground mining, onsite surface retorting and upgrading, surface disposal of processed shale, and delivery of shale oil to a regional pipeline system.

Pacific Shale Project ("Pacific") proposes to develop a 100,000-barrel-per-stream-day shale oil project on a site about 10 miles northwest of the town of DeBeque. The project would involve underground mining, onsite surface retorting, upgrading, surface disposal of retorted shale onsite, and transfer of shale oil to a regional multiproject product pipeline system.

This EIS has been prepared pursuant to requests from Mobil and from Pacific for rights-of-way, sales, or leases of public land.

1.1 BACKGROUND

The purpose of both of the proposed projects is to produce shale oil in an environmentally and economically acceptable manner. Domestic crude oil production has been less than U.S. consumption in recent years. This trend may continue through the end of the century. As a result, the United States has become heavily dependent on foreign oil imports.

Since the oil embargo in 1973, the United States has established, as a national priority, the development of domestic energy resources to eliminate dependence on unstable foreign supplies. Responding to the challenge, the United States has: (1) decontrolled oil prices, thus stimulating substantial increases in domestic exploration; (2) decreased energy consumption during the 1980s; and (3) enacted the Energy Security Act in 1981, which established the Synthetic Fuels Corporation. These positive advances are not expected to eliminate the shortfall between domestic demand and domestic production; therefore, it appears that the United States must either continue to rely on foreign sources for oil or develop alternate energy sources.

The events that led to preparation of this EIS for both projects are summarized below.

On November 11, 1981, Mobil applied for rights-of-way to public lands in proximity to its Main Elk Water Project near New Castle in Garfield County, Colorado. The application requested rights-of-way for relocation of County Road

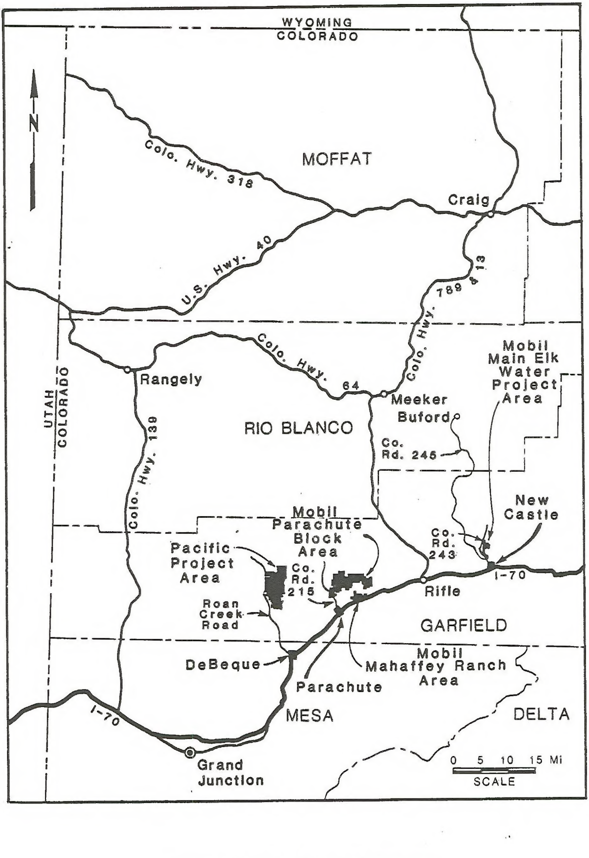


Figure 1.0-1. Map of region

243; for lands that would be inundated by the proposed Main Elk Reservoir; and for the western abutment site of the proposed dam; this request was supplemented by Mobil on January 6, 1983 because of additional land needed for a dam access road. On April 21, 1982, Mobil also requested the purchase or exchange of lands abutting their properties in Wheeler Gulch that would be involved in processed shale disposal plans for the Parachute Shale Oil Project. The two requests are related in that water from the Main Elk Water Project is proposed as a possible source of water for the Parachute Shale Oil Project. The BLM's decisions regarding the land requests will constitute major Federal actions. The National Environmental Policy Act (NEPA) requires preparation of an EIS prior to any major Federal action.

In order to comply with NEPA in an effective manner, the BLM proposed to combine the Mobil EIS with the NEPA review for other shale oil projects amenable to site-specific review and needing BLM land authorization. On Wednesday, July 7, 1982, a notice was published in the Federal Register, which requested parties interested in participating in a multiproject EIS to contact the Grand Junction District Office of the BLM. Those companies interested in participating were requested to submit a letter of intent and a project description with a status report.

On September 9, 1982, the BLM Grand Junction District Office received a letter from The Standard Oil Company (SOHIO) that confirmed the intent of Pacific to proceed with a shale oil project that would involve a right-of-way across, and the purchase of public lands administered by the BLM. The letter indicated Pacific's commitment to becoming a party to the joint EIS. Having received no other letters of intent, the BLM initiated the EIS process on these two separate, private oil shale developments, referred to hereafter as the Mobil Project and the Pacific Project.

On March 8, 1984 it was announced in the Federal Register that the Draft Mobil-Pacific Oil Shale EIS (DEIS) was available for public review and comment. The notice also stated that four public hearings would be conducted to solicit comments. The hearings were slated and held April 16, 17, 18, and 19, 1984 at New Castle, Parachute, DeBeque, and Grand Junction, respectively.

After evaluation of the public comments, this Final Environmental Impact Statement was prepared. Appendix A includes all comments on the DEIS; responses to comments are contained in Appendix B. For a further explanation of the EIS process, refer to Section 1.3.

1.2 MAJOR FEDERAL ACTIONS AND OTHER REQUIRED AUTHORIZATIONS

This is the NEPA compliance document for the following Federal actions requested for the Mobil and Pacific projects.

1.2.1 Mobil Project

1.2.1.1 U.S. Bureau of Land Management

- Mobil has requested rights-of-way across public domain in Township 5 South, Range 91 West administered by the BLM for development of a water reservoir on Main Elk Creek north of the town of New Castle, Garfield County, Colorado. Lands specified in the rights-of-way application are shown in Figure 1.2-1 and listed in Table 1.2-1. They include 520 acres contiguous to Mobil's Main Elk Corporation property. Portions would be used for relocation of County Road 243, for protection of the high water mark of the reservoir, and for a part of the dam access road.

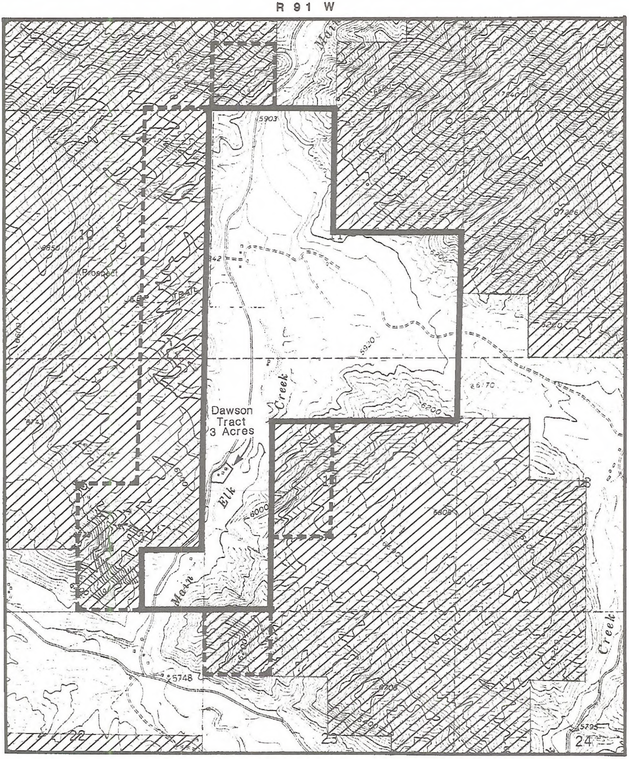
- Mobil has requested purchase, exchange, or lease of approximately 112 acres of public lands abutting Mobil's Wheeler Gulch property northwest of the town of Parachute, Garfield County, Colorado. Portions of the lands are proposed to be used for disposal of processed shale. The lands specified in the request for purchase or lease (Figure 1.2-2) are in Township 6 South, Range 96 West and are defined in Table 1.2-1.

- Mobil will request a right-of-way for a transmission line in Hayes Gulch in Township 6 South, Range 96 West, Sections 24 and 25. Approximately 18 acres of right-of-way are anticipated (see Figure 1.2-2).

1.2.1.2 U.S. Department of Energy

- Mobil will request rights-of-way for an access road, contractor's road, utility corridor, a funicular railway, and power transmission line across the Naval Oil Shale Reserve (NOSR-3) administered by the U.S. Department of Energy (DOE) south of Mobil's property (see Figures 3.1-3, 3.1-13, 3.1-15, and 3.1-17).

The Naval Oil Shale Reserves (NOSRs) 1 and 3 occupy 55,000 acres in Garfield County, Colorado. All of the lands on NOSR-1 and -3 are owned by the Federal government. NOSR-3 does not contain oil shale reserves and would be used primarily for access to NOSR-1 and disposal of waste and processed shales. NOSR-1, southeast of Federal tract C-b and adjacent (east) to Colony, contains about 43,000 acres (17,400 ha) and has considerable comparatively shallow reserves that outcrop in some areas.



BLM Land — BLM Land requested by Mobil — Mobil Property

Figure 1.2-1. Location of proposed land action, Main Elk Reservoir site

Table 1.2-1. Public land for which Mobil has requested rights-of-way or acquisition from BLM

Township 5 South, Range 91 West, 6th P.M. (rights-of-way requested)		
Section 2:	SW¼SW¼	40 acres
Section 10:	E½E½	160 acres
Section 14:	SE¼NW¼, NE¼SW¼	80 acres
Section 15:	E½NE¼, N½SE¼, SW¼SE¼	200 acres
Section 23:	NW¼NW¼	40 acres
Total		520 acres
Proposed use:	Main Elk Reservoir, Relocation of County Road, Dam Access Road.	
Relevant EIS sections:	3.1.1.1, 3.1.1.5, 3.1.2.6, 3.2, 3.3, and 3.4.3.3.	
Township 6 South, Range 96 West, 6th P.M. (purchase, exchange, or lease requested)		
Section 26:	NE¼NW¼, Lot 26	72.24 acres
Section 27:	Lot 15	39.53 acres
Total		111.77 acres
Proposed use:	Processed shale disposal.	
Relevant EIS sections:	3.1.1.1, 3.1.1.5, 3.1.2.5, 3.2, 3.3, and 3.4.3.8.	
Township 6 South, Range 96 West, 6th P.M. (right-of-way will be requested)		
Section 24 and Section 25		18 acres
Total		18 acres
Proposed use:	1.5-mile powerline corridor.	
Relevant EIS sections:	3.1.1.1, 3.1.1.5, 3.1.2.7, 3.2, 3.3, and 3.4.3.16.	

Mobil plans to cross NOSR-3 properties to gain access for personnel and major utilities to its Parachute Block from the Colorado River Valley. The proposed and alternative routes for access are described in Section 3.1 of this EIS. Table 1.2-2 indicates approximate minimum acreages required on NOSR-3. Some increases in corridor width and acreages could be required because of topographical conditions when the final routes are surveyed.

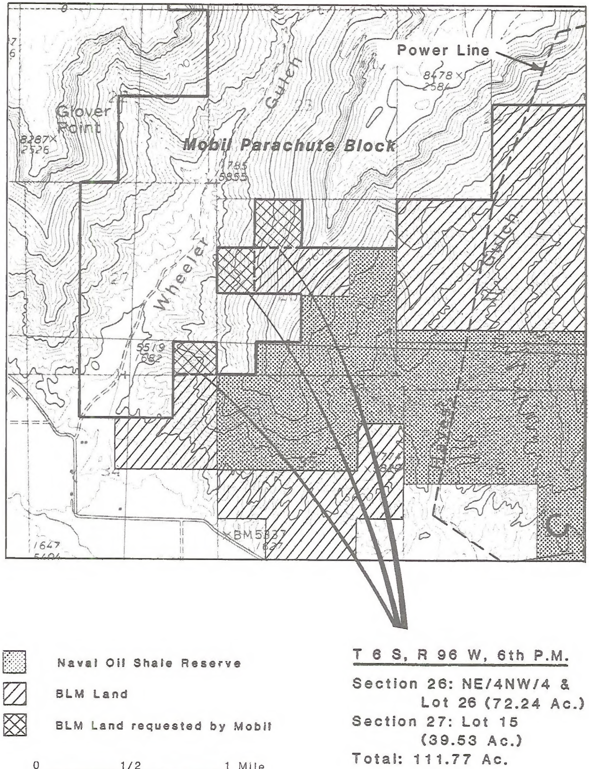


Figure 1.2-2. Location of proposed land action, Wheeler Gulch and Hayes Gulch areas

Table 1.2-2. Minimum disturbance and location on Naval Oil Shale Reserve (NOSR) because of construction of Mobil's proposed action

Proposed action	Disturbance on NOSR-3 (acres)	Location of disturbance
Powerline	13[a]	Sec. 36 T6S, R96W
Access road	110[b]	Sec. 28, 29, 20, 21, 17, 16, 19, 30 T6S, R95W
Contractor's road	28[c]	Sec. 20, 21, 29, 30 T6S, R95W
Utility corridor	51[d]	Sec. 33, 28, 29, 20 T6S, R95W
Funicular railway	8[e]	Sec. 21, 20 T6S, R95W
Relevant EIS sections: 3.1.1.1, 3.1.1.5, 3.1.1.6, 3.1.2.7, 3.2, 3.3, 3.4.3.13, 3.4.3.14, 3.4.3.16, 3.4.3.20, and 3.4.3.21.		

[a]Assumes 22 transmission towers with disturbed area of 0.6 acre per tower.
[b]Assumes disturbed area 5.2 mi long x 175 ft wide.
[c]Assumes disturbed area 1.3 mi long x 175 ft wide.
[d]Assumes disturbed area 2.4 mi long x 175 ft wide.
[e]Assumes disturbed area 3300 ft long x 100 ft wide.

1.2.1.3 U.S. Army Corps of Engineers

- Mobil applied for U.S. Army Corps of Engineers (COE) 404 Permit on November 9, 1983. This would be required for Mobil's proposed Main Elk Reservoir and water intake structure on the Colorado River.

1.2.1.4 Garfield County District Court

There are approximately 3 acres of privately owned land within the proposed reservoir area. This acreage encompasses the 35-year historical residence and home of Earl and Donna Dawson. Mobil has initiated a condemnation action in the District Court, County of Garfield (Case No. 81CV265, Mobil Oil Corporation vs. E.E. Dawson, et al.) to obtain title to the referenced property. If the suit is successful, compensation will be paid to the Dawsons.

If the suit is unsuccessful, then Mobil will not be able to build the reservoir and alternate sites or water storage methods may need to be analyzed in other NEPA documents.

1.2.2 Pacific Project

1.2.2.1 U.S. Bureau of Land Management

- Pacific has requested purchase of eight parcels of public domain in Garfield County, Colorado totaling 1853.44 acres. The descriptions and proposed uses of these parcels are indicated in Table 1.2-3. They are shown on Figure 1.2-3.

1.2.2.2 U.S. Army Corps of Engineers

- A U.S. Army Corps of Engineers 404 Permit would be required for Pacific's water intake structure on the Colorado River. A 404 Permit may also be required for Pacific to mine gravel in the 100-year floodplain of the Colorado River.

1.2.3 Additional requirements

Numerous other Federal, state, and local permits and approvals would be required for construction and operation of each of the two projects. Table 1.2-4 lists permits, approvals, and certifications that would generally be applicable to these two projects. No permitting schedules have been developed at this time. Permit stipulations would be defined when applications are approved. The Companies and BLM are in formal consultation with the U.S. Fish & Wildlife Service (USF&WS) regarding impacts on endangered species. The USF&WS Biological Opinions will be issued before publication of the Record of Decision (see Section 1.3).

Table 1.2-3. Public land that Pacific has requested to purchase

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The following lands are all located in Garfield County, Colorado (see Figure 1.2-3).

Parcel A

Township 6 South, Range 98 West, 6th P.M.
Section 11: Lot 1 — 40.00 acres

Use: Raw Shale Preparation and Retorting Area; approximately 20 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.3, 4.2, 4.3, and 4.4.3.1.

Parcel B

Township 6 South, Range 98 West, 6th P.M.

Section 23:	$SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}NW\frac{1}{4}$	2.50 acres
	$W\frac{1}{2}W\frac{1}{2}NE\frac{1}{4}SW\frac{1}{4}$	10.00 acres
	$W\frac{1}{2}NW\frac{1}{4}SE\frac{1}{4}SW\frac{1}{4}$	5.00 acres
	$NW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$	2.50 acres
	$NE\frac{1}{4}SE\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$	2.50 acres
	Total	22.50 acres

Use: Mining and Oil Upgrading Area; approximately 20 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.2, 4.1.1.4, 4.2, 4.3, and 4.4.3.1.

Parcel C

Township 6 South, Range 98 West, 6th P.M.
Section 15: Lot 7, Part of Tract 95 — 10.04 acres

Use: Electrical Substation Area; approximately 5 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

Table 1.2-3 (continued)

Parcel D

Township 6 South, Range 98 West, 6th P.M.

Sections 15 and 22:	Tract 77K	40.60 acres
	Tract 77T	40.60 acres
	Tract 77V	40.52 acres
	Tract 77U	40.56 acres
	Total	162.28 acres

Use: Plant Entrance, Administration Building, and Plant Corridor Area; approximately 60 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

Parcel E

Township 6 South, Range 98 West, 6th P.M.

Sections 22 and 27:	Tract 97A	40.70 acres
	Tract 97B	40.70 acres
	Tract 97C	40.69 acres
	Total	122.09 acres

Use: Construction Laydown Area; approximately 120 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

Parcel F

Township 6 South, Range 98 West, 6th P.M.
Sections 27 and 34: Tract 117B — 60.00 acres

Use: Terminal Reservoir and Plant Corridor Area; approximately 40 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

Parcel G

Township 6 South, Range 98 West, 6th P.M.
Sections 27 and 34: Lots 10 and 11 — 40.34 acres

Use: Project Visitors Center Area; approximately 40 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

Table 1.2-3 (continued)

Parcel H		
Township 6 South, Range 98 West, 6th P.M.		
Section 34:	Lot 7	35.47 acres
Township 7 South, Range 98 West, 6th P.M.		
Section 2:	Lot 4	40.28 acres
	SW¼NW¼	40.00 acres
	SW¼	160.00 acres
	SW¼SE¼	40.00 acres
Section 3:	Lot 1	40.22 acres
	Lot 2	40.15 acres
	Lot 3	40.07 acres
	Lot 4	40.00 acres
	S½NE¼	80.00 acres
	SE¼NW¼	40.00 acres
	NE¼SW¼	40.00 acres
	SE¼	160.00 acres
Section 10:	E½NE¼	80.00 acres
Section 11:	NE¼NE¼	40.00 acres
	W½NE¼	80.00 acres
	NW¼	160.00 acres
	N½SW¼	80.00 acres
	SE¼SW¼	40.00 acres
	W½SE¼	80.00 acres
	SE¼SE¼	40.00 acres
	Total	1396.19 acres

Use: Parking Area, Construction Camp Area, and Plant Corridor Area; approximately 235 acres to be disturbed.

Relevant EIS sections: 4.1.1.1, 4.1.1.5, 4.2, 4.3, and 4.4.3.1.

TOTAL ACRES REQUESTED OF PUBLIC LAND	1853.44 acres
Approximate total of above to be disturbed	540 acres

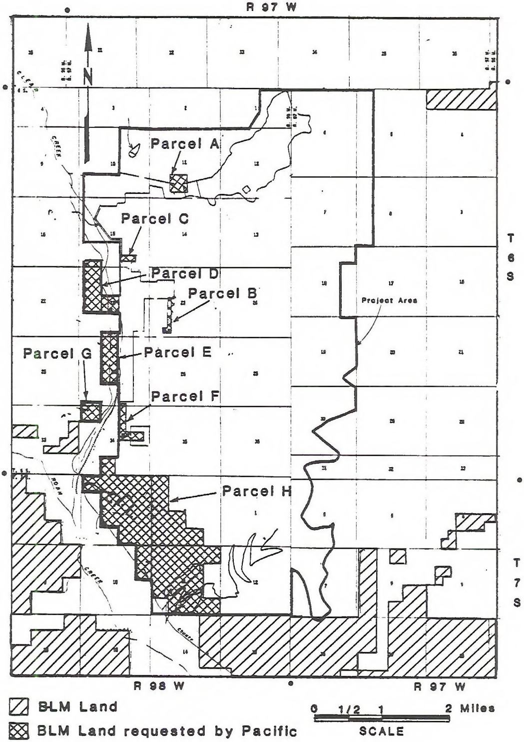


Figure 1.2-3. Location of proposed land actions for Pacific Project

Table 1.2-4. Permits, approvals, and certifications generally applicable to oil shale development projects

Issuing agency	Permit or approval
FEDERAL AGENCIES	
Environmental Protection Agency	Prevention of Significant Deterioration (PSD) and Certification of Best Available Control Technology
Environmental Protection Agency	Compliance with the New Source Performance Standards (NSPS)
Environmental Protection Agency	Hazardous Waste Treatment, Storage and Disposal Facility Permit/Notification of Hazardous Waste Activities
Environmental Protection Agency	TSCA Premanufacture Notification
Environmental Protection Agency	Spill Prevention Control and Counter-measures (SPCC)
Army Corps of Engineers	Permit for Discharge of Dredged or Fill Material (404 Permit)
Department of Interior	
Bureau of Land Management	Rights-of-Way and Temporary Use Permits
Bureau of Land Management	Oil and Natural Gas Pipelines Rights-of-Way
Bureau of Land Management	Permit for Firewood
U.S. Fish & Wildlife Service	Migratory Bird Permit
U.S. Fish & Wildlife Service	Permit to Move Eagle Nest
U.S. Fish & Wildlife Service	Consultation, Endangered or Threatened Species
U.S. Fish & Wildlife Service	Consultation and Coordination, Fish and Wildlife
Other DOI	Federal Antiquities Act Permit
Other DOI	Emergency Procedures for Consideration of Archaeological Sites
Department of Energy	Rights-of-Way

Table 1.2-4 (continued)

Issuing agency	Permit or approval
FEDERAL AGENCIES (continued)	
Economic Regulatory Administration	Temporary Exemption from Fuel Use Act Prohibitions
Federal Aviation Administration	Notice of Proposed Construction or Alteration of Objects Affecting Navigable Airspace
Federal Aviation Administration	Notice of Location of a Heliport
Federal Communications	Radio Licenses (Industrial Radio Services and Microwave Communications System)
Department of Treasury	
Bureau of Alcohol, Tobacco and Firearms	Manufacturer's License and User's Permit
Mine Safety and Health Administration	Notification of Commencement
Mine Safety and Health Administration	Legal Identity Report
Mine Safety and Health Administration	Approval of Safety Education Plan/ Instructor Approval
Responsible Federal Agency	Environmental Impact Statement
U.S. Forest Service	Rights-of-Way
STATE AGENCIES	
Colorado State Historical Society	National Historic Preservation Act Compliance; Cultural Resource Clearance
Department of Health	
Air Pollution Control Division	Air Pollutant Emission Permit
Air Pollution Control Division	New Source Performance Review Notification
Air Pollution Control Division	Open Burning Permit

Table 1.2-4 (continued)

Issuing agency	Permit or approval
STATE AGENCIES (continued)	
Water Quality Control Division	National Pollutant Discharge Elimination System (NPDES Permit)
Water Quality Control Division	Site Approval for Sewage Treatment Facility
Water Quality Control Division	Construction Approval for Sewage Treatment Facility
Water Quality Control Division	Approval of Location and Construction of Water Works
Water Quality Control Division	License for Water and Wastewater Treatment Plant Operators
Water Quality Control Division	Subsurface Disposal System Permit
Water Quality Control Division	Certification of Dredge and Fill Permits (Water Quality Certification)
Radiation and Hazardous Waste Division	Certification of Solid Waste Disposal Site
Division of Medical Care	Certificate of Public Necessity for Health Care Facility
Department of Highways	Access Control Permit (Driveway Permit)
Department of Highways	Underground and Utility Permit
Department of Labor and Employment	
Division of Labor	Certificate for Boilers
Division of Labor	Permit for Explosive Materials
Department of Natural Resources	
Division of Mines	Operator's Notice of Activity
Division of Mines	Underground Diesel Permit
Division of Mines	Permit to Store and Use Explosives
Division of Mines	Permit for Underground Storage of Flammable Liquids

Table 1.2-4 (continued)

Issuing agency	Permit or approval
STATE AGENCIES (continued)	
Division of Water Resources - District 5 Water Court	Application for Water Right (Underground or Well)
Division of Water Resources - District 5 Water Court	Application to Make Absolute a Conditional Water Storage Right
Division of Water Resources - District 5 Water Court	Application to Make Absolute a Conditional Water Right
Division of Water Resources - District 5 Water Court	Water Augmentation Plan Approval
Division of Water Resources - State Engineer	Approval of Plans and Specifications for the Construction, Enlargement, or Repair of Dams
Division of Water Resources - State Engineer	Approval to Construct an Erosion Control Dam
Division of Water Resources - State Engineer	Permit to Construct or Relocate a Non-exempt Well (>15 GPM) Outside Designated Basins
Division of Water Resources -	Permit to Construct or Relocate an Exempt Well (<15 GPM) Outside Designated Basins
Division of Mined Land Reclamation	Notice of Intent to Conduct Prospecting Operations
Division of Mined Land Reclamation	Permit for Regular Mining Operation
State Board of Land Commissioners	Rights-of-Way
Division of Wildlife (Wildlife Commission)	Coordination with Other Agencies
Department of Regulatory Agencies	
Public Utilities Commission	Certificate of Public Convenience and Necessity

Table 1.2-4 (continued)

Issuing agency	Permit or approval
LOCAL AGENCIES	
Garfield County Planning Commission	Special Use Permit
Garfield County Permits	Conditional Use Permit
Garfield County Permits	Sewage Disposal System
Garfield County Permits	Solid Waste Disposal
Garfield County Permits	Installation of Utilities in Public Rights-of-Way
Garfield County Permits	Driveway Permit Across County Roads
Garfield County Permits	Building Permit
Garfield County Permits	Permit to Conduct a Designated Activity of State Interest
Garfield County Permits	Impact Analysis - Planning Commission
Garfield County Permits	Area Wide Management Program Approval

1.3 THE EIS PROCESS

This document has been prepared pursuant to NEPA [Public Law 91-90, Section 102 (2)(c)] which requires that an EIS be prepared before a Federal agency takes any major action "significantly affecting the quality of the human environment." Accordingly, it is the NEPA compliance document for the BLM, DOE, and COE Federal actions sought by the Mobil Project and by the Pacific Project. The process followed in preparation of this EIS has been in accordance with the procedural and technical adequacy requirements of the Council on Environmental Quality (CEQ) regulations for implementation of NEPA (40 CFR, Part 1500). It has involved considerable interaction among Federal, state, and local agencies, the public, and proponents of the two projects.

This Final Environmental Impact Statement (FEIS) is the second step in the NEPA compliance process for the Federal actions requested for the Mobil and Pacific projects (see Section 1.2 above). The first step was the publication and review of a Draft EIS (March 8 to May 4, 1984). Following the Final EIS, a Record of Decision (ROD) will be issued by the BLM which outlines the decisions made in the EIS process.

After the EIS process is complete, the Companies may pursue applications for rights-of-way (ROW). An additional Environmental Analysis (EA) will be written prior to the issuance of each ROW. The BLM and the Department of Energy (DOE) will issue the EAs for their respective land management areas.

As written, this EIS analyzes access corridors that the BLM, DOE, and the Companies have determined will meet their project requirements. Before issuance of a ROW, the BLM and DOE will require the Companies to define the ROW within the corridor. Agency personnel will then perform an on-the-ground inspection of the route for site-specific information concerning potential impact to cultural sites, threatened or endangered plant and animal species, and other environmental concerns.

Following the inspection, an EA will be written which references the analysis in the EIS and then proceeds to analyze the site-specific impacts as discovered during the on-the-ground inspection. At that time, stipulations can be made to the ROW which will mitigate adverse environmental impacts.

1.3.1 Interactions, responsibilities, and scoping

The Grand Junction District Office of the BLM has the responsibility for issuance of rights-of-way and land sales, exchanges, or leases being sought by the Mobil and Pacific projects. Other Federal, state, and local agencies with jurisdictions and expertise involved in preparation of this EIS are listed in Table 1.3-1.

Preparation of this EIS was by the third-party contract process defined in the BLM Washington Office Instruction Memorandum 80-5 (dated October 2, 1979). The BLM, Mobil, and Pacific entered into a Memorandum of Understanding that delineated the responsibilities of each organization. The BLM was responsible for the structure, procedural adequacy, and timely completion of the EIS. A team of consultants directed by the firm of Dames & Moore was selected by the BLM to

Table 1.3-1. Agencies with jurisdiction and expertise related to this EIS

Agency	Jurisdiction	Expertise
	Federal	
U.S. Geological Survey		Geology, Hydrology
U.S. Fish and Wildlife Service[a]	Refuge Areas, Wildlife Coordination Act and Section 7 of the Endangered Species Act Consultation	Fish and Wildlife, T & E Species
U.S. National Park Service[a]	National Parks and Monuments, Visibility	Land Uses
U.S. Forest Service[a]	National Forest Lands, Visibility	Forest Management, Land Uses
U.S. Soil Conservation Service	Affects to Prime and Unique Agricultural Lands	Soil Management
U.S. Army Corps of Engineers[a]	Section 404 Permits	Hydrology
U.S. Environmental Protection Agency[a]		Air, Water Quality, Noise, Hazardous Waste
U.S. Department of Transportation		Pipeline Construction - Operation
U.S. Department of Energy[a]	Access, Rights-of-way	Oil Shale Reserves
U.S. Department of Interior Bureau of Land Management[b]	Rights-of-way; Land Sales, Exchanges, Leases	Public Land Administration, Land Use
	State of Colorado	
Department of Local Affairs Division of Planning	State Clearing House	Land Uses
State Historic Preservation Office	Historic & Archaeological Sites, Sec. 106 Compliance	Cultural Resources
State Forest Service	State Forests	Forestry
Department of Parks	State Parks	Parks and Recreation
State Archaeologist		Archaeology
State Engineer	Water Appropriation	Water Accounting

[a]Denotes Official Cooperating Agencies.
[b]EIS Lead Agency.

Table 1.3-1 (continued)

Agency	Jurisdiction	Expertise
	State of Colorado	
Department of Natural Resources		
Division of Wildlife	State Management Areas, Wildlife	Fish and Wildlife
Division of Parks and Outdoor Recreation	Recreation	Recreation
Mined Land Reclamation Division	Surface Disturbance	Vegetation, Soils, Hydrology
Colorado Joint Review Process	State Cooperative Efforts	Cooperative Arrangements
Department of Health		
Air Pollution Control Division	Air Quality	Air, Water Quality, Noise, Waste Management
Water Quality Control Division	Water Quality	
Waste Management Division		
	Local Government	
Mesa County Commissioners Garfield County Commissioners	Land use in unincorporated areas	

write the EIS; Mobil and Pacific entered into a third-party contract with Dames & Moore for its preparation. The BLM then initiated the public and agency scoping meetings for the EIS.

The scoping process included the following activities:

- Notification of Intent to prepare an EIS (news releases, Federal Register notice, oil shale event calendar, and other media notices).
- Information Meetings.
- Public and Agency Scoping Meetings.
- Written Comments and Scoping Summary Document Release.

The following is a summary of these scoping process activities.

1.3.2 Notification

News releases

The BLM issued news releases to inform the public and industry that an oil shale EIS was being prepared, and that it would consider the land action requests of two distinct oil shale developments within the context of a single EIS.

Notice of intent

A Notice of Intent to prepare an EIS and a schedule for scoping meetings was published in the Federal Register on Thursday, February 10, 1983 (Vol. 48, No. 29, pp. 6183-6184).

Oil shale event calendar

A "Preview of Coming Oil Shale Events" schedule was distributed, on February 20, to approximately 37,000 readers of the Grand Junction Daily Sentinel newspaper as a supplement to the Sunday edition. An additional 3000 schedules were handed out or mailed to individuals, news media, and to local, state, and Federal agencies. The schedule listed the dates of the Mobil and Pacific information and scoping meetings and gave a brief description of the proposed projects.

Other notices

News releases were distributed by the BLM and BLM personnel were guests on radio talk shows which discussed local events relative to both the Mobil Project and the Pacific Project.

In support of their public information meetings, Mobil announced the times and dates through local T.V., radio, and newspapers.

The Colorado Joint Review Process (CJRP) mailed informational notices in support of the Pacific Project's public information meetings.

1.3.3 Information meetings

Mobil conducted five information meetings for the benefit of the public. The meetings were held in Glenwood Springs (January 25, 1983), Denver (February 22, 1983), New Castle (February 23, 1983), Parachute (February 24, 1983), and Grand Junction (February 25, 1983).

Pacific, through the CJRP, held public information meetings in Denver (February 22, 1983), DeBeque (March 1, 1983), Grand Junction (March 2, 1983), and Rifle (March 3, 1983), and an interagency meeting in Denver (February 22, 1983).

1.3.4 Public and agency scoping meetings

Public scoping meetings were held in Rifle (March 21, 1983), DeBeque (March 22, 1983), Grand Junction (March 23, 1983), and Denver (March 24, 1983). They were conducted by the BLM with assistance from Mobil and Pacific. The Nominal Group Technique was employed by the BLM. The technique was used to provide a structure for identifying the public's concerns and to obtain a delineation or ranking among the issues.

A meeting was held in Denver, Colorado to give local, state, and Federal agencies an opportunity to express concerns and list issues that needed to be addressed in the EIS. Pursuant to this meeting, six Federal Cooperating Agencies were identified for this EIS (see Table 1.3-1 above).

1.3.5 Written comments and scoping summary document

All issues raised at the public and agency scoping meetings and written comments submitted to the BLM were grouped into 18 categories on the basis of similar topics of concern. The results of each scoping meeting are summarized in Table 1.3-2. For the purpose of comparing and ranking issues, the BLM assigned point values to each rating: high = 3; medium = 2; and low = 1. Thus, for example, if all participants at a five-person table rated a particular issue as "high" it received 15 points. Points were then totaled to rank issues. In Table 1.3-3, the relative importance of each issue is ranked in accordance with the total point scores listed in Table 1.3-2. In every instance, the socioeconomic and water resource issues ranked first and second, respectively.

A Scoping Summary Document was prepared and is available to the public through the BLM.

Table 1.3-2. Scoping meeting summary

	Rifle	DeBeque	Grand Junction	Denver	Overall
Date of scoping meeting	3/21/83	3/22/83	3/23/83	3/24/83	
Number of registered participants	12	14	15	2	43
Number of issues identified	73	81	86	2	242
Issues (prioritized)	Point scores				
1. Socioeconomics	257	267	225		749
2. Water resources	143	140	193		476
3. Land use and regulatory affairs	121	79	36		236
4. Project plans, schedules, and technology	72	96	58		226
5. Transportation	80	62	74		216
6. Biology	64	79	45		188
7. Air quality	84	34	29		147
8. Waste management	33	26	72		131
9. Energy	72	9	35		116
10. Cumulative impacts	34	15	58		107
11. Health and safety	44	11	33		88
12. Recreation	33	35	9		77
13. Geotechnical and mining	32	14	24		70
14. Reclamation and soils	17	6	44		67
15. Utility/pipeline corridors	0	18	33		51
16. Cultural resources	30	0	19		49
17. Noise	16	6	9		31
18. Visual resources	15	0	10		25

Table 1.3-3. Comparison of scoping meeting results

Rank	Rifle	DeBeque	Grand Junction	Overall
1	Socioeconomics	Socioeconomics	Socioeconomics	Socioeconomics
2	Water resources	Water resources	Water resources	Water resources
3	Land use and regulatory affairs	Project plans, schedule, and technology	Transportation	Land use and regulatory affairs
4	Air quality	Land use and regulatory affairs	Waste management	Project plans, schedule, and technology
5	Transportation	Biology	Project plans, schedule, and technology	Transportation
6	Energy	Transportation	Cumulative impacts	Biology
7	Project plans, schedule, and technology	Recreation	Biology	Air quality
8	Biology	Air quality	Reclamation and soils	Waste management
9	Health and safety	Waste management	Land use and regulatory affairs	Energy
10	Cumulative impacts	Utility/pipeline corridors	Energy	Cumulative impacts
11	Recreation	Cumulative impacts	Health and safety	Health and safety
12	Waste management	Geotechnical and mining	Utility/pipeline corridors	Recreation
13	Geotechnical and mining	Health and safety	Air quality	Geotechnical and mining
14	Cultural resources	Energy	Geotechnical and mining	Reclamation
15	Reclamation and soils	Noise	Cultural	Utility/pipeline corridors
16	Noise	Cultural resources	Visual resources	Cultural resources
17	Visual resources	Reclamation and soils	Noise	Noise
18	Utility/pipeline corridors	Visual resources	Recreation	Visual resources

1.4 SCOPE OF EIS

A number of oil shale and other energy development projects have been planned for west-central Colorado that could result in cumulative impacts, particularly on regional socioeconomic factors, water resources, ecology, and air quality. However, the actual development of the various projects and their schedule relationships are uncertain. Thus, this EIS analyzes two scenarios for oil shale development: low-level and high-level. This spectrum of production will enable the reader to understand potential impacts of the Mobil Project, the Pacific Project, and the cumulative impacts of multiple oil shale projects in the region.

In the low-development scenario, it is assumed that the existing effects of the Union Oil Company's Phase I (10,000 bpd) Parachute Creek Oil Shale Project (Union Phase I Project) would be combined with either the Mobil Project or the Pacific Project. Thus, the project-specific impacts of the Mobil Project are assessed in Chapter 3 relative to the existing environment that includes the Union Phase I Project. Similarly, project-specific impacts of the Pacific Project are assessed separately in Chapter 4 relative to the existing environment that includes the Union Phase I Project.

The high-development scenario is used in Chapter 5 to assess cumulative impacts of several shale oil projects. It assumes that there will be simultaneous development of the following projects: the Mobil Project (100,000 bpd), the Pacific Project (100,000 bpd), the Phase II (90,000 bpd) Parachute Creek Oil Shale Project (Union Phase II Project), Chevron Clear Creek Shale Oil Project (100,000 bpd), Colony Shale Oil Project (47,000 bpd), and the Colorado-Ute Southwest Electrical Generation Project (Units 1 and 2), which it is assumed would be built because of the need for additional electrical energy.

The future of oil shale development is controversial because of the fluctuating price of oil and unproven technological developments. Because of this uncertainty, the BLM chose to include in the high-development scenario future oil shale developments which would be within the probable environmental impact area of the Mobil and Pacific projects, and for which there was sufficient information available from EISs to evaluate impacts.

2 Regional Setting

The locations of the Mobil Project and the Pacific Project are at the southern edge of the Piceance Basin in Garfield County, Colorado (Figure 1.0-1). The regional environment of this geologic structural basin was described by the BLM (1983a). The following are summaries of significant features.

2.1 CLIMATE AND AIR QUALITY

This section summarizes the important climate and air quality characteristics of the region. Additional details are included in the air quality technical report (Dames & Moore, 1984) prepared for this EIS.

The oil shale region is topographically and meteorologically complex, consisting of the Roan Plateau, deep steep-walled canyons which dissect it, and the Colorado River valley along its southern edge. Elevations range from 8400 to over 8700 feet on the plateau and from 5000 to 7000 feet in canyons and valleys. The region is characterized by a semiarid, continental climate with low precipitation (except at higher elevations), low relative humidity, large temperature variations, and high evaporation.

Elevation, site exposure, and the channeling of winds by topography affect the climate and dispersion potential at any particular location. In the absence of strong prevailing winds, flow in the canyons and valleys is controlled by diurnal and seasonal surface heating and cooling effects. During daytime periods of strong solar insolation, air gains heat from the ground surface, becomes lighter, and tends to flow upslope to higher elevations. Air cools during the night, becomes heavier, and tends to flow downslope to lower elevations because of gravity. In the Piceance Basin, downslope winds are common and appear to be stronger than the corresponding upslope winds (BLM, 1983a).

Weather patterns are influenced by broad high- and low-pressure areas in the atmosphere that tend to move easterly through the region. Moist air masses affecting the region generally originate over the Pacific Ocean and lose much of their moisture as they pass over mountain ranges west of the Roan Plateau. Occasionally, moist air from the Gulf of Mexico also influences the regional climate. Interaction of the broad-area meteorological factors with local climatic and surface conditions determines the regional wind flow and dispersion characteristics.

Average temperature in the region varies primarily with elevation. The coldest nighttime temperatures and the warmest daytime temperatures occur in the valleys and low-lying basins. Temperatures on the plateaus show less variation, but average temperatures are generally lower than in the valleys. Average summer temperatures range from lows of approximately 7°C (45°F) to highs of 30°C (85°F). Average winter temperatures range from a low of approximately -15°C (5°F) to highs of 2°C (35°F). Temperature extremes have been recorded from a low of -45°C (-50°F) to highs of over 38°C (100°F). Frost-free periods vary with elevation and year, ranging from 25 to 150 days within the region.

Precipitation is highly variable within the region, generally ranging from 20 to 60 cm (8 to 24 inches), and occurs mostly in late spring and early fall. Variation in precipitation is related to local topography and the orientation of major mountain ranges with respect to broad-area wind patterns. Orographic uplifting cools air masses and causes frequent and more abundant precipitation at higher elevations than in valleys. Snow generally occurs between November and April. Variation in recorded snow depths is related to elevation, topography, and redistribution of snow cover by wind.

The prevailing direction of upper-level winds is from the west-southwest (Figure 2.1-1). Surface wind speeds and directions are highly site-specific and strongly influenced by local terrain. Those on the plateau are similar to upper-level winds; however, because of ground cover and surface frictional effects, the prevailing plateau surface winds are more commonly from the southwest and south-southwest.

Data for Grand Junction show that the annual average sunshine is 70 percent of that possible, ranging from 60 percent in winter to 79 percent in summer and fall. A 40-year record for 1938 through 1977 shows an average of 140 days per year that were clear from sunrise to sunset.

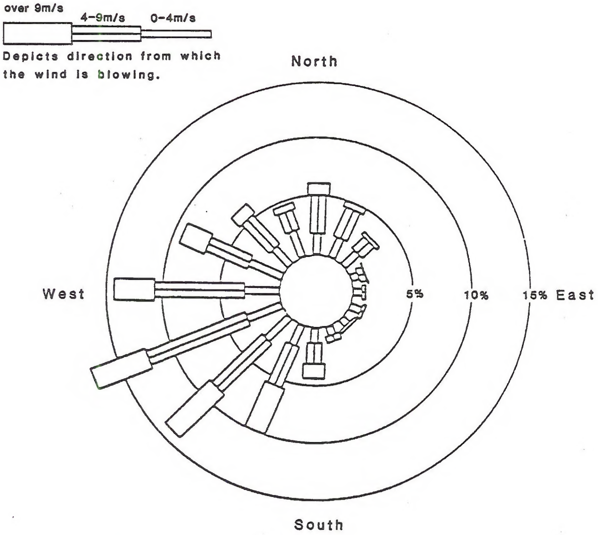
Spring, summer, and fall relative humidity at Grand Junction averages 20 to 30 percent during the day and 30 to 40 percent in the evening. Winter relative humidity is 50 to 60 percent during the day and 70 to 80 percent during the evening. Average annual lake evaporation is 86 cm (34 inches).

Severe weather conditions such as tornadoes, floods, damaging hail, high winds, and severe thunderstorms are rare, although blizzards and frigid winter conditions do occur. Highly localized thunderstorms occur about 35 days each year, being most frequent in August.

Vertical and horizontal mixing of pollutants in the air is directly related to atmospheric stability and mixing height. Average seasonal morning and afternoon mixing heights and wind speeds for the region are listed in Table 2.1-1. Atmospheric stability varies with local topography, time of day, and season. Table 2.1-2 indicates the frequencies of stability classes measured at several locations in the region. The considerable variation among these data is a function not only of the season and the location of the monitoring stations (i.e., valley or plateau), but also of the method employed for determining stability.

The existing air quality in the Piceance Basin (Table 2.1-3) is typical of undeveloped regions in the western United States, where ambient pollutant levels are usually near or below the measurable limits. Exceptions to this include high, short-term concentrations of total suspended particulates (TSP) (primarily windblown dust), ozone (O_3), and carbon monoxide (CO).

Applicable Colorado and Federal air quality standards are shown in Table 2.1-4. Under the Federal PSD Regulations, areas are classified by the incremental degradation of air quality that would be allowed in terms of additional amounts of particulates and sulfur dioxide. Class I areas, predominately national parks and certain wilderness areas, have the greatest limitations. Areas where moderate, controlled growth can take place are designated as Class II. Class III areas are those areas that allow the greatest degree of impacts. Most



Source: BLM 1983a

Figure 2.1-1. Annual average wind frequency of occurence (%) at 3048 meters above sea level over Grand Junction, Colorado

Table 2.1-1. Seasonal and annual average morning and afternoon mixing heights[a] and wind speeds[b] for Grand Junction, Colorado

	Morning		Afternoon	
Season	Height (meters)	Wind speed (meters/second)	Height (meters)	Wind speed (meters/second)
Winter	329	3.4	1160	3.4
Spring	628	5.4	3166	6.6
Summer	307	4.7	3940	6.1
Autumn	273	3.9	2133	4.6
Annual	384	4.3	2600	5.2

[a]Mixing height is the height in the atmosphere to which pollutants emitted near ground level can be diluted.

[b]Average wind speed in the layer below the mixing height.

Source: As derived from Holzworth (1972) and cited in Latimer et al. (1983).

Table 2.1-2. Stability class distributions (percent) for regional and project area locations

Station	Grand Junction	Chevron Clear Creek	Mobil Roan		Pacific Mesa[a]	
Topography	Broad Basin	Plateau	Plateau		Plateau	
Classif. Method	NOAA Star[b]	σθ[c]	σθ[c]	ΔT[d]	σθ[c]	ΔT[d]
Class						
A - Very Unstable	1	17	11	23	4	1
B - Unstable	9	5	6	5	6	0
C - Slightly Unstable	15	8	9	4	11	1
D - Neutral	35	34	47	25	58	35
E - Slightly Stable	20	16	21	39	20	55
F - Stable	19	20	6	5	2	9

Station	Parachute Cabin Water Gulch	Parachute Wheeler Gulch	Parachute Mahaffey Ranch		Pacific[a] Mid Deer Park		Pacific[a] Scott Gulch		Pacific[a] Lower Deer Park	Pacific[a] Clear Creek
Topography	Valley	Valley	Valley		Valley		Valley		Valley	Valley
Classif. Method	σθ[c]	σθ[c]	σθ[c]	ΔT[d]	σθ[c]	ΔT[d]	σθ[c]	ΔT[d]	σθ[c]	σθ[c]
Class										
A - Very Unstable	26	26	14	7	29	5	34	0	27	14
B - Unstable	3	3	6	4	13	3	8	1	13	12
C - Slightly Unstable	1	1	7	5	11	4	5	1	12	14
D - Neutral	7	9	25	24	16	25	9	24	15	35
E - Slightly Stable	10	6	11	44	2	40	2	58	4	12
F - Stable	52	56	47	17	30	23	43	17	31	14

[a]Data from a 6-month collection period: November 1982 - April 1983.

[b]A method for classifying atmospheric stability from National Oceanic and Atmospheric Administration (NOAA) weather records of sky cover (cloudiness) and wind speed.

[c]A method for classifying atmospheric stability from onsite measurements of wind direction fluctuations, known as the sigma theta (σθ) method.

[d]A method for classifying atmospheric stability from onsite measurements of the difference in temperature at two levels in the atmosphere (e.g., 10 m and 60 m above the ground), known as the delta-T (ΔT) method.

Source: Mobil, 1983a; CDM, 1983a, 1983b.

Table 2.1-3. Summary of background air quality in Piceance Basin and Grand Junction (concentrations in $\mu g/m^3$)

	Rio Blanco			Cathedral Bluffs				Chevron	Naval Oil Shale Reserve		Grand Junction			Rifle [a]
	1978	1979	1980	1978	1979	1980	1981	1981	1980	1981	1979	1980	1981	1981-82
Sulfur Dioxide (SO_2)														
3-hour maximum	78[b] 286			88				17	44	118				
24-hour maximum				43				14	13	69				
Annual average	26 26	26 26	5.2 7.9	1	0.6 0.3	2.0 1.1	3.2 1.8	1						c
Total Suspended Particulates (TSP)														
24-hour maximum	59 160[d]	303[d] 192[d]	61 96	178[d]	63 81		69 86	89	30	37	176[d,e]	144[e]	232[d,e]	219[d]
Annual geometric mean	14 26	11 21	13 18	11	16 16	10 11	14 14	15			82[d]	78[d]	77[d]	42
Nitrogen Dioxide (NO_2)														
Annual average	11[f]			10[f]	0.5 1.6	0.7 0.8	1.0 2.1	4.0						26.3
Carbon Monoxide (CO)														
1-hour maximum	575	1,725	1,035 575	2,800	2,300 3,600	1,700 3,800	1,800 1,800	3,000			8,050	16,100	18,400	21,150
1-hour maximum 2nd highest											8,050	13,225	14,375	
8-hour maximum				1,700				2,500			5,060	7,015	9,660	
8-hour maximum 2nd highest											4,370	7,015	9,315	
Ozone (O_3)														
1-hour maximum	176 144	157 157	157 137	160	192 246[d]	122 154	161 155		206	265[d]				92
1-hour maximum 2nd highest					204	130	151							
Annual average	114 76	98 78	98 78		52 76	59 75	65 77							33

[a]Data for fall 1981 - spring 1982; Source: Mobil, 1983a.
[b]Two values indicate two separate reporting stations.
[c]Negligible concentration.
[d]Concentration exceeds National Ambient Air Quality Standard.
[e]Second highest concentration.
[f]Total NO_x concentration ($NO + NO_2$).

Sources: BLM, 1983a, 1983b; Dietrich et al., 1983; Latimer et al., 1983.

Table 2.1-4. Colorado and Federal air quality standards (micrograms per cubic meter)

Pollutant	Averaging time[a]	Ambient[b]				Increment[c]					
		Federal		Colorado		Federal			Colorado		
		Primary	Secondary	Primary	Secondary	Class I	Class II	Class III	Category I	Category II	Category III
Carbon Monoxide	8-hour	10,000	10,000	10,000	--	--	--	--	--	--	--
	1-hour	40,000	40,000	40,000	--	--	--	--	--	--	--
Lead	Quarterly	1.5	1.5	--	--	--	--	--	--	--	--
Nitrogen Dioxide	Annual (Arith.)	100	100	100	--	--	--	--	--	--	--
Oxidants (Ozone)	1-hour	235	235	160[d]	--	--	--	--	--	--	--
Sulfur Dioxide	Annual (Arith.)	80	--	--		2	20	40	2	10	15
	24-hour	365	--	--	--	5	91	182	5	50	100
	3-hour	--	1,300	700	--	25	512	700	25	300	700
Total Suspended Particulates	Annual (Geom.)	75	60	75	60[e]	5	19	37	--	--	--
	24-hour	260	150	260	150	10	37	75	--	--	--

[a]Short-term standards (those other than Annual and Quarterly) are not to be exceeded more than once each year, except the Federal ozone standards. Under Federal regulations, the "expected number of days" with ozone levels above the standard is not to be exceeded more than once per calendar year.

[b]Ambient standards are the absolute maximum level allowed to protect either public health (primary) or welfare (secondary).

[c]Incremental (Prevention of Significant Deterioration) standards are the maximum incremental amounts of pollutants allowed above the baseline in regions of clean air.

[d]Colorado enforces only the 235 $\mu g/m^3$ Federal standard.

[e]The Colorado annual secondary TSP standard was established as a guide in assessing implementation plans to achieve the 24-hour standard.

Sources: National Primary and Secondary Ambient Air Quality Standards (40 CFR 50 et seq, as amended January 5, 1983).

Requirements for Preparation, Adoption and Submittal of Implementation Plans (40 CFR 51.24, as amended September 3, 1982).

Approval and Promulgation of Implementation Plans (40 CFR 52.21, as amended June 25, 1982).

Code of Colorado Regulations (Volume 5, Part 14 as amended May 27, 1980).

of the study region is Class II. Portions of Mesa County are classified as a Nonattainment Area for TSP, which means that they do not currently meet the National Ambient Air Quality Standards (Table 2.1-4).

Class I areas closest to the proposed project areas are the Flat Tops, Maroon Bells-Snowmass, and Mount Zirkel wilderness areas. The State of Colorado has also established increments to limit additional air quality deterioration by establishing SO_2 increments in State-designated Category I, II, and III areas. The Colorado Category I increments are identical to the Federal PSD Class I SO_2 increments and are applicable to the Class I areas listed above plus Dinosaur and Colorado National Monuments.

Class I PSD regulations also address the potential for impacts on Air Quality Related Values (AQRVs). The AQRVs include visibility and odors, and such things as acid deposition impacts to flora, fauna, soils, water, and geologic and cultural structures. Acid deposition data for selected regional locations indicate pH values varying from 4.63 to 5.92 (NADP, 1980-82; Turk and Adams, 1982, as cited in Dietrich et al., 1983). Visibility data collected at a number of regional sites indicate visual ranges averaging about 150 to 200 km (Dietrich et al., 1983).

2.2 TOPOGRAPHY AND GEOLOGY

The Piceance Basin, a subprovince of the Colorado Plateau Physiographic province (Hunt, 1956), occupies about 1600 square miles of Garfield, Mesa, and Rio Blanco counties, Colorado. In general, the basin is a high plateau rimmed by steep slopes, capped by sheer cliffs, and cut by deep gulches. The northern two-thirds of the basin are moderately dissected, and have an average relief of 300 to 500 feet. The southern third is deeply eroded, and is characterized by narrow valleys with topographic relief ranging between 2000 and 3500 feet.

Sedimentary rocks totaling 26,000 feet in thickness and ranging in age from Cambrian to Tertiary underlie the Piceance Basin. Varicolored claystone, mudstone, siltstone, and fine-grained to conglomeratic sandstone beds of the Early Eocene Wasatch Formation are the oldest sedimentary rocks exposed in the basin (Figure 2.2-1). The Green River Formation of Early and Middle Eocene Age overlies and intertongues with the upper part of the Wasatch Formation. The Green River Formation consists of the Douglas Creek, Garden Gulch, and Parachute Creek members. Near the eastern margin of the basin, the Anvil Points Member is the lateral equivalent of the Douglas Creek, Garden Gulch, and the lower part of the Parachute Creek members. The Uinta Formation of Middle and Late Eocene Age, that overlies and intertongues with the upper part of the Green River Formation and is the surface rock in most of the basin, consists mainly of siltstone and fine- to coarse-grained sandstone (BLM, 1983b).

Pleistocene and Holocene terraces containing gravels derived from the White River Uplift are developed along the White and Colorado rivers on the northern and southern margin of the basin. Quaternary pediments containing debris from the Green River Formation are cut on the Wasatch Formation near the southern margin of the basin. Streams in the basin contain Quaternary alluvium that, in places, exceeds 100 feet in thickness. Many of the streams have extensive

System	Series	Formation	GEOLOGIC UNIT - DESCRIPTION
Tertiary	Eocene		Uinta Formation, 0'-400' (Roehler, 1973b). Sandstone, very fine-to-medium-grained with thin marlstone and siltstone interbeds. Extensively intertongues with underlying Green River Formation (CSOC 1982a).
		Green River Formation 820' - 3500' (CSOC, 1982a)	Parachute Creek Member, 200' (Roehler, 1973a).- 1700'. Varved marlstone, alternating layers lean to rich in kerogen with saline lacustrine shale, tuff interbeds and evaporite lenses. Evaporites deposited near center of the basin. Seven zones of kerogen-rich oil shale identified, separated by zones low in kerogen content. Intertongues extensively with overlying Uinta Formation (CSOC, 1982a).
			Garden Gulch Member, 100'-1000'. Fresh water, lacustrine shale with two zones of kerogen-rich marlstone near top. Local, thin beds of sandstone, breccia and limestone (CSOC 1982a). Locally enveloped by Douglas Creek Member (Cashion, 1973).
			Douglas Creek Member, 100' (Roehler, 1973a)-800'. Brown-to-buff-colored sandstone, with interbeds of limestone and minor shale (CSOC, 1982a).
		Wasatch Formation 180' (Roehler, 1972a) - 3700' (CSOC, 1982a) (Thins westward) (Cashion 1982a)	Shire Member, 800'-1800'. Gray and maroon variegated claystones and sandstone beds, with siltstone, sandstone and interbeds of thin coal and limestone near the middle part (Johnson, 1975).
			Molina member, 0'-500'. Medium-to-coarse grained, arkosic sandstone, with siltstone and claystone (Johnson, 1975). Present only in the DeBeque-Roan Creek area (Donnell, 1961).
	Paleocene		Atwell Gulch Member, 700'-1850'. Gray claystone and siltstone, with some brown sandstone, carbonaceous shale and coal (Johnson, 1975).
Cretaceous	Upper Cretaceous		Ohio Creek Formation, 0'-230' (Roehler, 1973a). Sandstone and conglomerate, present locally (Donnell, 1961).
		Mesaverde Group 2500'±(CSOC, 1982a)	Hunter Canyon Formation, 375'-1400'. Buff and gray, medium-to-coarse-grained sandstone and green to greenish gray shale (Cashion, 1973).
			Mount Garfield Formation. Buff and grey, fine to medium-grained sandstone and grey shale. Lower part contains thick, persistent coal beds (Cashion, 1973).
			Sego Sandstone, 300'. Buff and light gray, fine-grained sandstone and gray shale. Intertongues with underlying Mancos Formation. Thins eastward (Cashion, 1973).
			Mancos Shale, 4000'. Dark gray to black marine shale with thin beds of sandstone intertongues with overlying Mesaverde Group (Cashion, 1973).

Figure 2.2-1. Regional stratigraphic column

alluvial fans at their termini. Colluvium, talus, and other mass wasting materials exist on many of the steep slopes, particularly along the southern and western margins of the basin.

A series of subsidiary flextures are superimposed on the general basinal structure. The few faults that are present are normal faults that trend generally to the northwest and have small displacements. They usually occur in pairs, with a down-dropped block between them. Well-developed joint sets in the Green River and Uinta formations are believed to control the drainage pattern in much of the basin.

Two low-to-moderate seismic events have occurred during the past 20 years, and were associated with nuclear, gas-stimulation detonations in and adjacent to the basin. Seismic events of similar intensities were associated with water flooding in the Rangely oil field.

2.3 PALEONTOLOGY

Three Tertiary formations in the region are known to be fossiliferous: the Wasatch Formation, the Green River Formation, and the Uinta Formation. The Wasatch has yielded remains of fossil fish, reptiles, birds, and numerous mammals from several localities within the Piceance Basin (Wallace, 1983). The Wasatch Formation, locally containing crocodilian and garfish remains (Wallace, 1983), is also considered significant because of its potential as a quarry site for small mammals (rodents and insectivores).

The Green River Formation, which is the formation containing the oil shale, contains fish, reptile, mollusk, insect, and plant fossils (Wallace, 1983).

The Uinta Formation in the Piceance Basin contains isolated occurrences of fossil vertebrate remains as well as the more common insect and plant fossils (Lucas and Kihm, 1982). The Quaternary gravels and alluvium have yielded no reportable fossils from the vicinity of the projects (Wallace, 1983).

2.4 SOILS

The region includes portions of two major land resource areas (MLRA) described by the Soil Conservation Service (SCS, 1978). Most of the region lies in MLRA 34 (Central Desertic Basins, Mountains, and Plateau), while the balance lies in MLRA 48A (Southern Rocky Mountains). Each MLRA consists of a range of soil units that reflect overall climate, topography, and parent material differences, although some soils can occur in both resource areas.

Soils classes in the region range from Aridic Haploborolls, Torriorthentic Haploborolls, and Aridic Argiborolls to Typic Cryoborolls and Typic Cryoboralfs. Many of these soils have developed from sandstone and shale parent materials. Soils are typically alkaline except for those of the higher precipitation zones at the upper elevations. Low organic matter percentages are characteristic of the less acidic soils.

2.5 GROUND WATER

Within the Piceance Basin, ground water occurs both within the unconsolidated surficial deposits and within the consolidated bedrock. Within the bedrock, the principal water-bearing units are within the Uinta Formation and the Parachute Creek Member of the Green River Formation. The Eocene-age strata underlying these units, including some of the basal units of the Parachute Creek Member of the Green River Formation, are relatively impermeable and are not considered as significant local or regional aquifers.

The ground-water system of the Piceance Basin was described by Coffin et al. (1971) as a two-aquifer system separated by the Mahogany Zone, a semi-confining layer. These are designated as the "lower" and "upper" aquifers and are shown in Figure 2.5-1 (Colorado Division of Water Resources, 1978). Robson and Saulnier (1980) described the geohydrology of the basin as a five-layered aquifer system. The system is similar to that described by Coffin et al., with the first and second layers corresponding to the upper aquifer, the third layer corresponding to the Mahogany Zone, and the fourth and fifth layers corresponding to the lower aquifer. This system is illustrated in Figures 2.5-2 and 2.5-3.

The upper aquifer consists of fractured lean marlstone of the Parachute Creek Member above the Mahogany Zone and the fractured marlstone, siltstone, and sandstone of the overlying Uinta Formation. The lower aquifer consists of the fractured marlstones of the Parachute Creek Member located below the Mahogany Zone.

Primary porosity and permeability are essentially lacking in both aquifers. In most cases, the in situ porosity and permeability are associated with fracture zones and dissolution cavities. The major dissolution zone occurs in the lower aquifer and is referred to as the "leached zone." The leached zone along the basin margins is stratigraphically higher and is less prominently developed than in the central portions of the basin. Robson and Saulnier (1980) report that the primary direction of fracturing is approximately west-northwest and that an extensive network of surficial joints and minor faults subordinate to the

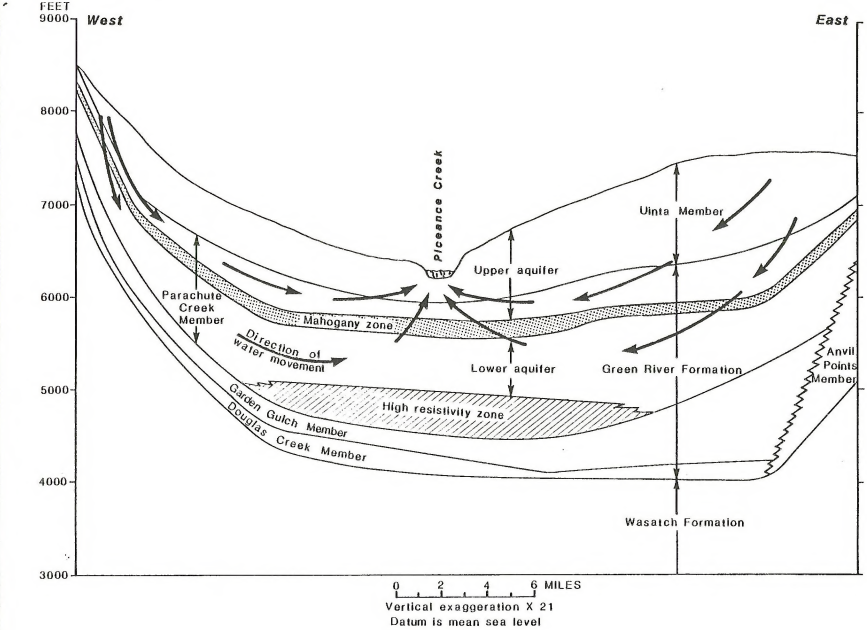


Figure 2.5-1. Generalized geologic sections through the Piceance basin

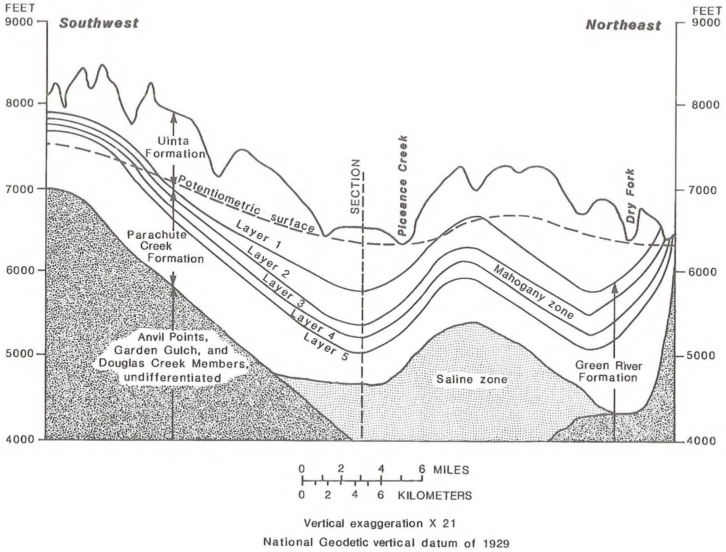


Figure 2.5-2. Generalized geologic sections through the Piceance basin

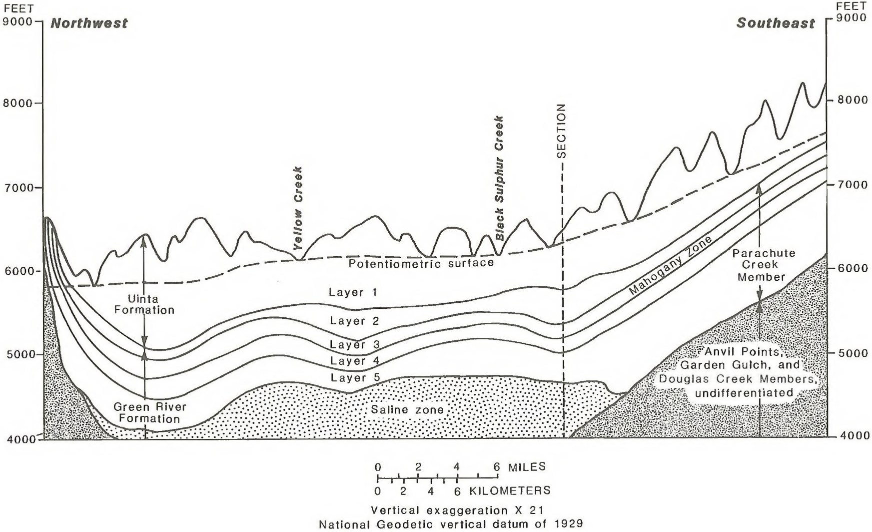


Figure 2.5-3. Generalized geologic sections through the Piceance basin

major faults existing in the basin. This network may also occur at depth in a pattern similar to that indicated at the surface and may function as ground-water conduits.

The transmissivities of the aquifers vary considerably. This variation is a function of the degree of fracturing and leaching within the bedrock units. Weeks et al. (1974), in a ground-water modeling study of the Piceance Basin, used transmissivity values ranging from 70 to 270 square feet per day for the upper aquifer and values ranging from 130 to 670 square feet per day for the lower aquifer.

Recharge to the bedrock aquifers is primarily through infiltration of incident precipitation and snowmelt in outcrop areas. Most aquifers are recharged in higher elevations along the basin margins where greater snow accumulation occurs. Ground-water discharge from the bedrock aquifer system is by direct discharge to surface drainages and major alluvial aquifer systems, and by evapotranspiration. Weeks et al. (1974) reported that approximately 80 percent of total surface-water flow in the basin is supplied by ground-water discharge. Ground-water flow in the margin areas is downward and, except near the escarpment, is lateral towards the north-central portion of the basin. In the north-central portion of the basin, the piezometric head differentials are reversed, allowing for upward ground-water movement with eventual discharge into Piceance and Yellow creeks.

Regionally, the saturated thickness of all units is variable and ranges from zero in outcrop areas to more than 2000 feet near the northeastern portion of the basin. Potentiometric elevation contours for the upper and lower aquifers are shown in Figures 2.5-4 and 2.5-5.

Ground-water quality ranges from good along the basin margins to very poor in other portions of the basin. Total dissolved solids (TDS) increase towards the center of the basin where concentrations have been reported as high as 40,000 mg/l. TDS concentrations also increase with depth. Other ground-water chemical changes which occur during lateral movement from recharge to discharge areas include change of water type from mixed cation-bicarbonate to sodium-bicarbonate, oxidation and reduction of sulfate minerals, and general increases in concentrations of several trace constituents. The chemical reactions and ground-water processes which cause these water quality changes are described in detail by Robson and Saulnier (1980).

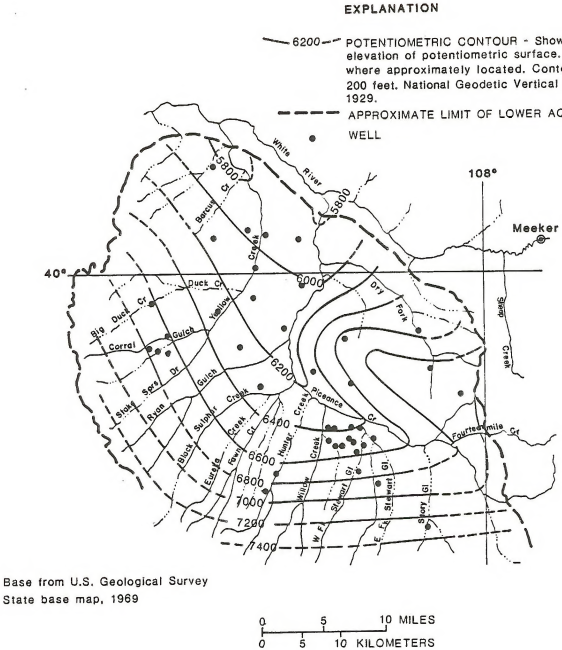


Figure 2.5-4. Potentiometric surface of the upper aquifer

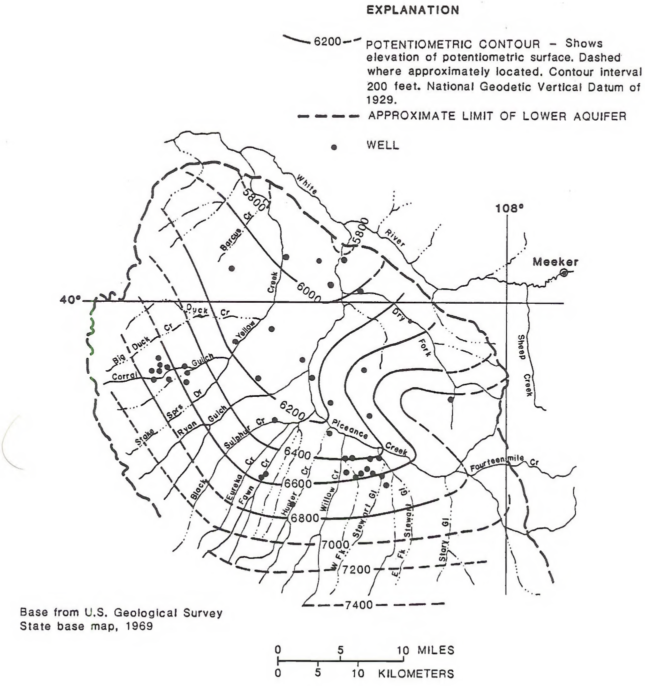


Figure 2.5-5. Potentiometric surface of the lower aquifer

2.6 SURFACE WATER

The region is part of the Colorado River drainage basin.

2.6.1 Surface-water quantity

The hydrologic regime of the region consists of a number of ephemeral, perennial, and small- and medium-sized tributaries with average annual flows and drainage areas ranging from <0.5 to 75 cubic feet per second (cfs) and 1 to 200 square miles, respectively. At DeBeque, the Colorado River has a drainage area of 7370 square miles. Mean annual, maximum, and minimum streamflows recorded over a period of 15 years are 3511, 22,500, and 914 cfs, respectively.

Peak tributary discharges in the region are mostly produced by thunderstorms. A major portion of the surface runoff during the period April through June is contributed by snowmelt. Surface runoff from rainfall occurs during the period July through early fall. Streamflows of most of the tributaries are the lowest during the period from fall through winter, except for periodic runoff resulting from thunderstorms. A typical pattern of diurnal streamflows is a daytime rise because of thawing followed by a nighttime low as a result of freezing. Surface-water springs produce up to 20 percent of the average flows of smaller streams.

2.6.2 Surface-water quality

Water quality in the upper Colorado River Basin is influenced by natural conditions and the pattern of water diversions and uses. The salinity of the Colorado River is currently a major Federal concern. Above Dotsero, Colorado, the mainstem is a low total dissolved solids (TDS) high-quality water, and constitutes a significant trout fishery despite dewatering for agricultural uses, transbasin diversions to eastern Colorado, mine drainage pollution from headwaters of streams, and increasing population and economic growth along major tributaries (USDI, 1983). As the river passes the Dotsero-Glenwood Springs area, major salt and temperature loadings occur as a result of natural geothermal springs.

Major increases in TDS concentration, sediment loadings and sodium absorption ratio (SAR) occur in the reach of the river between Glenwood Springs and Grand Junction, associated with runoff contributions from erosive and saline drainages in the oil shale country and the effects of agricultural irrigation return flows. At the confluence with Parachute Creek, the mainstem Colorado River becomes a warm water fishery by designation of the Colorado Department of Health (1983). As the river crosses into Utah from Colorado, it is still a relatively high-quality water suitable for all uses.

Increases in TDS and SAR become more severe in the lower Colorado River Basin because of natural causes, numerous large-scale mainstem reservoirs, major transbasin diversions to Arizona and California, and heavy use in irrigated agriculture. The average annual TDS values below Hoover Dam and at Imperial Dam are 697 and 879 mg/l, respectively. These statistical averages account for fluctuations associated with natural hydrologic phenomena and significant increases in reservoir storage in the lower basin (USDI, 1983). The standards for salinity at key lower basin monitoring points (CRBSCF, 1981) are:

- Below Hoover Dam - 723 mg/l.
- Below Parker Dam - 747 mg/l.
- At Imperial Dam - 879 mg/l.

2.7 AQUATIC ECOLOGY

The Colorado River contains both cold-water and warm-water fisheries. Cold-water fishery habitat also occurs in several tributary streams and numerous montane lakes. Drainages from both the Mobil and Pacific project areas flow into the Colorado River between New Castle and DeBeque. The Federally threatened and endangered (USF&WS, 1980a) Colorado squawfish (Ptychocheilus lucius) and humpback chub (Gila cypha) have been recorded in the Colorado River below DeBeque (Miller et al., 1982). Two species listed by the State of Colorado as threatened or endangered are being reviewed for Federal listing (USF&WS, 1982): the razorback sucker (Xyrauchen texanus), which occurs in the reach of the Colorado River adjacent to the projects (Miller et al., 1982); and the Colorado River cutthroat trout (Salmo clarki pleuriticus), which occurs in Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch (Colorado Division of Wildlife, unpublished data).

2.8 VEGETATION

The vegetation of the Piceance Basin is in a transition zone between the complex montane ecosystems of the Rocky Mountains to the east and the arid intermountain basin regions to the west. Because of the extremes of topography and variability of environmental factors, the flora tends to be very diversified and locally variable. The lower elevations tend to support vegetation communities which are characteristic of the deserts to the west, while higher elevations support communities more typical of the mountains to the east.

The regional vegetation is composed of a mosaic of forests, shrublands, and grasslands. The numerous vegetation types are distributed in response to a variety of environmental factors. Elevation ranges from approximately 4500 feet to more than 8000 feet and produces complex growing season, temperature, and precipitation gradients. The extreme topography and erosional patterns set into this elevational gradient have created a multitude of microenvironmental conditions that favor the development of a diverse and varied vegetational landscape.

In the southern portion of the Piceance Basin, the major Roan Creek and Parachute Creek valley systems support a variety of grassland and shrubland vegetation types which are characteristic of the intermountain basin region. The environment in the valleys tends to be hot and dry in the summer and cold and dry in the winter. The major vegetation types in the valleys consist of shrublands, dominated by big sagebrush (Artemisia tridentata), black greasewood (Sarcobatus vermiculatus), shadscale (Atriplex confertifolia), four-wing saltbush (Atriplex canescens), and species of wild buckwheat (Eriogonum sp.). Forest or woodland vegetation occurs on upland areas in the form of pinyon-juniper woodlands. This dry forest type occurs on thin rocky soils in areas exhibiting a variety of slope steepness and aspect. The major species in the pinyon-juniper woodlands include pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma). On selected valley bottom sites, Gambel oak (Quercus gambelii) attains tree size and forms limited stands of dwarf woodlands. Forests also develop in areas immediately adjacent to stream courses. Major species in the riparian woodlands include box elder (Acer negundo), plains cottonwood (Populus sargentii), and narrowleaf cottonwood (P. augustifolia). The valley bottoms also provide the only major areas for active agriculture in the region. Areas close to the creeks are used primarily for production of irrigated hay crops and developed pastures.

Side slopes, cliffs, and escarpments rise approximately 2000 feet above the valley floors to the Roan Plateau. The side slopes tend to be steep, dry, and in many cases rocky. The major vegetation on these areas consists of shrublands dominated by big sagebrush, Utah serviceberry (Amelanchier utahensis), mountain snowberry (Symphoricarpos oreophilus), mountain mahogany (Cercocarpus montanus), and wild buckwheat species. Indian ricegrass (Oryzopsis hymenoides), and cheat-grass (Bromus tectorum) occur as dominant species in grasslands which grow on the lower portions of the steep talus slopes. In many areas, the side slopes are very sparsely vegetated. At lower elevations, the sparsely vegetated areas are composed of eroded Wasatch Formation clays and silts which form a badlands vegetation type. At higher elevations, the barren areas are composed primarily of weathered shales of the Green River Formation. In addition to the shrublands and grasslands, pinyon-juniper woodlands also occur on the side slopes. On steep, extreme northeast exposures, forests dominated by Douglas-fir (Pseudotsuga menziessi) occur. This type also occurs on the upland areas of the Roan Plateau.

The vegetation on the top of the Roan Plateau is composed of an intricate pattern of shrublands, grasslands, and forests. Shrublands dominated by big sagebrush form the most characteristic vegetation of the Roan Plateau. On moister slopes, other shrub species, such as Utah serviceberry, mountain snow-berry, antelope bitterbrush (Purshia tridentata), and Gambel oak occur as dom-inants. On north and northeast exposures, quaking aspen (Populus tremuloides) occurs as the dominant species and forms closed-canopy forests. These same exposures at higher elevations in the basin support Douglas-fir forests which, in addition to Douglas-fir, also contain Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa). In some areas, dry exposed ridges support a grassland type in which bluebunch wheatgrass (Agropyron spicatum), Indian rice-grass, and needle-and-thread grass (Stipa comata) occur as dominants.

Several rare plant species occur in the southern portion of the Piceance Basin (Table 2.8-1). These species have received considerable attention by government agencies and private research institutions. To date, only one of these species, the Uinta Basin hookless cactus (Sclerocactus glaucus), has been listed as threatened; none has been listed as endangered (USF&WS, 1980). Sedge fescue (Festuca dasyclada), Grand Junction milkvetch (Astragalus linifolius), dragon milkvetch (Astragalus lutosus), Barneby's columbine (Aquilegia barnebyi), and phacelia (Phacelia submutica) are all candidate species for classification as being either threatened or endangered. The remaining species are of special

Table 2.8-1. Special-status species known to occur in the region[a]

Scientific name	Common name	Family
Aquilegia barnebyi	Barneby's Columbine	Ranunculaceae[b]
Arabis oxylobula	Rockcress	Cruciferae
Astragalus detritalis	Milkvetch	Leguminosae
A. linifolius	Grand Junction Milkvetch	Leguminosae
A. lutosus	Dragon Milkvetch	Leguminosae
A. wetherillii	Wetherill Milkvetch	Leguminosae
Festuca dasyclada	Sedge Fescue	Gramineae
Phacelia submutica	Phacelia	Hydrophyllaceae
Sclerocactus glaucus	Uinta Basin Hookless Cactus	Cactaceae
Sullivantia hapemaniia var. purpusii	Sullivantia	Saxifragaceae
Thalictrum heliophilum	Sun-loving Meadowrue	Ranunculaceae

[a]Based on lists prepared by the USF&WS (1980a, 1980b), BLM (1981e), and Colorado Natural Heritage Inventory (1980).

[b]Was under consideration for threatened or endangered listing but was recently proposed to be dropped from this consideration (USF&WS, 1983a).

concern, and may or may not be proposed for listing as threatened or endangered in the future. Only Federally listed threatened and endangered species are protected under the Endangered Species Act of 1973.

2.9 WILDLIFE

Wildlife populations in the region include species that are characteristic of mountainous as well as cold desert ecosystems. The division between these ecosystems is sharply defined by the cliffs of the Roan Plateau.

Big game, notably mule deer and elk, migrate seasonally between plateau summer range and valley winter range, although some deer remain in the valleys throughout the year. Migration patterns are not well defined, but winter concentrations of big game occur in the valleys near both project areas each year, deer occurring more abundantly than elk. Mountain lion and black bear also occur in the region.

Coyotes are common throughout the Piceance Basin and can be encountered in any habitat at any season of the year. Bobcat, raccoon, striped skunk, red and gray fox, long-tailed weasel, and badger are present, but are rarely seen. Desert and Nuttall's cottontails and white-tailed jackrabbits are a major component of the prey base for the larger predatory mammals and birds. Beaver and muskrat can be found in streams at the lowest and highest elevations, although they are not abundant in the region.

The most conspicuous small mammal species are least chipmunks and golden-mantled ground squirrels (open, brushy habitats), Uinta chipmunks (forests), and rock squirrels (valley riparian habitats). Other common small mammal species include the deer mouse, apache pocket mouse, long-tailed vole, montane vole, northern pocket gopher, and bushy-tailed woodrat (Keammerer and Stoecker, 1975).

Upland game birds in the region include sage and blue grouse (plateau habitats), chukar (valley habitats), and mourning doves (ubiquitous). Three Federally endangered birds have been recorded: the peregrine falcon, bald eagle, and whooping crane. The greater sandhill crane, a state endangered species, migrates through the region as well. Other bird species of high Federal interest that are present in the region include the great blue heron, Cooper's hawk, golden eagle, prairie falcon, ferruginous hawk, osprey, burrowing owl, long-billed curlew, Lewis' woodpecker, Williamson's sapsucker, black swift, band-tailed pigeon, and western bluebird.

Reptiles and amphibians are not abundant in the region. In the Roan Creek and Parachute Creek valleys, the more common species include the wandering garter snake, northern plateau lizard, and western chorus frog. Other species present include the western rattlesnake, bull snake, racer, collared lizard, sagebrush lizard, and western toad.

2.10 CULTURAL RESOURCES

Cultural resources consist of the nonrenewable remains of past human activity, occupation, or endeavors. These evidences are reflected in districts, sites, structures, buildings, objects, artifacts, ruins, works of art, and natural features important in human events. In west-central Colorado, cultural resources span a period of at least 12,000 years, subdivided into five temporal/cultural periods (Reed, 1983): 1) Paleo-Indian (ca. 10,000 to 5500 B.C.); 2) Archaic (5500 B.C. to A.D. 1); 3) Formative (A.D. 1 to 1300); 4) Proto-Historic/Historic Aboriginal (ca. A.D. 1200-1400 to 1881); and 5) Euro-American (ca. 1776 to present).

The pre-Formative cultures were hunting and gathering groups. The Paleo-Indians depended on several now-extinct species of large mammals, while subsequent Archaic peoples relied more on the collection of wild plants and smaller game animals. No actual sites associated with the Paleo-Indians have been identified; however, scattered isolated artifacts have been found dating to this period. The Archaic period, on the other hand, is well represented by sites throughout the region.

The Formative period was characterized by a continuance of the hunting-and-gathering subsistence pattern, but also included the addition of a more settled way of life and a partial reliance on cultivated foods and manufacture of ceramics. During this time frame, west-central and northwestern Colorado were used by the Fremont Culture. Fremont sites include distinctive rock art and scattered evidences of gardening, masonry structures, and ceramics.

Following the disappearance of the Fremont, the region was occupied by the Shoshonean-speaking Utes, who used the area until their removal in 1881. During the Ute occupation, Euro-Americans began exploring this area. Intensive use and settlement of this area did not begin until the last half of the nineteenth century (Mehls, 1982).

2.11 VISUAL RESOURCES

The Piceance Basin is in a transition zone between the Colorado Plateau and Middle Rocky Mountain physiographic provinces. Colorado Plateau landscapes are typically arid and eroded canyon, mesa and basin landscapes, while Middle Rocky Mountain landscapes are composed of mountain and mountain valley landforms with forest and meadow vegetation (Fenneman, 1931). The landform patterns are more typical of those found in the Colorado Plateau and are dominated by the Roan Cliffs, which rise sharply some 2500 to 3400 feet above the Colorado River valley adjacent to Interstate 70 (I-70). These cliffs consist of nearly vertical faces with exposed horizontal formations of tan, white, yellow, and occasionally red rock above steep, partially vegetated talus slopes. The Colorado River valley and various smaller valleys contain a mixture of native riparian and shrub vegetation mingled with agricultural pastures and meadows. The Roan Plateau is a rolling elevated plateau and exhibits a vegetational landscape consisting of meadows, shrubs, conifers, and aspen.

Cultural modifications are generally associated with the valley bottoms. Communities in the region are typically small and include DeBeque, Battlement Mesa, Parachute, and Rifle. Larger cities occur further to the west (Grand Junction) and to the east (Glenwood Springs). Other types of cultural modifications include farming and ranching related land uses and buildings, the Denver and Rio Grande Western Railroad, and, more recently, oil shale mining and processing facilities. Oil shale related activities are currently most notable in the Anvil Points and Parachute Creek areas. Overall, the region's character continues to be dominated by its natural landscape features.

2.12 NOISE

Ambient noise is defined as the existing level of sound associated with a given environment resulting from composite sounds from many sources. Typical sources of ambient noise in western Colorado include automobiles, trucks, airplanes, heavy equipment, wildlife activity, wind (rustling brush or leaves), and flowing water. In the small town urban areas of the shale oil region, local construction, street traffic, and trains are the primary sources of noise (BLM, 1983a).

The L_{eq} is the equivalent sound level on an energy basis of the actual fluctuating noise under consideration. The ambient noise level in remote areas of western Colorado is about 40 decibels (dBA). This estimate is based on representative levels according to population densities and noise level measurements in rural western Colorado (Gulf and Standard, 1977).

2.13 LAND USE AND RECREATION

Predominant land uses in the region are rangeland and agriculture. Other significant land uses reflect oil shale development and coal mining, which have been major factors in the rapid transition of land use from agricultural to residential, commercial, and industrial (BLM, 1982a).

2.13.1 Land use

Existing land use in the two-project region is indicated in Figure 2.13-1. Agriculture, including livestock production on native range and cultivation of hay, fruit, and other crops, is by far the dominant land use. Another important land use in the region is wildlife habitat. Cultivated lands occur primarily along the valley bottoms and benches above the Colorado River. Prime agricultural lands, as identified by the USDA Soil Conservation Service, are located in several areas, including the Grand Valley from Palisade west to Fruita, in the Roan Creek drainage near DeBeque, and along the Colorado River east of Rifle.

Urban development is concentrated in the Grand Junction vicinity and at several smaller communities scattered along the Colorado River east to Glenwood Springs. These existing urban areas and areas projected for urban growth are shown in Figure 2.13-1.

Other significant land uses include oil shale development and mining, which have been major factors in the region's rapid land use transitions from agricultural to residential, commercial, and industrial (BLM, 1982a). A large portion of the region is publically owned. As shown in Figure 2.13-1, public lands are concentrated in the upland areas that are less suited for cultivation.

The 1981 Garfield County Comprehensive Plan identifies county concerns and policies, and includes a discussion of intracounty management districts and performance standards for development. More recently (September 7, 1982), the Mesa County Planning Commission adopted draft county land use policies that will be incorporated into a comprehensive master plan for that county. Both the Garfield County and Mesa County land use plans address the issue of preserving highly productive agricultural lands. The Garfield County plan cites many objectives and policies to further the goal of keeping farmland and ranchland in active and productive use.

Land use plans and policies for the communities of Grand Junction, Palisade, Rifle, DeBeque, Silt, Parachute, New Castle, and Glenwood Springs have been adopted or are being developed. In general, these management policies are pro-growth in nature; however, they show the communities' desire to direct and control the growth in their region. Areas for urban expansion have also been designated. These areas are generally located adjacent to developed areas. The policy is to encourage an orderly, phased manner for new development to occur, and to avoid a noncontiguous, scattered development pattern. Avoidance of development in geologic hazard areas, and preservation of prime agricultural land and other valuable natural areas are also expressed as concerns by these policies.

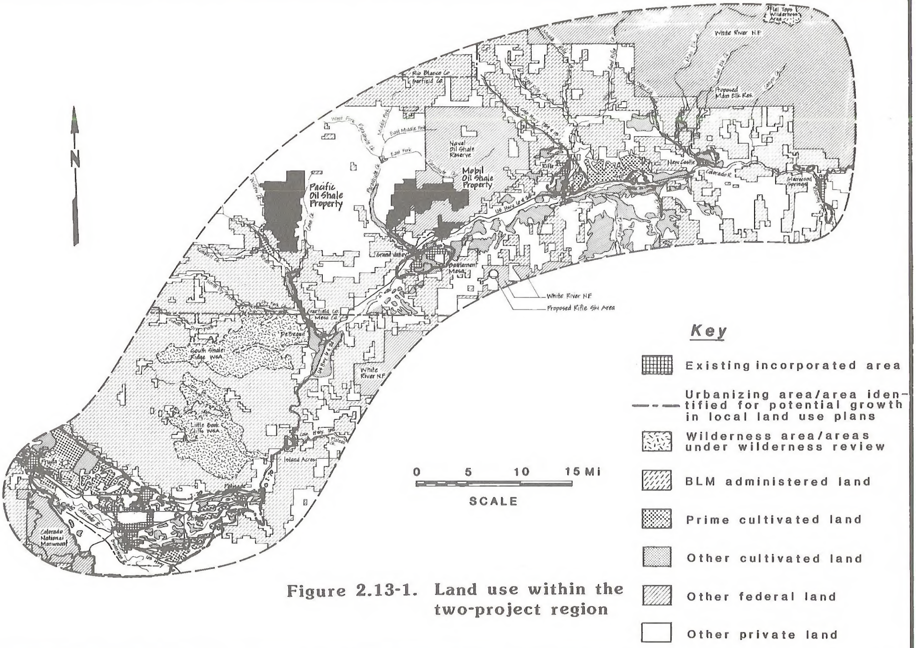


Figure 2.13-1. Land use within the two-project region

Based on projected land requirements, and assuming the current pro-growth policies of the counties and communities continue, no shortage of available land is anticipated through the year 2009.

2.13.2 Recreation

Mesa and Garfield counties (together with Moffat and Rio Blanco counties), are in state planning and management Region 11, as defined in the 1981 State Comprehensive Outdoor Recreation Plan (SCORP). According to the SCORP, the five most popular outdoor recreational activities in Region 11 (as evidenced by total activity days) are bicycling, camping, picnicking, swimming, and fishing. Big game hunting is also a significant activity, but has a relatively low number of activity days because of the short season of use. Substantial floatboating also occurs on the Colorado River from Glenwood Canyon to New Castle. Major public recreational lands within Mesa and Garfield counties include three national forests, one national monument, three state recreation areas, and large tracts of public land administered by the BLM.

Recreation in Mesa and Garfield counties occurs along with other activities, including grazing, mining, and timber production. Also included in the region are remote lands that are either designated as, or are under consideration for, designation as wilderness areas. The Flat Tops Wilderness Area is located in Garfield and Rio Blanco counties, and is managed by the U.S. Forest Service (USFS). Colorado National Monument (managed by the National Park Service) is entirely within in Mesa County. In addition, the Grand Junction District of the BLM is considering the designation of 11 tracts of land in Mesa and Garfield counties containing approximately 250,000 acres as wilderness (see Figure 2.13-1). A description of each of these areas is in BLM (1983b).

In 1981, visitations to national forests in Mesa and Garfield counties totaled over 6 million visitor days. Although most types of recreational forest use are increasing, most carrying capacities do not seem threatened in the near future. The exception is in wilderness areas, where USFS officials expect current management capacities to be reached by the year 2000. Based on the SCORP participation rate data and baseline population forecasts, select recreational activities are projected to increase in participation days through the year 2009, but none of these increases is anticipated to threaten existing capacities with the exception of back-country camping.

Recreational use of BLM lands in the two-county region is also significant and totaled more than 375,000 visitor days in 1980 (combined Grand Junction and Glenwood Springs resource areas). Off-road vehicle use and hunting are the dominant activities and, together, account for more than half of total use. Off-road vehicle use is concentrated in the Grand Valley Recreation Management Area and hunting occurs primarily on the Naval Oil Shale Reserve and in the Book Cliffs, Castle Peak, and Plateau Creek valley vicinities. Floatboating is also an important activity and accounted for approximately 100,000 activity days in 1980. Most of the floatboating occurs on the Colorado River upstream of Dotsero and on the Roaring Fork River.

2.14 SOCIOECONOMICS

This section presents a description of existing socioeconomic conditions in Garfield and Mesa counties. It describes the development and current condition of the area economy, population, housing, public facilities and services, governmental fiscal conditions, and the social structure.

2.14.1 Background

The social history of the Western Slope extends back to the hunting and gathering activities of Indians who inhabited the region for centuries before the first arrival of Spanish explorers and missionaries in the eighteenth century. During the early 1800s, fur traders were active, followed by miners, farmers, and ranchers.

The steady expansion of white influence produced frequent conflict with the Ute Indians in the 1870s, finally resulting in the removal of the Utes to northeast Utah by 1881. Subsequently, the extension of the railroad from Leadville down the Colorado River valley prompted settlement and development during the last decades of the nineteenth century. Orchards were established in the Grand Valley; farming and livestock raising were important additional components of the agricultural activities. Some coal mining took place in the early 1900s, followed by exploration of the oil shale, and oil and gas resources (Mobil, 1982a).

Oil shale resources have been recognized since the turn of the century, and, during the period 1916-1920, there was somewhat of an oil shale boom. Local residents have expected that sooner or later, depending upon demand, economics, and technology, the oil shale resources would be developed. This expectation has always implied that there would be substantial increases in population and economic activities.

Events in the 1970s prepared the way for the most serious and extensive attempts to date to develop oil shale in Garfield County. The demand for oil was strong and growing when supplies were suddenly restricted, most notably with the 1973 oil embargo and other limitations of foreign supply. The Federal government adopted policies to support the development of American energy resources, including synfuels. Oil prices increased rapidly, making it possible to project oil shale development as economically feasible in the future. Extraction technology also advanced, based on the economies of scale which apply to modern mining and transportation and on improved designs of the retort and upgrading processes.

In 1977, major oil shale developments by Union, Occidental, and Exxon were underway, and other projects were in various stages of planning. The period 1977 to mid-1982, when Exxon and Occidental suddenly halted their projects, was one of rapid change for both Garfield and Mesa counties.

The socioeconomic impacts that occurred during this period enhanced the ability of local communities to accommodate change. Significant capabilities in the public and private infrastructures were expanded and in some cases new capacities were created. These areas of development are discussed in some detail below, but it should be noted that the response ranged from an enhanced planning capability to the actual purchase and construction of public and private facilities. Also, this 5-year period provides an outline of the patterns of change which might characterize a major new project. Finally, this period sensitized the local population to both the theory and experience of socioeconomic impact.

During the scoping process for this EIS, the BLM identified the significant issues to be addressed. The results of this process were reported in a scoping summary document (Dames & Moore, 1983b). In a prioritized listing of 18 categories of potential impact, socioeconomics was identified as the most important area of concern. The total number of issues identified by the scoping process was 242. Socioeconomics accounted for 57 listed items or almost a quarter of the total. The socioeconomic concerns were: the effects on quality, availability and cost of public services, employment, housing and land use, transportation, population characteristics and social change. The historical and current conditions for each of these areas are discussed below.

2.14.2 Economics

The historical data on employment and income are important for understanding the socioeconomic conditions of the study area. The distribution of their effects helps explain the development of population, housing, public- and private-sector facilities and services, and the social structure. While employment and income are not the sole determinants of conditions in these various categories, they are most often the primary causes of socioeconomic change.

2.14.2.1 Employment

Tables 2.14-1 and 2.14-2 show the employment trends for Garfield and Mesa counties during the period 1976-1981. For Garfield County, the largest gains were in wholesale trade; construction; finance, insurance and real estate (F.I.R.E.); and transportation and public utilities. The changes in the mining sector are the result of a reporting change by the Bureau of Economic Analysis (BEA), and do not represent an abrupt employment change. BEA reallocated the workers to Pitkin County, where the jobs are located. Growth in the trade and services sectors has been strongest in the Glenwood Springs area located in eastern Garfield County. The growth in the construction sector was mainly related to oil shale development in the Rifle and Parachute areas. Data for 1981 and 1982 indicate an even greater impact as employment in oil shale development peaked prior to the shutdowns of mid-1982 (BMML, 1983).

Mesa County's economy is more diverse and complex than that of other counties in the region, and the Grand Junction area serves as the major economic and administrative center for the Western Slope. The sector with the greatest historical growth rate has been mining-related, primarily at the administrative level, as several energy companies established major offices in the Grand Junction area. The increase in construction, followed by F.I.R.E. and retail trade, reflects the general strength of the area economy during the reporting period.

Unemployment in Garfield County historically has been above the state rate by about one percentage point, while Mesa County has tended to parallel the

Table 2.14-1. Employment by type and broad industrial sources for Garfield County, 1976-1981

Sector	Garfield County 1976[a]	1977[a]	1978[a]	1979[a]	1980[a]	1981[a]	Average annual % growth 1976-81
Employment by place of work							
Total employment[b]	8,477	8,787	9,502	10,049	10,762	12,765	8.5
Number of proprietors	1,520	1,651	1,761	1,915	1,974	2,007	5.7
Farm proprietors	415	403	396	386	388	395	-1.0
Nonfarm proprietors	1,105	1,248	1,365	1,529	1,586	1,612	7.8
Total wage and salary employment	6,957	7,136	7,741	8,134	8,788	10,758	9.1
Farm	182	205	205	161	215	211	3.0
Nonfarm	6,775	6,931	7,536	7,973	8,573	10,547	9.3
Private	5,273	5,373	5,831	5,999	6,486	8,192	9.2
Ag. serv., for., fish., and other[c]	(L)	(L)	58	60	63	(D)	---
Mining	501	536	530	99	93	124	-24.4
Construction	651	629	734	849	906	1,565	19.2
Manufacturing	220	167	161	202	208	239	1.7
Nondurable goods	74	81	83	83	86	96	5.3
Durable goods	146	86	78	119	122	143	-.4
Transportation and public utilities	520	543	547	659	807	978	13.5
Wholesale trade	129	154	199	239	234	(D)[d]	16.1[d]
Retail trade	1,621	1,754	1,843	2,012	2,048	2,319	7.4
Finance, insurance, and real estate	257	262	303	315	400	541	16.1
Services	1,338	1,287	1,456	1,564	1,727	2,104	9.5
Government and government enterprises	1,502	1,558	1,705	1,974	2,087	2,355	9.4
Federal, civilian	177	159	184	196	194	207	3.2
Federal, military	74	60	61	64	67	71	-.8
State and local	1,251	1,339	1,460	1,714	1,826	2,077	10.7

[a]Estimates based on 72 SIC.

[b]Consists of wage and salary jobs (full- and part-time) plus number of proprietors.

[c]Includes number of jobs held by U.S. residents working for international organizations in the U.S. Primary source for private nonfarm employment: ES-202 covered wages - Colorado Division of Employment.

(D) Not shown to avoid disclosure of confidential data. Data are included in totals.

(L) Less than 10 wage and salary jobs.

[d]1976-80, figures not available for 1981.

Source: Bureau of Economic Analysis (1983).

Table 2.14-2. Employment by type and broad industrial sources for Mesa County, 1976-1981

Sector	Mesa County 1976[a]	1977[a]	1978[a]	1979[a]	1980[a]	1981[a]	Average annual % growth 1976-81
Employment by place of work							
Total employment[b]	28,590	31,562	33,987	36,269	38,340	41,951	8.0
Number of proprietors	4,172	4,572	4,782	5,025	5,176	5,263	4.8
Farm proprietors	1,397	1,354	1,329	1,295	1,304	1,327	-1.0
Nonfarm proprietors	2,775	3,218	3,453	3,730	3,872	3,936	7.2
Total wage and salary employment	24,418	26,990	29,205	31,244	33,164	36,688	8.5
Farm	504	562	562	444	592	581	2.9
Nonfarm	23,914	26,428	28,643	30,800	32,572	36,107	8.6
Private	18,803	21,407	23,513	25,441	27,078	30,413	10.1
Ag. serv., for., fish., and other[c]	95	108	82	90	116	132	6.8
Mining	950	1,095	1,251	1,729	2,357	2,710	23.3
Construction	1,835	2,269	2,671	2,862	2,740	3,589	14.4
Manufacturing	2,378	2,565	2,595	2,639	2,627	2,654	2.2
Nondurable goods	631	699	658	645	712	815	5.3
Durable goods	1,747	1,866	1,937	1,994	1,915	1,839	1.0
Transportation and public utilities	1,693	1,812	2,069	2,274	2,339	(D)[d]	8.4[d]
Wholesale trade	1,254	1,424	1,436	1,581	1,592	(D)[d]	6.1[d]
Retail trade	4,764	5,530	6,027	6,394	6,738	7,758	10.2
Finance, insurance, and real estate	849	947	1,094	1,209	1,344	1,561	13.0
Services	4,985	5,657	6,288	6,663	7,225	7,832	9.5
Government and government enterprises	5,111	5,021	5,130	5,359	5,494	5,694	2.2
Federal, civilian	828	900	953	996	1,048	1,074	5.3
Federal, military	262	205	212	224	241	254	-.6
State and local	4,021	3,916	3,965	4,139	4,205	4,366	1.7

[a]Estimates based on 72 SIC.

[b]Consists of wage and salary jobs (full- and part-time) plus number of proprietors.

[c]Includes number of jobs held by U.S. residents working for international organizations in the U.S. Primary source for private nonfarm employment: ES-202 covered wages - Colorado Division of Employment.

(D) Not shown to avoid disclosure of confidential data. Data are included in totals.

[d]1976-80, figures not available for 1981.

Source: Bureau of Economic Analysis (1983).

state averages. A sharp upturn in unemployment during the latter months of 1982, 8.0 percent for Garfield County and 6.7 percent in Mesa County compared to the state rate of 4.8 percent, was directly related to the shutdown of oil shale development (BMML, 1983; DRI, 1983). Unemployment will drop as the labor force is reduced through out-migration, and as workers relocate to other employment both within the study area and in other areas. The timing and extent of the decline in unemployment will depend to a large extent on the national economy and job opportunities in other areas.

2.14.2.2 Income

Tables 2.14-3 and 2.14-4 show personal income for Garfield and Mesa counties for the period 1976-1981. In Garfield County, the major sources of personal income have been services, retail trade, and state and local government. The most rapid growth was in construction, transportation and public utilities, F.I.R.E., and services. The residence adjustment, which accounts for wages and salaries earned outside the county, was over 20 percent of total personal income by place of residence for 1980 and 1981. This was because of the number of workers who lived in Garfield County but worked in the Aspen resort area or in Rio Blanco County. Mesa County, by contrast, recorded only 0.4 percent of total personal income as residence adjustment in 1980 and 1981 (BMML, 1982; Mobil, 1982a).

In Mesa County, the leading sources of personal income have been construction, F.I.R.E., services, and transportation and public utilities. The mining sector expanded most rapidly during the late 1970s, mostly due to growth of the administrative and management functions of energy companies associated with oil shale development. Other sectors where personal income showed rapid growth were retail and wholesale trade, agricultural services, and manufacturing.

Traditionally, Garfield and Mesa counties recorded per-capita income figures below the state and national averages. However, in 1980, Garfield County per-capita income was $10,055, exceeding the state figure of $10,033. Mesa County was considerably lower ($8512). For 1981, per-capita income increased by 21.4 percent in Garfield County to $12,209 and by 15.4 percent in Mesa County to $9821. At the same time, worker income by place of work was higher in Mesa County, $15,597 in 1980 compared to $13,812 in Garfield County. This phenomenon is accounted for by the residence adjustment and dividends, interest, and rents which accrue to Garfield County.

2.14.2.3 Economic and trade centers

Grand Junction serves as the major trade and service center for a multi-county area in western Colorado and eastern Utah. In 1981, services and retail trade accounted for more than 40 percent of total employment in the county and more than 80 percent of these jobs were in the Grand Junction area. Garfield County is clearly divided between the recreational and tourist activities of the eastern portions of the county and the agricultural and resource developmental activities of the western portions. In the oil shale area, the trade center is Rifle, with Parachute and Battlement Mesa serving strictly local retail needs.

Table 2.14-3. Personal income by major sources (thousands of dollars) for Garfield County, 1976-1981

Item	1976[a]	1977[a]	1978[a]	1979[a]	1980[a]	1981[a]	Avg. annual % change 1976-81
INCOME BY PLACE OF RESIDENCE							
Total personal income	118,005	129,385	153,726	190,749	229,019	303,039	20.8
Nonfarm personal income[b]	116,950	129,398	148,278	188,667	227,724	302,459	20.9
Farm income	1,055	-13	5,448	2,082	1,345	580	-11.3
Population (thousands)	19.2	19.9	20.5	21.9	22.8	24.8	6.9
Per capita personal income (dollars)	6,141	6,489	7,511	8,726	10,055	12,209	14.7
Derivation of total personal income							
Total earnings by place of work[c]	79,209	84,202	102,039	103,859	121,384	169,173	16.4
Less: personal contrib. for social insurance	3,895	4,286	4,971	5,511	6,577	9,639	19.9
Plus: residence adjustment	3,538	6,142	7,956	35,437	46,073	62,401	77.5
Equals: net earnings by place of residence	78,852	86,058	105,024	133,785	160,880	221,935	23.0
Plus: dividends, interest, and rent[d]	24,979	27,598	31,760	38,418	46,670	56,368	17.7
Plus: transfer payments	14,174	15,729	16,942	18,546	21,519	24,736	11.8
EARNINGS BY PLACE OF WORK							
Components of earnings							
Wages and salaries	65,150	69,655	79,769	85,152	102,918	148,489	17.9
Other labor income	5,312	6,065	6,926	6,133	7,338	9,750	12.9
Proprietor's income	8,747	8,482	15,344	12,574	11,128	10,934	4.6
Farm	13	-1,319	3,953	678	-428	-1,282	—
Nonfarm	8,734	9,801	11,391	11,896	11,556	12,216	6.9
Earnings by industry							
Farm	1,055	-13	5,448	2,082	1,345	580	-11.3
Nonfarm	78,154	84,215	96,591	101,777	120,039	168,593	16.6
Private	64,448	69,304	79,610	81,166	96,202	139,126	16.6
Ag. serv., for., fish., and other[f]	615	676	898	925	927	(D)[h]	10.8[h]
Mining	13,340	14,655	16,102	2,412	2,518	3,261	-24.6
Construction	10,292	9,732	11,783	14,841	16,914	37,372	29.4
Manufacturing	2,158	1,862	2,061	2,891	3,400	4,467	15.7
Nondurable goods	593	680	806	862	1,098	1,438	19.4
Durable goods	1,565	1,182	1,255	2,029	2,302	3,029	14.1
Transportation and public utilities	7,854	9,010	9,833	14,077	18,096	22,903	23.9
Wholesale trade	1,787	2,079	2,729	3,695	3,705	(D)[h]	20.0[h]
Retail trade	13,012	14,351	15,835	18,422	20,833	24,289	13.3
Finance, insurance, and real estate	2,952	3,298	4,011	4,396	5,718	8,025	22.1
Services	12,438	13,641	16,358	19,507	24,091	33,211	21.7
Government and government enterprises	13,706	14,911	16,981	20,611	23,837	29,467	16.5
Federal, civilian	2,590	2,510	2,934	3,315	3,531	4,015	9.2
Federal, military	160	139	151	174	208	240	8.4
State and local	10,956	12,262	13,896	17,122	20,098	25,212	18.1

[a]Estimates based on 1972 SIC.
[b]Total personal income less farm earnings (labor and proprietor's income) equals nonfarm personal income.
[c]Consists of wage and salary disbursements, other labor income, and proprietor's income, primary source for private nonfarm wages: ES-202 covered wages - Colorado Division of Employment.
[d]Includes the Capital Consumption Adjustment for rental income of persons.
[e]Includes the Capital Consumption Adjustment for nonfarm proprietors.
[f]Includes wages and salaries of U.S. residents working for international organizations in the United States.
[g]The estimates for Federal military earnings have been revised for the years 1977-81.
(D) Not shown to avoid disclosure of confidential information, data are included in totals.
[h]1976-1980 -- figures not available for 1981.

Source: Bureau of Economic Analysis (1983).

Table 2.14-4. Personal income by major sources (thousands of dollars) for Mesa County, 1976-1981

Item	1976[a]	1977[a]	1978[a]	1979[a]	1980[a]	1981[a]	Avg. annual % change 1976-81
INCOME BY PLACE OF RESIDENCE							
Total personal income	367,574	435,423	506,732	603,286	704,521	851,126	18.3
Nonfarm personal income[b]	360,340	429,167	503,972	594,626	698,363	846,129	18.6
Farm income	7,234	6,256	2,760	8,660	6,158	4,997	-7.1
Population (thousands)	66.6	68.6	72.2	76.9	82.8	86.7	5.4
Per capita personal income (dollars)	5,517	6,349	7,016	7,840	8,512	9,821	12.2
Derivation of total personal income							
Total earnings by place of work[c]	265,527	318,289	374,905	443,088	517,261	633,147	19.0
Less: personal contrib. for social insurance	13,260	16,267	19,552	23,701	28,071	36,385	22.4
Plus: residence adjustment	840	1,736	-59	2,448	3,023	3,231	30.9
Equals: net earnings by place of residence	253,107	303,758	355,294	421,835	492,213	599,993	18.8
Plus: dividends, interest, and rent[d]	60,377	72,361	86,686	107,859	125,087	150,977	20.1
Plus: transfer payments	56,090	59,304	64,752	73,592	87,221	100,156	13.1
EARNINGS BY PLACE OF WORK							
Components of earnings							
Wages and salaries	222,321	267,279	320,636	376,718	449,076	556,899	20.2
Other labor income	17,441	22,174	26,932	30,984	36,638	43,425	20.0
Proprietor's income	25,765	28,836	27,337	35,386	31,547	32,823	5.0
Farm	4,665	2,998	-975	5,171	1,723	344	-40.6
Nonfarm	21,100	25,838	28,312	30,215	29,824	32,479	9.0
Earnings by industry							
Farm	7,234	6,256	2,760	8,660	6,158	4,997	-7.1
Nonfarm	258,293	312,033	372,145	434,428	511,103	628,150	19.5
Private	207,576	256,427	310,876	365,743	434,177	541,227	21.1
Ag. serv., for., fish., and other[f]	800	1,136	1,071	1,173	1,320	1,659	15.7
Mining	13,968	19,421	28,364	37,242	57,121	79,141	41.5
Construction	27,877	37,147	47,123	55,216	57,120	79,276	23.2
Manufacturing	24,124	29,065	31,933	35,502	39,987	47,596	14.6
Nondurable goods	7,955	9,639	9,235	10,313	12,517	15,726	14.6
Durable goods	16,169	19,426	22,698	25,189	27,470	31,870	14.5
Transportation and public utilities	28,109	33,163	40,768	48,335	55,309	(D)[h]	18.4[h]
Wholesale trade	15,250	17,919	19,742	23,770	27,226	(D)[h]	15.6[h]
Retail trade	39,325	46,591	54,129	61,828	71,516	87,284	17.3
Finance, insurance, and real estate	9,554	11,784	15,391	18,090	21,240	26,006	22.2
Services	48,569	60,201	72,355	84,587	103,338	122,634	20.4
Government and government enterprises	50,717	55,606	61,269	68,085	76,926	86,923	11.4
Federal, civilian	13,520	15,921	17,669	19,623	21,786	24,176	12.3
Federal, military	587	483	537	615	753	899	8.9
State and local	36,610	39,202	43,063	48,447	54,387	61,848	11.1

[a]Estimates based on 1972 SIC.
[b]Total personal income less farm earnings (labor and proprietor's income) equals nonfarm personal income.
[c]Consists of wage and salary disbursements, other labor income, and proprietor's income, primary source for private nonfarm wages: ES-202 covered wages - Colorado Division of Employment.
[d]Includes the Capital Consumption Adjustment for rental income of persons.
[e]Includes the Capital Consumption Adjustment for nonfarm proprietors.
[f]Includes wages and salaries of U.S. residents working for international organizations in the United States.
[g]The estimates for Federal military earnings have been revised for the years 1977-81.
(D) Not shown to avoid disclosure of confidential information, data are included in totals.
[h]1976-1980 -- figures not available for 1981.

Source: Bureau of Economic Analysis (1983).

For this area of Garfield County, however, the major service and trade center is Grand Junction in Mesa County. In fact, many of the administrative functions of the companies involved in day-to-day oil shale development are located in the Grand Junction metropolitan area (Mobil, 1982a; DRI, 1983).

2.14.3 Population

This section presents a summary of historical and current demographic characteristics for Garfield and Mesa counties. The emphasis of this discussion is on the period from 1970 to the present. Census data are available for 1970, 1977 (Special Census), and 1980. The discussion below includes: historical population trends, age, sex, racial/ethnic characteristics, and household size.

The population in Garfield County increased from 11,625 in 1950 to 12,017 in 1960, less than 4 percent for the decade. In contrast, the Mesa County population increased from 38,974 to 50,715, over 30 percent during the same period, mainly because of uranium, and oil and gas development. By comparison, the population increase for the state of Colorado during the decade was just over 32 percent (Mobil, 1982a; BMML, 1983).

During the 1960s, Garfield County grew by 23 percent to 14,821 while Mesa County increased by only 7.2 percent to record a population of 54,374 at the time of the 1970 Census. Both these growth rates were under the state figure of 26.6 percent increase for the same period (Mobil, 1982a; BMML, 1983).

Table 2.14-5 shows the 1970, 1977, and 1980 census population figures for the two counties. In contrast to the earlier growth rates, the overall trend was sharply upward for the 1970s. For the decade, the Garfield County population increased by 51.9 percent, while in Mesa County the figure was 49.9 percent. The state increase for the period 1970-1980 was 30.8 percent, while the national average was 11.4 percent.

The growth rates for the period 1970-1977 were greater than for the preceding decades, with Garfield County recording an average annual rate of 3.5 percent and Mesa County 3.0 percent compared to the state rate of 2.5 percent. For the period 1977-1980, these rates were up sharply, with Garfield County recording an average annual rate of 6.2 percent and Mesa County 6.8 percent. For the same period, the state rate was 3.3 percent.

During the period 1977-1980, the major Garfield County growth took place in Rifle (43.3 percent), Carbondale (26.8 percent), and the unincorporated areas (18.9 percent). For Mesa County, the greatest proportional increases were in Palisade (49.4 percent), the unincorporated areas (29.0 percent), and Fruita (20.7 percent). The Mesa County unincorporated areas increased from 56.1 percent of the county population in 1977 to 59.4 percent in 1980.

The 1970 median ages for Garfield (30.0 years) and Mesa (30.2 years) counties were significantly higher than for the state as a whole (26.2 years). The elderly (those 65 years of age or more) accounted for 11.3 percent of the population in Garfield, and 12.0 percent in Mesa compared to 8.5 percent for the state. By 1980, the county figures had converged with the state figures--the median age for Garfield County and the state was the same, 28.6 years, while Mesa County was

Table 2.14-5. Population in Garfield and Mesa counties, 1970-1983

Place	Pop.[a] 1970 census	Pop.[b] 1977 census	Average annual growth rate 1970-77 (%)	Pop.[a] 1980 census	Average annual growth rate 1970-80 (%)	Average annual growth rate 1977-80 (%)	Pop. 1981[d]	Pop. 1982[d]	Pop. 1983[d]	Average annual growth rate 1980-83 (%)
Garfield County	14,821	18,800	3.5	22,514	4.3	6.2	27,054	29,160	27,521	6.9
Carbondale	726	1,644	12.4	2,084	11.1	8.2	2,278	2,313	2,344	4.0
Glenwood Springs	4,106	4,091	--	4,637	1.2	4.3	4,935	4,978	5,000	2.5
Grand Valley (Parachute)	270	377	4.9	338	2.3	-3.4	834	1,119	855	36.2
New Castle	499	543	1.2	563	1.2	1.2	623	670	644	4.6
Rifle	2,150	2,244	0.6	3,215	4.1	12.7	4,861	5,290	4,959	15.5
Silt	434	859	10.2	923	7.8	2.4	1,102	1,161	1,113	6.4
Unincorporated[c]	6,636	9,042	4.5	10,754	4.9	6.0	12,421	13,629	12,606	5.4
Mesa County	54,374	66,848	3.0	81,530	4.1	6.8	86,084	86,955	84,847	1.3
Collbran	225	293	3.8	344	4.3	5.5	348	344	344	--
DeBeque	155	264	7.9	279	6.1	1.9	344	371	341	6.9
Fruita	1,822	2,328	3.6	2,810	4.4	6.5	2,994	3,021	2,950	1.6
Grand Junction	20,170	25,398	3.3	28,144	3.4	3.5	30,029	30,314	29,364	1.4
Palisade	874	1,038	2.5	1,551	5.9	14.3	1,784	1,817	1,729	3.7
Unincorporated	31,128	37,527	2.7	48,402	4.5	8.9	50,585	51,088	50,119	1.2
State of Colorado	2,209,596	2,625,308	2.5	2,889,964	2.7	3.3				

[a]Colorado State Demographers Office (1981).
[b]U.S. Bureau of the Census (1979).
[c]Includes Battlement Mesa.
[d]PAS estimates.

Source: BMML (1982); Bureau of Economic Analysis (1983).

only slightly higher at 29.0 years. The proportion of elderly had dropped to 8.9 percent in Garfield County and 10.7 percent in Mesa County. The state rate was up slightly to 8.6 percent (Mobil, 1982a).

The Garfield County male/female ratio changed from 49.6 percent male in 1970 to 50.9 percent in 1980. For Mesa County there was a similar trend with the male population increasing from 48.9 to 49.6 percent in 1980 (Mobil, 1982a).

Individuals of school age (ages 5 to 18) made up almost a quarter of the population for Garfield and Mesa counties in 1970. By the time of the 1980 U.S. Census, this age group had decreased to just over 20 percent of the population. In absolute numbers, the school age population grew by more than 4000 persons because of the general population increase in the two-county area (Mobil, 1982a).

In 1980, almost 20 percent of the population in Garfield County aged 18 and older had not finished high school. In Mesa County, the figure was over 25 percent, compared to the state's 21.3 percent. The proportion of the population who had 4 or more years of college was 17.3 percent for Garfield County, 14 percent for Mesa County, and 19.8 percent for the state (Mobil, 1982a).

Racial/ethnic composition of the population is overwhelmingly white, with both Garfield and Mesa counties recording more than 99 percent in this category for 1970. For 1980, Garfield County was 99.3 percent white, while in Mesa County the figure was 95.8 percent. The Hispanic population in 1980 was 4.2 percent in Garfield County and 7.0 percent in Mesa County. The 1980 Colorado figure for Hispanics was 12.0 percent (BMML, 1983).

In 1970, household sizes in both Garfield (2.98) and Mesa (2.97) counties were lower than the state average of 3.08 persons per household. By 1980, the state figure had dropped to 2.65, while those in Garfield County (2.77) and Mesa County (2.75) declined less rapidly. The 1980 proportion of the population over 14 years of age which was married was 63 percent for Garfield County and 62 percent for Mesa, a slight decline from the 1970 figures of 69 and 65 percent, respectively. The 1980 state figure was 58 percent (Mobil, 1982a).

2.14.4 Housing

The number of housing units recorded by the 1970 and 1980 Census for Garfield and Mesa counties is shown in Table 2.14-6. Housing stock increased by almost 69 percent in Garfield County and by almost 72 percent in Mesa County during the decade. In both counties, the rate of increase in the housing stock was greater than the rate of population increase because of the decline in average household size.

About half of the housing stock increase took place between the time of the 1977 Special Census and the 1980 Census when 8815 units were built in the two counties. During that 3-year period, Mesa County recorded 51.6 percent and Garfield County recorded 49.6 percent of the total decade's growth in new housing units.

During the 18-month period from April 1980 to October 1981, an additional 5871 housing units were added to the two counties (Colorado West Area Council of

Table 2.14-6. Total housing units in Garfield and Mesa counties, 1970-1980 and estimated building activity, April 1980 - October 1981

Place	1970	1980	Increase 1970-1980		April 1980 - October 1981			
			Number	Percent	Single	Multifamily	Mobile	Total
Garfield County	5,537	9,345	3,808	68.8	312	1,229	643	2,184
Carbondale	264	830	566	214.4	6	46	--	52
Glenwood Springs	1,574	2,160	586	37.2	42	47	--	89
Parachute (Grand Valley)	120	144	24	20.0	2	207	39	248
New Castle	200	255	55	27.5	2	24	1	27
Rifle	803	1,370	567	70.6	57	541	265	863
Silt	155	357	202	130.3	23	14	8	45
Unincorporated	2,421	4,229	1,808	74.7	180	350	330	860
					(14%)	(56%)	(30%)	100%
Mesa County	18,982	32,573	13,591	71.6	1,654	1,173	860	3,687
Collbran	113	159	46	40.7	5	2	8	15
Clifton Area					370	336	232	938
DeBeque	82	136	54	65.9	2	4	6	12
Fruita	635	1,025	390	61.4	69	18	27	114
Grand Junction	7,626	12,706	5,080	66.6	1,022	779	435	2,236
Palisade	351	657	306	87.2	17	22	23	62
Unincorporated	10,175	17,890	7,715	75.8	169	12	129	310
					(45%)	(32%)	(23%)	100%
Total	24,519	41,918	17,399	71.0	1,966	2,402	1,503	5,871
					(33%)	(41%)	(26%)	100%
State of Colorado	757,070	1,194,253	437,183	57.7				

Source: U.S. Bureau of the Census (1971, 1981); Colorado West Area Council of Governments (1982); BMML (1982).

Governments, 1982). This rate of building is even higher than that achieved during the 1977 to 1980 period.

The mix of new housing constructed during 1980 and 1981 was largely multifamily and mobile units, especially in Garfield County where only 14 percent of the new units were single-family dwellings while 56 percent were multifamily and 30 percent were mobile homes. Rifle, Parachute, and the unincorporated areas (including Battlement Mesa) accounted for the largest portion (1732 units or 93 percent) of new multifamily and mobile units added in Garfield County. For Mesa County, single-family units were 45 percent of the total built during this time, while 32 percent were multifamily and 23 percent were mobile homes. The Grand Junction and Clifton areas accounted for 86 percent of the new construction. This rate of building activity appears to have continued into mid-1982, when the announcement of the Colony shutdown was made.

The physical condition of housing stock is generally good. Many of the units are less than 5 years old. In October 1981, Rifle recorded over 60 percent of its units as less than 5 years old. The entire stock of housing at Battlement Mesa, including 62 single-family homes, 280 apartments, and the mobile homes (600 sites available), is less than 3 years old (DRI, 1983).

The value of owner-occupied housing in Garfield and Mesa counties rose more rapidly during the 1970s than was the case for Colorado as a whole. The percent increase in Garfield County was the greatest, 407 percent for the decade. For Mesa County the increase was 346 percent, while the increase for the state was 273 percent. Median rents also increased more rapidly than the state average of 132 percent between 1970 and 1980: a 241 percent increase in Garfield County, and a 203 percent increase in Mesa County (BLM, 1983). Part of the increase was because of the fact that a large proportion of the housing stock was new construction, and because lower-than-average costs had prevailed in the area in 1970. For example, rents in Mesa County in 1970 were only about three quarters as much as the state rate, but rose to the same level by 1980. This increase was because of the strong demand late in the decade. The same basic pattern was true for owner-occupied housing values.

The decline in housing demand which has taken place in late 1982 and 1983 has resulted in lower prices for houses, lower rental costs, increased vacancy rates, and abrupt declines in housing starts (DRI, 1983).

2.14.5 Public facilities and services

This section provides an outline and brief description of the services most commonly provided by local government, including police and fire protection; water supply; wastewater and solid waste removal; education; health care; general government; energy/transportation; and human services.

2.14.5.1 Police protection

Law enforcement facilities and services are described in Table 2.14-7. Police personnel, equipment, and facilities are shown for the Garfield and Mesa

Table 2.14-7. Law enforcement service, equipment, and facilities

Place	Service area	1982[a] service population	Personnel		Equipment		Facilities sq ft[d]	Calls for service 1981
			Sworn	Nonsworn[b]	Patrol	Other[c]		
Garfield County								
Garfield County Sheriff's office	Unincorporated Garfield County	13,629	24	5	10	1	1,956	1,821
Rifle	Incorporated city limits and Rifle Mountain Park	5,290	16	10.5	5	1	3,040	7,329
Parachute	Incorporated city limits	1,119	7	5	2	—	1,800	N/A
Mesa County								
Mesa County Sheriff's office	Unincorporated Mesa County	51,088	46	24	9	19	11,100	15,804
Grand Junction	Incorporated city limits	30,314	65	32	12	17	7,881	28,946
Fruita	Incorporated city limits	3,021	7	5	3	1	1,075	1,163
Palisade	Incorporated city limits	1,817	4	—	3	—	384	2,448
Collbran	Collbran incorporated area, County from I-70 to Vega Reservoir, and Mesa Lakes	344	1	1	2	—	100	N/A
DeBeque	Incorporated city limits and east end of Mesa County	371	2	—	2	—	480	N/A

[a]PAS estimates, see Table 2.14-5.
[b]Nonsworn = communications, clerical, reserves, etc.
[c]Nonmarked autos, meter wagons, animal vans, motorcycles, snowmobiles, boats, etc.
[d]Garfield Sheriff has two offices, one at Glenwood Springs and the other at Battlement Mesa. Other agencies have one office each.

Source: BMML (1982); Bureau of Economic Analysis (1983).

County Sheriff's offices and for the police departments of Rifle, Parachute, Grand Junction, Fruita, Palisade, Collbran, and DeBeque.

Calls for service have risen as the population of the area has increased over the last several years. Incidents of frequent report are driving while intoxicated, disorderly conduct, family disturbances, theft from construction sites, and traffic problems (Mobil, 1982a).

Jail facilities for Garfield County are located in Glenwood Springs, which requires about a 4-hour round trip from the Parachute/Battlement Mesa area. In addition, these county facilities are currently in excess of capacity. Mesa County's facilities have recently been upgraded and are considered adequate (BLM, 1983b).

2.14.5.2 Fire protection

Fire protection facilities and services are listed in Table 2.14-8. Of the nine fire departments and districts that are profiled in the table, only one, the Grand Junction Fire Department, is a full-time professional department. The others are volunteer units. Increasing population and housing have increased the demand for fire protection and facilities for some of the districts. All the departments have made efforts to address these problems. Major additions have been made to the Grand Valley Rural Fire Protection District with the facilities and equipment at Battlement Mesa.

2.14.5.3 Water, wastewater, and solid waste

Water

Water system characteristics are summarized in Table 2.14-9. The Ute Water Conservancy District is a primary water supplier in the Grand Valley. Its main sources of domestic water are reservoirs on Grand Mesa and the Colorado River. Other suppliers are the city of Grand Junction, the towns of Fruita and Palisade, and the Clifton and Ridges Metro Water Districts. In the DeBeque vicinity, the towns of DeBeque and Collbran, along with the privately owned Mesa Water Works Company, provide water to about 1000 people. In the Rifle vicinity, the town of Parachute and the city of Rifle operate municipal systems that also supply some of the surrounding areas. Battlement Mesa has established a Planned Unit Development (PUD) to take care of the water supply and wastewater treatment (BMML, 1982).

Water suppliers have responded to recent population and housing increases by upgrading existing systems, planning and building new facilities, increasing the number of operating personnel, and in some cases (e.g., Battlement Mesa) creating new and modern capabilities. During the early 1980s, more than $20 million have been committed or spent in the Grand Valley area on the water systems. At the present time, all the systems are adequate and several have substantial excess capacity that will accommodate future growth (BLM, 1983b).

Table 2.14-8. Fire protection services, equipment, and facilities

	Population served	Area sq mi	Personnel: Volunteer	Personnel: Professional	Equipment: Pumpers	Equipment: Rescue/ ambulance	Equipment: Other	Stations: Location	Stations: Sq ft
Rifle Rural Fire Dist.	6,000-7,000	294	31		3	2	2	Rifle	6500
Grand Valley Rural Fire Protection Dist. (Parachute, Battlement Mesa)		360	30		3	2	2	Parachute Battlement Mesa	2400 5000
Plateau Valley Fire Protection Dist.			20		4	2		Collbran Mesa	4000 4000
DeBeque Fire Dept.	500	Town + 5 mi radius	12		1	2	1	Old Town Hall	928
Palisade Fire Dept. and Palisade Fire Protection Dist.			25		3	1		Palisade	2000 3000
Clifton Fire Protection Dist.	17,000-18,000	16	20		3	1	1	3254 "F" Rd.	5 bays
Grand Junction Rural Fire Protection Dist.					2	1	1		
Grand Junction Fire Dept.	75,000	784		66[a]	3	2	7	330 S. 6th 1135 N. 18th 251 27 1/2 Rd. 582 25 1/2 Rd.	3900 3500 6000 7200
Lower Valley Fire Protection Dist.	10,000-20,000	100	24		3	2		Fruita	4000

[a]Including two clerical.

Source: BMML (1982).

Table 2.14-9. Water system customer demand, 1981

System	Average daily demand	Peak daily demand	Water rights/source	Facility capacity
Town of Fruita	239,000 gpd	375,000 gpd	Pinion Mesa: 27 cfs Colorado R: 25 cfs (seldom used)	Another 1,000 pop; with $2 million improvements, 12,000 capacity; with $3 million, 24,000 capacity.
City of Grand Junction	6 mgd	14 mgd	Colorado R. & Gunnison R.; 59,000 m.g.p.a., Kannah Ck. & North Fork; 2,507 m.g.p.a. Some very junior rights	At treatment, flow line, and storage capacity during peak days.
Town of Palisade	538,374 gpd	1.6 mgd	Springs; surface runoff in reservoirs on Grand Mesa; senior rights.	400 additional taps with improvements; 5,000-6,000 pop. total capacity.
Clifton Water District	3 mgd	8 mgd	Colorado R.: 20 cfs Grand Valley Irrigation District: 2.12 cfs (207 shares) Gr. Jct.: 0.5 mgd	1,200 additional taps, total 136,700 tap with 12 mgd treatment capacity. Adequate for 10 years.
Ridges Metro District	80,000 gpd	200,000 gpd (approx.)	Water purchased from Ute District, no limit on amount.	10,000 pop. capacity 8,900 additional, 2.6 mgd system capacity.
Ute Water District	5 mgd	8 mgd	Colorado R.: 14 cfs (absolute), 1 cfs (conditional) Jerry Ck. Res.: 10,693 ac-ft (conditional);	With improvements completed by 1984: approx. 168,000 pop. or year 2000.

Table 2.14-9 (continued)

System	Average daily demand	Peak daily demand	Water rights/source	Facility capacity
Ute Water District (continued)			Ute pipeline: 30 cfs (conditional); Ute pumping station: 50 cfs (conditional); water rights adequate to 1990.	
Town of DeBeque	NA	NA	Colorado R.: 0.47 cfs	Approx. 480 additional pop. (200,000 + 240 gpd).
Town of Collbran	50,000 gpd	150,000 gpd	Spring at Buzzard Ck.: 600,000 gpd; Grove and Plateau cks. not used.	25-30 additional taps.
Mesa Water Works Co.	26,000 gpd (winter)	52,000 gpd (summer)	Ute Spring: 1 cfs 2 well: 1 cfs & 0.4 cfs	200 taps estimated total capacity
Battlement Mesa Inc.	NA	NA	Colorado R.: 30 cfs	NA
Town of Parachute	150,000 gpd	285,000 gpd	Springs in Revell Drainage: 2 cfs Colorado R.: 30 cfs	2,500 pop. capacity; with treatment plant expansion, 8,000.
City of Rifle	655,000 gpd (Jan-Mar 1982)	2 mgd (June 1981)	Colorado R. Beaver Ck. Rifle Ck. Water rights unknown.	2,000 pop. capacity
Rifle Village South Metro District	NA	NA	NA	NA

cfs = cubic feet/second.
gpd = gallons per day.
mgd = million gallons/day.
NA = not available.

Source: BMML (1982); BLM (1983b).

Wastewater

Wastewater services and facilities are outlined in Table 2.14-10. The communities appear to have adequate treatment facilities to meet present demand. The smaller rural communities and unincorporated areas are mostly operating at or near capacity and would require upgrading if demand were to rise sharply. The EPA has established a 201 planning region for Grand Junction and the adjacent providers. This 201 region has already completed considerable examination and planning work for the area, including scheduling construction and operation of a new $18.98 million treatment plant. The plant will have a capacity of 12.5 million gallons per day (mgd) and serve 98,500 people. The scheduled completion date is 1984. Rifle has commissioned a 4.16 mgd plant capable of serving 10,700 people, while the new PUD facilities at Battlement Mesa were designed for a population of 25,500 (BMML, 1982; BLM, 1983b).

Solid waste

Solid waste management is the responsibility of the two counties, with collection varying with each municipality or jurisdiction. The new Garfield County landfill has a capacity of 160 acres and should handle the county's solid waste disposal needs at least through the year 2000. Mesa County has two landfills. However, the Orchard Mesa site (140 acres leased from the BLM) has reached capacity. The county is in the process of adding an additional 140 acres to the landfill, which should meet current needs and provide capacity for significant growth. Also, a solid waste management plan is being prepared for Mesa County to correct inefficiencies in the collection and handling of wastes (BMML, 1983).

2.14.5.4 Education

School districts

The school districts discussed in this section include two in Garfield County and three in Mesa County. The district boundaries are shown in Figure 2.14-1. Garfield County School Districts are RE-16, which includes Parachute/ Battlement Mesa, and RE-2 which includes Rifle, New Castle, and Silt. The Mesa County School Districts are: District #51, which includes Grand Junction, Fruita, and Palisade; District #50, which includes Collbran, Mesa, Plateau City and Molina; and Joint District #49, which includes DeBeque in Mesa County and Roan Creek valley in Garfield County. Recent enrollments and the 1980 student/ teacher ratios are shown in Table 2.14-11.

Garfield County School Districts have shown dramatic growth because of oil shale development. School District RE-2 (Rifle) increased its enrollment from 1601 for the 1979-80 school year to 1916 for the 1980-1981 session, a 19.6 percent rise. For 1981-1982, the district recorded another increase of 14.8 percent, enrolling 2200 students. For 1982-1983, enrollment increased to 2359. During the last 4 years, the district has received more than $13 million from the Oil Shale Trust Fund (OSTF). These funds have been used mostly to expand facilities to accommodate enrollment increases. At the present time, the school district has a maximum capacity of 3475 students (BLM, 1983b; BMML, 1982).

Table 2.14-10. Wastewater systems

Place	Average daily demand	Peak daily demand	Type of treatment	Facility capacity
Central Grand Valley Sanitation District	378,000 gpd	945,000 gpd	Contracts with Grand Junction	5,000 population capacity now; 42,500 population with expansion
Clifton Sanitation District #1				
Clifton Sanitation District #2	630,000 gpd	1,050,000 gpd	2 plants in south of district with 2 aerated cells and one contact chlorination cell	434 more units on east treatment plant; total of 4,000 on west treatment plant; total population capacity of 20,000
Town of Fruita	(3,500 taps)	N/A	One plant southwest of town; three cells, aerated lagoons	Total population of 10,800 can be served now; 20,000 with additional cell.
Fruitvale Sanitation District	520,000 gpd	650,000 bpd	Contracted with City of Grand Junction	700 additional taps or 2,310 people
City of Grand Junction	5.35 mgd (1981) average annual	8.7 mgd (Dec. 1981)	Plant at west Grand River Rd. with trickling filter and vacuum sludge drying	System is operating over capacity; new plant will come on line in 1984 with a 12.5 mgd capacity capable of serving 98,500
Mack Sanitation District	(90 taps/ 350 people)	N/A	2 non-aerated lagoons	350 additional equivalent taps have already been sold, thus the system cannot accept additional development
Orchard Mesa San District	(1,600 taps, 1980)	N/A	Contract with City of Grand Junction (1,200 additional population capacity)	8,000 total population capacity

Table 2.14-10 (continued)

Place	Average daily demand	Peak daily demand	Type of treatment	Facility capacity
Town of Palisade	100,628 gpd	211,888 gpd	Two non-aerated lagoons (6,400 additional population capacity)	2,800 total population capacity
Ridges Metro District	60,000 gpd	150,000 gpd	Contract with City of Grand Junction	2.6 mgd or 10,500 people total capacity
Town of Collbran	70,000 gpd	190,000 gpd	Activated sludge, oxidation ditch	Collection and treatment facility are at capacity
Town of DeBeque	50,000 gpd	75,000 gpd	Lagoons: aerated cell 1 settling pond 1 chlorine contact	830 population capacity (approx. 500 additional population)
Mesa Water & Sanitation District	60 taps/ 170 people)	N/A	1 non-aerated lagoon	400 tap capacity (340 additional taps)
Battlement Mesa, Inc.	N/A	N/A	2 aerated lagoons (interim plant)	25,500 total population
Town of Parachute	(330 taps/ 1,200 people)	N/A	Uses BMI treatment plant	8,000 population or 3,500 capacity; (additional 3,150 taps)
City of Rifle	(1,694 taps/ 5,500 people)	N/A	Lagoons west of town 2 aerated cells; 1 non-aerated	10,700 total population treatment capacity
Rifle Village South Metro District	N/A	N/A	3 cell, aerated lagoons on south side of Colorado River	N/A

gpd = gallons per day.
mgd = million gallons/day.
N/A = not available.

Source: BMML (1982); BLM (1983b).

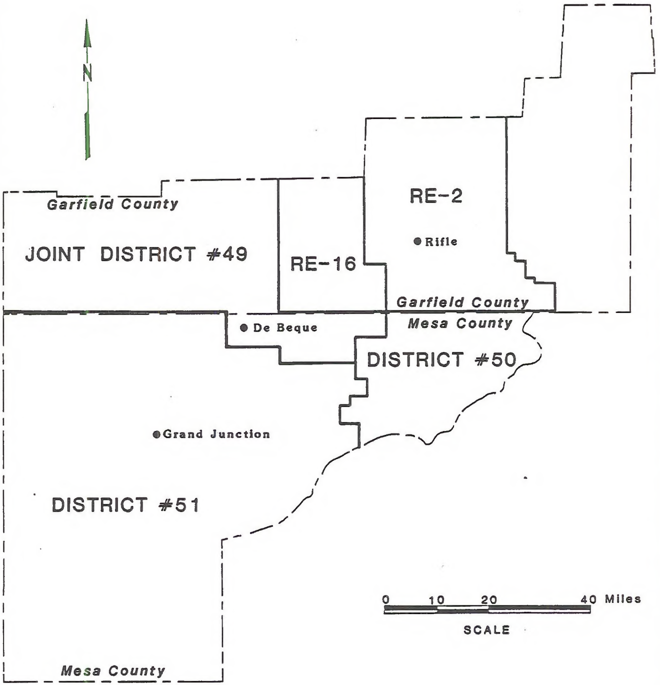


Figure 2.14-1. School district boundaries, Garfield and Mesa counties

Source: BLM, 1982.

Table 2.14-11. School enrollments by district, Garfield and Mesa counties

School district		1976	1977	1978	1979	1980	1981	1982	1980 student/ teacher ratio
Garfield County									
RE-16	Parachute/ Battlement Mesa	176	165	173	179	202	434	628	18.5
RE-2	Rifle, New Castle, Silt	1,466	1,467	1,467	1,601	1,916	2,200	2,359	18.1
Mesa County									
District #51	Grand Junction, Fruita, Palisade	13,293	13,653	14,126	14,621	15,075	15,630	16,188	19.1
District #50	Collbran, Mesa, Plateau City, Molina	284	288	322	342	375	393	421	18.1
Joint District #49	DeBeque, Roan Creek Valley	145	132	117	119	113	122	165	9.1

Source: BMML (1982); BLM (1983b).

School District RE-16 (Parachute) had only 179 students enrolled for the 1979-1980 school year. The following year, it experienced an increase to 202, up 12.8 percent. For 1981-1982, however, a dramatic rise to 434 more than doubled the number of students (up by 114.9 percent). Enrollment rose again for the 1982-1983 school year when 628 students were attending classes, an increase of 44.7 percent. Thus, over a 4-year period, enrollment increased by almost 251 percent. The addition of a new elementary school (1982) and junior high school (1983) in Battlement Mesa raised the maximum capacity of the district to 1105. In spite of the growth, the district is in a relatively strong financial position, largely because of external assistance. In 1982, the district received $3,988,500 in direct payments from oil shale developers and $1,117,682 from the Oil Shale Trust Fund and Energy Impact Assistance Fund (BMML, 1982).

School districts in Mesa County, including Joint District #49, were not as severely impacted by enrollment increases resulting from oil shale development. District #49 showed the fastest growth rate (11.5 percent per year) as its enrollment increased from 119 in 1979 to 165 in 1982. While these rates of increase were not as dramatic as those recorded for the Garfield County School Districts, they, nonetheless, made major demands on these systems. Joint District #49 has sufficient capacity for about 180 to 190 students. In early 1982, the enrollment reached 165, but following shutdown of the Colony Project and other oil shale projects, enrollment dropped by 22 percent. In January 1983, there were 128 students enrolled, about 70 percent of capacity (DRI, 1983).

District #50 increased its enrollment from 342 in 1979 to 421 in 1982, a 7.2 percent average annual rate of increase. Overcrowding because of rising enrollments has resulted in class sizes as large as 42 students. The recent decline in employment and population has relieved the enrollment pressures and the school district is currently operating within capacity. Future growth may require new facilities, with a new elementary school the most likely addition to be made (BMML, 1983).

District #51, which includes Grand Junction, is a large urban system that enrolled over 16,000 students in 1982-1983. Its size allowed it to assimilate the oil shale-induced growth. For the period 1979 to 1982, the district grew at the rate of 3.4 percent per year. At the current time, the district has capacity for an additional 200 to 300 students at each of the three levels: elementary, junior high, and high school (BMML, 1982).

School districts in the study area have experienced a number of different fiscal conditions and currently face distinctly different problems. The rapid growth of the enrollments in RE-2 (Rifle and vicinity) and RE-16 (Parachute/Battlement Mesa) has required large increases in expenditures for all phases of school operations. These two districts have also made major additions to their facilities in recent years.

The state equalization formula for funding education tends to adequately compensate the districts for the operating costs of increased enrollments. In addition, the Garfield County districts also received substantial state aid through the Oil Shale Trust and Energy Impact Assistance Funds. RE-16 will eventually realize large increases in its assessed valuation because of the development of energy projects. For RE-2, most of the increase will be indirect, through residential, commercial, and industrial development, since the major oil shale sites are outside the school district boundaries.

In the case of Joint District #49 (DeBeque and vicinity) any substantial increases in enrollment would overtax the district facilities. The district has been allocated only minor amounts from the Oil Shale Trust and Energy Impact Assistance Funds, about $80,000 between 1978 and 1982 (BMML, 1982). In the case of oil shale development in the Roan Creek area, however, the district could realize large additions to its assessed valuations.

Operating funds for District #50 schools in Mesa County have about kept pace with growth because of state equalization funds. The district received a grant of $100,000 from the Oil Shale Trust Fund, which was used to build a new vocational education shop facility and to convert the old shop into classrooms. There is no bonded indebtedness and the district has a debt capacity of over $2 million, about the amount required to build a new elementary school. However, voters recently turned down a land purchase proposal in which the county had offered to pay half the $155,000 purchase price. There is doubt that local voters would agree to use the bonding capacity for a new school at this time, and the district capacity must be considered to have been reached (BMML, 1982).

The financial profile of District #51 clearly describes a more urban school system than the other districts in the study area. As an urban district, #51 has faced many problems common to other areas; operating revenues have barely kept pace with inflation and enrollment increases have strained the district's facilities. Voters approved a $23.6 million first phase of a four-phase capital improvement program in 1980. The district is concerned about future facility needs as enrollments increase in the upper grades. The geographical distribution of demand due to new housing development is also a concern. The district has not received significant amounts from the Oil Shale Trust Fund; in the mid-1970s about $400,000 was obtained (BMML, 1982).

Higher education

Colorado Mountain College is a community college providing 1- and 2-year programs for nine Western Slope counties. The college serves about 20,000 persons overall and has centers in Glenwood Springs, Rifle, and Carbondale. It also provides classes in other communities as the need arises.

Mesa College, in Grand Junction, is a 4-year, state- and tuition-supported school that offers a number of degree programs. Mesa College's Area Vocational School also provides a wide variety of training programs, and offers certificates of occupational proficiency and associated degrees.

2.14.5.5 Health care

Hospitals and clinics

The region provides health care to the general public through six hospitals and one community clinic/emergency center. The Veterans Administration Hospital in Grand Junction provides only specialized services and is not available to the general public. The remaining public facilities are shown in Table 2.14-12. The Clagett Memorial Hospital in Rifle and the Plateau Valley Clinic in Collbran are public facilities operated by hospital districts. Clagett Memorial has steadily expanded, added to its services, and is now considering construction of a new

Table 2.14-12. Area hospitals

Hospital	Number of licensed beds	Planned bed expansion	Number of physicians
Grand Junction Osteopathic Hospital	78	--	36
St. Mary's Hospital & Medical Center (Grand Junction)	222	40	150+
Mesa Memorial Hospital (Grand Junction)	42	(division of St. Mary's Hospital & Medical Center)	
Lower Valley Hospital (Fruita)	20	--	11
Plateau Valley Clinic (Collbran) (Plateau Valley Hospital District)	2	--	1
Clagett Memorial Hospital (Rifle) (Grand River Hospital District)	32	--	4

Source: BMML (1982); BLM (1983b).

90-bed hospital by 1990. The Plateau Valley Clinic provides out-patient and emergency care, but refers patients needing hospitalization to other area facilities. St. Mary's Hospital and Medical Center and Mesa Memorial Hospital (a division of St. Mary's) provide 264 licensed beds, or 66 percent of the beds in the Grand Valley area. In 1981, these joint facilities admitted 13,044 patients. Services included at St. Mary's are all those found in major metropolitan facilities with the exception of open-heart surgery and organ transplants. The Grand Junction Osteopathic Hospital is the second largest facility in the area. It provides full service care and in 1981 recorded 3116 in-patient admissions (BMML, 1982).

Public health

Garfield County Public Health Department has a staff of nine and operates out of three offices located in Glenwood Springs, Rifle, and Parachute. The department is responsible for a visiting nurse, health education programs, and other services. Environmental health functions are the responsibility of the Department of Development.

Mesa County Public Health Department provides similar services under two categories: nursing programs and environmental health programs.

2.14.5.6 General government

Garfield County is governed by three elected Commissioners, each serving a 4-year term. Other elected officials include the County Assessor, County Treasurer, County Clerk and Recorder, and the District Attorney. Currently, the administrative staff totals 116. The county is responsible for the construction and maintenance of county roads and bridges, land use planning for the unincorporated areas, maintenance of the county fairgrounds, and law enforcement in the unincorporated areas. The Garfield County Library is part of the Three Rivers Regional Library System (BMML, 1982; Mobil, 1982a).

Municipalities provide many of their own services: water and sewer, law enforcement, street maintenance, planning and zoning, and recreation. The City of Rifle has a Manager-Council government. Appointed boards include: the Planning Commission, Board of Adjustments (zoning), Building Commission, Rifle Housing Authority, and the Senior Citizen Center. The city administrative staff numbers 19. Parachute is a statutory town with a Mayor and Board of Trustees. City boards and commissions include: Planning and Zoning Commission, Parks Commission, Water and Sewer Commission, and the Police Board. The town employs approximately eight full-time people. Battlement Mesa is an unincorporated Planned Unit Development (PUD) that is administered by Battlement Mesa, Incorporated. New Castle has a Mayor and six-member Board of Trustees. An appointed Town Administrator is responsible for planning and daily operations. Services include: water and sewer, street maintenance, and law enforcement. The town of Silt has a Mayor and a six-member Board of Trustees. The town employs 11 people for police, public works, and administrative services (BMML, 1982; Mobil, 1982a).

Mesa County elects three Commissioners, each for a 4-year term. They appoint a County Administrator to supervise daily operations. The administrative departments include: Legal, Judicial, Finance, Accounting, Planning, Building Inspection, Surveying, Clerk and Recorder, Assessor, Treasurer, Personnel, Computer Services, and Ground and Buildings. Total employment is approximately 190. Mesa County has a Development Department for planning functions. Other county functions are overseen by nonsalaried county boards, including: Highways, Fire, Health, Library, Museum, Parks and Recreation, Social Services, Adjustment, and the Airport Authority (BMML, 1982; Mobil, 1982a).

The City of Grand Junction has a Council-Manager form of government. The Council is made up of seven elected members, five of which are elected from districts, and two of which are elected at-large. Important boards and commissions are: the Planning Commission, Advisory Commission for Parks and Recreation, Parking Authority, Downtown Development Authority, and the Grand Junction Housing Authority. The city administrative staff totals about 63 (BMML, 1982; Mobil, 1982a).

Fruita is a home rule town with a Council-Manager government. Appointed boards and commissions include: Planning Commission, Board of Adjustment, Police Commission, Parks and Recreation, and Elections. The town has about seven full-time employees. Palisade is a statutory town with a Council-Manager government. The city has three full-time and three part-time employees. Members of the Planning Commission and the Board of Adjustments are appointed. DeBeque has a Mayor and six Town Councilmen. Boards include the Planning Commission and the Contractors' License Board. Town administration is provided by a part-time "circuit rider" who is employed by the state and who is shared with Collbran. Collbran has a mayor and Board of Trustees. The Town Clerk is the only full-time employee (BMML, 1982).

2.14.5.7 Energy/transportation

Energy

Power generation within the area is provided by hydroelectric and fossil fuel steam-generating plants. Total generating capacity in the Western Slope area exceeds 2000 megawatts. Numerous gas pipelines are operated in the area, including one that runs north and south through the Pacific Project area.

Transportation

Highways, roads, and streets. Interstate 70 (I-70) is the major highway in the area. It is a four-lane roadway through most of the study area except for two, 2-lane segments. Both of these sections are scheduled to be expanded to four lanes, the Parachute segment in 1983 and the DeBeque Canyon segment between 1988 and 1990. Other major highways are U.S. Highways 6, 24, and 50 and State Highways 139 and 13.

Garfield and Mesa counties maintain about 2529 miles of local roads. The Garfield County system consists of about 929 miles, 409 miles of which are considered primary thoroughfares. Mesa County has about 1600 miles of county roads, about 500 miles of which are paved. Local cities and towns maintain the roads and streets within their jurisdictions. Grand Junction has the greatest street mileage, about 150 miles within the city limits (BMML, 1982).

Airports. The major airport in the area is Walker Field located near Grand Junction; it is operated by a public airport authority. The field is capable of handling commercial jet traffic and serves as the general aviation facility for northwestern Colorado and eastern Utah. The Garfield County Airport at Rifle serves private air traffic.

Railroads. The Denver and Rio Grande Western Railroad Company serves the area with major terminal facilities in Grand Junction. Capacity of the main line is 48 trains a day; current use is about half this amount. Passenger service between Denver and Salt Lake City includes stops at Glenwood Springs and Grand Junction.

2.14.5.8 Human services

Human services in the region involve a large number of public and private providers. In Mesa County, the Human Service Commission identified about 70 individuals and agencies, the largest being the Mesa County Department of Social Services which has a staff of over 50 employees. Garfield County has a coordinator for human services. Generally, human services are health-related, including mental health, or they deal with problems of social integration or adjustment (BLM, 1983b).

It is a common theory that rapid growth, particularly for relatively stable rural areas, results in increased social problems both for the long-term residents and for the newcomers. Among the types of problems most commonly thought to occur are delinquency, alcohol and drug abuse, marital and family instability, and personal disorganization. In Garfield and Mesa counties, both formal and informal support systems deal with the social change brought about by the oil shale development of the late 1970s and early 1980s. Numerous service agencies, staffed by trained professionals, exist in both counties. Informal support groups such as churches and volunteer organizations are also active. In particular, programs to integrate new and old residents were established in Rifle, Parachute, and Battlement Mesa (Mobil, 1982a).

At the county levels, Human Service Commissions were formed to plan, establish, and coordinate human service efforts. The general rationale for these commissions is that social problems are most amenable to effective intervention with advance management and that after-the-fact efforts are often too late to be effective.

Data on human services are often inconsistent and sketchy, and although efforts are being made to correct this problem, it is not possible at this time to provide quantified information for these areas. Proposed record-keeping and monitoring systems should allow local officials and planners to track human services much more effectively in the future (BMML, 1983).

2.14.6 Local finances

The fiscal condition of local governments, counties, municipalities, and other jurisdictions, depends upon their ability to provide facilities and services (expenditures) within the limitations of their revenues. Both expenditures and revenues are subject to forces outside the total control of local communities and officials. Expenditures, for example, often depend upon demand created by population, a variable that is not subject to direct control by local government. In another way, revenues are also restricted, because local governments are subject to limitations imposed by state and Federal statutes. Over the years, various fiscal characteristics have developed in the study area.

2.14.6.1 Revenues

The major revenue sources for local governments and jurisdictions are the property tax, sales tax, Federal and state intergovernmental transfers, and miscellaneous minor taxes, fees, charges, and fines. Grants can also be obtained from nontax revenue sources for one-time use, such as the grants and contributions of energy developers to local public jurisdictions. Table 2.14-13 shows the 1982 budgeted amounts for the major revenue categories for Garfield and Mesa counties and the relevant municipal jurisdictions.

Property tax

Garfield County's assessed valuation has increased significantly during the first 3 years of the 1980s, exceeding the rate of inflation. Per capita assessed valuation grew at the rate of about 8 percent per year. The county has maintained its property tax rate to cover increased costs and the property tax has produced about the same proportion of general fund revenues (30 percent) over the past several years. Until 1982, the property tax was also the major source of revenue for Mesa County. However, effective January 1, 1982, Mesa County imposed

Table 2.14-13. Fiscal characteristics of county and municipal governments -- revenues -- fiscal 1982 (budgeted) (thousands of dollars)

County/ City	1982 population	Assessed valuation	Property tax rate[a]	Property tax	Sales tax	Shared revenues	Other revenues	Total[b] revenues	Per capita revenues
Garfield County	29,160	124,551	19.367	2,413	325	3,077	4,206	10,021	344
Rifle	5,290	12,233	9.82	110	925	106	410	1,551	293
Parachute	1,119	685	13.74	10	85	14	906	1,015	907
Mesa County	86,955	340,880	16.79	5,642	9,249	8,220	16,382	39,493	454
Collbran	344	692	12.67	9	162	2	24	197	573
DeBeque	371	542	18.16	11	138	13	234	396	1,067
Fruita	3,021	7,963	16.06	119	800	32	1,328	2,279	754
Grand Junction	30,314	128,355	12.0	1,544	8,806	650	6,293	17,293	568
Palisade	1,817	4,129	23.77	96	460	27	73	656	361

[a]Mills.

[b]Does not include grants from the Oil Shale Trust Fund or individual energy developers. These additional funds are expressed as expenditures in Table 2.14-14.

Source: Bureau of Economic Analysis (1983); BMML (1982).

a 2 percent sales tax and subsequently lowered the property tax rate by about 22 percent. Since the Grand Junction area serves as the major market center for a multi-county region, the sales tax, together with other charges and fees, will probably produce revenues in excess of the property tax. In Grand Junction, the city property tax rate in 1982 was 12 mills; the total property tax rate (including city, county, school, and other taxing districts) has averaged 85 mills for the past 10 years, which is not considered excessive compared with other jurisdictions.

Sales and use taxes

Sales and use taxes are major contributors to local government revenues in the study area. Garfield County has collected a 0.25 percent sales tax (with food, residential fuel, and machinery exempt) since January 1981. These funds have been designated for construction of a new library facility. The county does not levy a use tax at this time. Rifle imposes a 2 percent sales tax. Mesa County imposes a 2 percent sales tax that, when added to the 3 percent the state collects, allows incorporated municipalities the right to levy 2 percent, since the total sales tax may not exceed 7 percent. The county also collects a use tax, which is levied on motor vehicles and certain building materials (BMML, 1982; DRI, 1983).

Intergovernmental transfers

Intergovernmental revenues come from a variety of state and Federal programs. The future of some of these revenues is not clear because several Federal programs have been reduced, cut, or are in danger of being discontinued. State programs, aside from those that are shared on a formula basis such as cigarette taxes or highway user fees, are appropriated by the legislature and are subject to change from session to session. Grants and loans from programs such as the Energy Impact Assistance Fund, which is financed by severance taxes and mineral royalties, are under the direct control of the state legislature. Some local jurisdictions (e.g., DeBeque in 1982) have received significant revenues from the Energy Impact Assistance Fund for the purpose of making capital improvements.

2.14.6.2 Expenditures

Per-capita expenditures vary widely for the different jurisdictions, depending upon the services provided, resources, demand, and local circumstances. County services tend to be limited to the essentials necessary for the unincorporated areas and for overall county administration. For the most part, the large municipalities provide a higher level of services and, therefore, spend more per capita. Expenditure data for 1982 are shown in Table 2.14-14. While these data show that per-capita expenditures in the three smaller communities of DeBeque, Parachute, and Fruita were greater than in Grand Junction, they were all one-time cases and the usual year-to-year figures tend to be substantially lower than those for Grand Junction. For instance, Fruita's per-capita expenditures for general fund items in 1980 and 1981 were about one third the 1982 figure. For DeBeque the 1980 and 1981 figures were a quarter of the 1982 amount. Parachute recorded less than 10 percent of the 1982 figure as general fund expenditures in 1980. There was a variety of sources for the revenues and subsequent higher expenditures made by these communities in 1982. For Parachute and DeBeque, funds

Table 2.14-14. Fiscal characteristics of county and municipal governments -- general fund expenditures -- fiscal 1982 (budgeted)

	Total expenditures[a]	Per capita expenditures	Debts outstanding	Debt service general remaining obligation capacity
Garfield County	$4,239,961	$165.73	N/A	$1,745,217
Rifle	$1,778,647	$422.68	$765,000 general obligation	$366,993
Parachute	$2,541,149	$2,118.00	$300,000 (water) general obligation	$68,492
Mesa County	$8,885,367	$95.17	$1,000,000 (est) general obligation	$5,113,197
			$8,165,000 revenue (sewer)	
Grand Junction	$19,932,184	$659.85	$360,000 (municipal) general obligation	$12,504,913
			$5,350,000 (water) $385,000 (revenue-golf course)	
Fruita	$2,335,887	$727.46	$4,000,000 (municipal) $448,000 revenue (sewer)	Voter approval required for bonding
Palisade	$255,613	$121.43	$1,300,000 (water) revenue (sewer) $290,000	$393,674
Collbran	$197,002	$511.69	$112,000 (water) revenue (sewer) $73,000	$69,278
DeBeque	$1,494,526	$5,153.54	$93,000 (water/sewer)	$58,764

[a]Includes general fund tax revenues and grants from Oil Shale Trust Fund and individual energy development companies.

Source: BLM (1983b).

from the Oil Shale Trust Fund and grants by oil shale developers made up the major portion of the difference between normal amounts and the one-time expenditures. In Fruita, about $1.5 million was spent or committed on capital projects funded by special grants from the county (BMML, 1982; 1983).

2.14.6.3 Bonded indebtedness

Capital improvements can be financed out of current revenues, from reserve and special funds, or by borrowing from the general public through bond issues. There are various restrictions placed on the limit of bonded indebtedness for counties and the larger municipalities. Debt can be tied to a specific source of income, such as the Mesa County sewer revenue bonds, which were issued by the county and are paid back solely from revenues of the Joint Sewer System. Another type of bond is paid back through general revenues. For example, Grand Junction has only a small balance of municipal general obligation debt and a capacity of about $12.5 million that could be obligated in the future. Garfield County has no bonded debt and a general obligation capacity of about $1.7 million. The debt and debt capacity for the counties and municipalities are shown in Table 2.14-14 (BLM, 1983b).

2.14.6.4 Overall fiscal conditions

Garfield County has adequate financial resources. These resources are expanding more quickly than service demand and inflation. This is because of the fact that the actual site of much of the Western Slope oil shale development is located in Garfield County, a condition that can make huge additions to the tax base without equivalent service demands. Given the housing market and transportation patterns, much of the service demand from these projects takes place in Mesa County, especially the Grand Junction area.

For the municipalities of Rifle and Parachute, however, the effects of growth are quite different. These communities have already experienced tremendous growth because of oil shale projects, but the actual development sites are outside of their jurisdictional boundaries and, therefore, do not make a direct contribution to local property tax revenues. The general funds of these municipalities have increased rapidly; in the case of Rifle, per-capita spending increased by 38 percent between 1980 and 1982. Most of the revenue increase for this growth has come from the sales and use tax, which makes up about one-half of the income to the general fund. Property taxes for both Rifle and Parachute have decreased in their relative contribution to revenue. This is mainly because of the lag time between additions to the assessed valuation and the collection of taxes. A similar lag will occur in the future as long as current tax collection procedures remain in effect.

Mesa County has recently strengthened its revenue position with the addition of a 2 percent county sales tax. Of this 2 percent sales tax, 22.5 percent is allocated to the county general fund, 27.5 percent is allocated to municipalities, and 50 percent is allocated to repay revenue bonds issued in 1982. Using this together with its traditional revenue sources, the county should be able to support its future operations and growth-related needs. Grand Junction appears to have excellent fiscal management and employs financial practices that are appropriate for a municipality in Colorado having to accommodate growth (BLM, 1983b).

Smaller communities in Mesa County (DeBeque, Palisade, Collbran, and Fruita) vary widely in their current fiscal condition. DeBeque and Collbran have very limited resources to deal with growth. Palisade has experienced rapid growth, but its revenues have not kept pace with the increased expenditures because of rising demand and inflation. Fruita reduced its sales and use tax from 3 to 2 percent, because of enactment of the county-wide sales tax. During the recent past, however, Fruita has taken a number of measures to finance growth. It has added to its tax base through annexation. The funds received from the county in return for support of the county-wide sales tax have gone into infrastructure improvements--sewer, water, and other capital projects (BMML, 1982).

2.14.7 Social structure

The purpose of this section is to describe the social structure of the region by profiling the significant social groups and outlining their interaction patterns. The following attributes are considered in the group identification process: 1) size of the group; 2) occupation or livelihood of group members; 3) demographic characteristics; 4) geographical location; 5) property ownership; 6) opinions, attitudes, and values; and 7) patterns of interaction within the group. Three spheres of activity are considered for the intergroup analyses: economic, political, and social interaction patterns.

Current conditions of the social structure in the study area are the result of both long-time historical developments and the more recent oil shale experience. Garfield and Mesa counties have experienced rapid growth over the last 5 years because of the oil shale development. The area has also gone through a recent economic decline, following the halt to all oil shale construction activities except for those associated with the Union I Project.

The growth in employment that took place in the recent past required the social structure in the area to accommodate thousands of newcomers, some permanent and some temporary. This process not only changed the overall configuration of the social structure, it also significantly changed the composition of the groups that make up the social structure. This discussion concentrates on two distinct areas: south-central Garfield County and the Grand Junction metropolitan region of Mesa County.

2.14.7.1 Garfield County

Five groups were identified to help explain the often complex interaction patterns that make up the social structure of south-central Garfield County. At the current time, the significant groups are: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) other long-time residents, and (5) newcomers. The first four groups are dominated by natives and in-migrants who have lived in the area for a long time (at least a decade or more) and are, therefore, well-integrated into the indigenous social structure. Additions to these groups have occurred recently, as, for example, new additions to the business and professional community in Rifle. These additions to existing groups are considered to be distinct from the newcomers group, which has not been assimilated into the established social groups and which constitutes a new entity in the social structure.

Agriculturalists

The term "agriculturalists" includes farmers, ranchers, and orchardists. In south-central Garfield County, the ranchers and farmers dominate. There are many small landholders, and a few large ones, who have a strong influence in county and city governments. The smaller operators are often second-income farmers and hold primary jobs in the local economy. Many of the landholdings are still in the families of the original homesteaders and the traditional values (family, hard work, religion, conservative politics, independence) are strongly held. The social and political behavior of this group is very cohesive, being oriented around family and church ties; support for local businesses is strong. The image of the rancher is pervasive and many visitors and newcomers imitate it by adopting the "western look."

Businessmen and professionals

The businessmen and professionals group is concentrated in Rifle, where there are a number of small businesses and professional practices. A majority of the group is made up of natives and people who have been in the area for a long time. This group is dominant in local government and is influential even at the county level. Its members tend to be quite conservative and their values are very similar to those of the natives and long-time residents in other groups. Personal independence and private property, family, church, and established civic groups are important.

Rifle is the local trade and service center, with Parachute and Battlement Mesa providing only elementary amenities. The businessmen and professionals group has a strong sense of community pride, a desire to improve things, and will support change and growth that "pays its own way." A number of new shops, businesses, and services sprang up in Rifle during the oil shale boom. Many of these establishments were the work of newcomers. Outside money was especially active in many of the development projects in the area. The shutdown of the Colony Project strongly affected these newcomers, especially in Parachute and Battlement Mesa. Local developers were hardest hit, and several experienced foreclosures and bankruptcies.

Elderly

The elderly make up about 9 percent of the total population in the county, slightly more than for the state as a whole. In the south-central section of Garfield County, the elderly are concentrated in Rifle, where they are politically active and very influential. They are almost all long-term residents and many are natives; they have strong ties to families and local institutions, such as the churches. Religion generally is important in their lives. A large proportion of the elderly are low-income people. Through their political and community influence they have managed to obtain low-income housing in Rifle. Politically, they are conservative, and socially, they associate primarily with their families and with other elderly friends.

Other long-time residents

The other long-time residents group includes all those people who live and work in the area but are not identifiable as members of the first three groups. Included are the workers of the area, those who are paid wages and salaries for their labor, craft work, or other employment. Generally, members of this group live in or near the service center where their jobs are, primarily Rifle and, to a much lesser degree, Parachute. The group members have strong family and friendship ties in the community and with the other groups. They often prefer to do business with local people and many trace family ties to long-established agricultural and business enterprises. They have close ties with the elderly. Family, church, personal independence, and private property are important values. There is solid support for economic growth which increases the value of property and local businesses, and provides opportunities for jobs. Economic growth is seen as a way of providing jobs for younger members of the group who would otherwise have to move away in order to work and support their families.

Newcomers

Newcomers are defined as those people who have come into the area in the last decade, mostly for reasons of employment. The largest contingent of this group is composed of the oil shale workers, who came in the late 1970s and early 1980s. Those who are construction workers mostly rent and live in Rifle or the Parachute and Battlement Mesa area. The management employees concentrate in Rifle. The construction workers tend to be conservative or apolitical. Many are either single or married without children. Although some of those from the South are fundamentalists, most appear to be less religious than the local people. Many of these newcomers stay to their own group or are isolated because it has been difficult for them to establish social networks or join the social interaction of the area.

Another type of newcomer has come as part of the business and professional community. These people have integrated much more easily into the social structure through membership in the businessmen and professionals group. They tend to buy homes, mostly in Rifle, and to become involved in the ongoing social, political, and economic activities. For the most part, they have found Rifle to be an open, receptive place for newcomers.

Summary

Garfield County had a long history of out-migration prior to the oil shale boom. Although the population grew after 1940, it did so at a very slow rate, less than natural increase. For the four endemic groups--agriculturalists, businessmen and professionals, elderly, and the other long-time residents--the social, political, and economic ties are strong ones. Shared values, a common background, kin and friendship ties, all have helped to create a cohesive community in an essentially rural area. The influx of newcomers created a new group that has not been easily assimilated into the existing social structure. The oil shale employees, mostly construction workers, have been too distinct in terms of their background, values, and attitudes to be incorporated into the existing groups; therefore, they have constituted a new group in the social structure. Those newcomers who came to take advantage of the increased business and professional opportunities, especially in Rifle, have been assimilated quite easily.

Their interests, values, social skills, and plans for long-term residency fit well with the established social structure.

2.14.7.2 Mesa County

As might be expected of adjacent areas, there are a number of essential similarities between Mesa and Garfield counties. The historical experiences were, in large part, regional in their sphere of influence and this accounts for a similarity in the overall types of groups in both areas. At the same time, the Grand Junction vicinity has many urban characteristics and its place as the trade and service center for the entire Western Slope has been instrumental in the creation of numerous distinctive characteristics in its social structure. Therefore, while the types of groups are similar, their composition and interaction patterns are quite different. Both the similarities and differences are discussed in detail below.

Six groups are described for Mesa County: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) Hispanics, (5) other long-time residents, and (6) newcomers.

Agriculturalists

This group includes farmers and ranchers with orchardists predominating in the eastern part of the Grand Valley. One major path of residential and commercial development has been through the orchard areas, so there is a great deal of pressure on these owners to convert their land to developed uses. Many are old-time families and there are fundamental differences of opinion on whether to preserve the land and the way of life, or to sell out. Perhaps 50 percent strongly support preservation with growth and land use control. This is probably the single most significant issue for the agricultural community.

There are numerous small, backyard, second-income agriculturalists. Among them, many of the values, opinions, attitudes, and way of life that evolved through the conservative political attitudes are coupled with established business connections and support for economic growth. The full-time agriculturalists are declining in number while the part-time or split households that rely on wages and salaries as the primary source of income are increasing.

Businessmen and professionals

Because Grand Junction is the major trade and service center for a large area, the business and professional community is especially well developed. The group is very active in local politics and effective in their influence of governmental policies at both the county and city levels. Realtors, developers, and financial people play especially active roles regarding land use and planning issues. There is a notable number of physicians and dentists in the area because of St. Mary's Hospital, the major regional medical center, and a number of active development investors comes from this group. People in the wholesale and retail trades, as well as those in services, strongly support economic development and growth, but tend to be less involved than those who have a continuing interest in specific development proposals.

The business people are very active in clubs and civic organizations. The Chamber of Commerce is a strong organization, as is the Lions Club and the Rotary; Club 20 is a pro-development group that enrolls members from communities throughout the Western Slope. In addition to their economic interests, the businessmen and professionals support the arts and culture through such efforts as the development of the civic center.

The shutdown of oil shale development projects has greatly affected business in the wholesale and retail trades, real estate and other development, and service sectors. The "ripple effect" of the shutdown continues to the present and the economy has still not recovered. An attitude of caution would be expected before and during any future oil shale boom.

Group values are strongly oriented toward economic issues and group members tend to support economic development as a public policy. The basic political attitudes are conservative, and there are few individuals who disagree with these viewpoints. Consequently, political contests tend to be decided on the basis of the individuals involved rather than on differences of public policy. Many of those involved in local politics and government are from the businessmen and professionals group.

Elderly

The elderly made up a substantial part (11 percent) of the population for Mesa County in 1980. The rapid growth since the 1980 Census means that the proportion of elderly has declined, even while their number has increased. Many of this group migrated to Grand Junction because of the availability of services, especially medical care. Most live on very modest incomes; as many as 65 percent of the elderly households in 1979 earned under $7000. Housing is a critical issue since there is a shortage of low-income housing for the elderly in the Grand Junction area.

The elderly have extensive social ties within their own group, and they tend to maintain close relationships with their families. Those in Mesa County are less active politically than those in Garfield County, perhaps because the larger urban setting tends to scatter their efforts and their problems are less visible and unique in this larger social setting. They hold traditional values on family, work, religion, and growth.

Hispanics

The Hispanic population made up about 7 percent of the county total in 1980 and is estimated to be about 12 percent of Grand Junction's population and about 20 percent of Fruita's. The group is somewhat more distinct in Fruita; in Grand Junction it tends to be dispersed in mixed neighborhoods. An increasing number of Hispanics own their own homes. They are cohesive socially and they support each other economically through business patronage and employment. Most are blue-collar workers and Democrats. They have been effective politically, and an Hispanic is currently mayor of Grand Junction. The interaction with Anglo groups is not completely open, but there has been little conflict, perhaps because of the relatively small Hispanic population and the fact that their opinions and attitudes are similar to those of the majority. For example, on growth policies, some support low or no growth while others are pro-development.

Hispanics have been in the area for many generations, some before the Anglo-Saxon settlers. Recent in-migration by Mexican farm laborers, some of whom are not citizens, has occurred over the last several years. This has produced some conflict between government agencies and local farmers and orchardists. On the whole, however, there has been little difficulty. The Hispanic community sponsors several festive occasions during the year. The most notable is Cinco De Mayo, in which both Hispanics and Anglos participate.

Other long-time residents

This group is made up of natives and residents who have lived in the area for at least a decade but does not include people assigned to the other groups. As in the case of Garfield County, this group is made up mostly of wage and salary workers and their households. These people are the laborers, craft workers, government employees in nonadministrative positions, sales persons, and all those in the work force who are not included as members of the businessmen and professionals or the agriculturalists groups. In terms of numbers, this is the largest group in the area.

Natives make up a smaller portion of this group in Mesa County than was the case for Garfield County and, consequently, the ties with the other groups are not as strong. Grand Junction, as a trade and service center, has traditionally grown faster than the rural regions and offers much greater employment opportunities. The in-migrants who became long-time residents were attracted to the area for the employment opportunities. A recognizable segment of this group came during the 1950s and 1960s when the area experienced growth because of uranium and oil and gas development.

Family, church, personal independence, private property, outdoor experience, and support for economic growth are all positive values for the group. Politically, the tendency is towards conservative attitudes and voting behavior. Support for the local businesses and economy is strong, as is concern about general economic conditions. Socially, there is fairly easy access to members of the other groups but, for the most part, people tend to concentrate interest within a portion of their own group. Often church, family, school, work, or recreational activities serve as the main structure for social behavior.

Newcomers

The rapid growth of Mesa County over the past several years has resulted, in large part, because of in-migration, which contributed about 87 percent of the total growth during the 1970s. This group has included three main components: energy (oil shale) personnel, mainstream, and transients.

Energy newcomers have come to fill the jobs in a new basic industry. These people are made up of two types: the executive and middle-management personnel and the field and shop workers. The permanent employees tend to buy their homes and integrate into the neighborhoods and areas. Construction workers tend to rent. Family size and marital status seem to coordinate with age. The older are generally married with larger families; the younger are single, or married with small families or no children. The older tend to have traditional religious beliefs (protestant and Catholic). Among the younger members of this group, many are less religious, while a small number are noticeable as born-again Christians.

Most of this group are either apolitical or they have not been in the area long enough to develop effective political behavior.

The mainstream newcomers have filled many of the nonbasic jobs that opened up in the area because of the economic growth of the late 1970s and early 1980s. They have tended to buy housing and actively establish social connections within the community. Many have selected the area because of its recreation and openness; there is a committed environmentalist faction in this group. Aside from the environmentalists, this segment of the newcomers tends not to be politically involved and assimilation is relatively smooth for most people.

A third type of newcomer has been the transients, forming a relatively small but highly visible portion of the group. Mostly younger, many are single and looking for jobs. Often they have few skills and they have been the focus of some community resentment. There have been relief and referral programs, but little else. Further attempts would be controversial. These people are more or less actively discouraged from staying in the area and, therefore, they remain separate from the main social structure.

Summary

The Mesa County social structure is concentrated in Grand Junction, which is a major urban trade and service center serving the entire Western Slope. The businessmen and professionals group, in addition to its obvious economic control, seems to be the most influential socially and politically. In many ways, it is also the most open to newcomers and has cooperated with the growth of the energy sector. Of the other groups, the agriculturalists and the elderly seem to be least affected socially by in-migration of new people, although they have changed in a number of ways in response to other aspects of rapid growth. For example, housing for the elderly has been a concern as has the issue of land development for the agriculturalists. The other long-time residents and the Hispanics groups have absorbed much of the impact of new growth as both construction workers and other wage and salary personnel have moved into the county creating new competition for jobs and other resources. Those newcomers who have come as permanent residents, buying homes and settling their families, have been the most fully integrated. The temporary and transient newcomers have remained on the outside. Although growth has brought with it a number of tensions and demands, the social structure has demonstrated great flexibility in dealing with large-scale change.

3 The Mobil Project

3.1 PROPOSED ACTION AND ALTERNATIVES

3.1.1 Description of the proposed action

3.1.1.1 Introduction and overview

Mobil's proposed actions for full development of the Parachute Shale Oil Project would involve underground mining and surface retorting of oil shale with onsite upgrading to achieve a production level of 100,000 barrels of syncrude per calendar day (100 TBCD). Mining would be started by developing drifts into the mining zone from a cliffside bench. Shale would first be crushed underground. It would then be taken to the surface by a conveyor for feed preparation or stockpiling. Shale from the stockpiles would be crushed and screened before it was sent to the retorts.

Mobil proposes to use a combination of three retort types to extract hydrocarbons from the raw shale. There would be two types of process streams from the retorts. One would be processed shale; the other would be raw shale oil and product gas.

Processed shale would be conveyed to an engineered fill in a large gulch for disposal. The processed shale disposal area would be designed to control surface runon and runoff of water, as well as any water which might leach through the fill. A dam and evaporation pond placed downstream of the fill would be designed to prevent these waters from leaving the property and reaching adjacent surface waters or ground water. Revegetation would be performed as areas become available for reclamation following completion of disposal activities.

Raw shale oil would be upgraded through processes of coking and hydrotreating. The upgrading process would produce a syncrude and coke. The syncrude would be transported by pipeline to refineries. Coke would be burned onsite as a fuel for power generation. During upgrading, nitrogen would be removed from the raw shale oil, producing an ammonia byproduct. Product gas would be treated to remove sulfur compounds and would then be burned as fuel gas in onsite facilities. Syncrude would generally be transported to refineries by an industry pipeline. Some syncrude, naphtha, or raw shale oil may be transported by unit train. The sulfur and ammonia would be collected as by-products and shipped to markets by train and truck.

Water requirements for the project would be supplied from a storage reservoir on Main Elk Creek, a tributary to the Colorado River. Stored water would be released from the reservoir into the Colorado River. A water intake would be built on the Colorado River in the vicinity of the project facilities. Water would be withdrawn at that point, treated for use, and transported by pipeline to various parts of the project. The project's water balance would always be controllable by controlling the pumping rate from the river.

Location of major facilities

Mobil's major properties for the Parachute Shale Oil Project are indicated on Figures 3.1-1 and 3.1-2. The oil shale resource is contained within the Parachute Block which is to the north and northeast of Parachute, Colorado, in the southeastern portion of the Piceance Basin. The block includes over 16 square miles (10,600 acres) extending from Wheeler Gulch on the west to Anvil Points on the east. Most of the property is on the Roan Plateau at elevations ranging from 8000 to 8900 feet. The oil shale resource is located in the Mahogany Zone of the Green River Formation, which underlies the surface at an average depth of 700 feet. The Parachute Block would be used as the site for major project facilities including:

- An underground mine
- Surface crushing and screening facilities
- A mine bench
- Retorts
- Upgrading facilities
- Processed shale disposal
- Product, by-product, and miscellaneous tankage
- Other ancillary facilities

The south unit of Mahaffey Ranch consists of about 1350 acres, located south of the Parachute Block at the base of Cottonwood Gulch. The main ranch straddles Interstate 70 and the D&RGW Railroad and borders the Colorado River on the south. The Mahaffey Ranch would be used for ancillary facilities including:

- A Colorado River water intake
- River water primary treatment facilities
- Construction staging areas, worker facilities, and parking areas
- A rail spur (receiving and loading)
- Product and by-product storage
- Storage of ammonium nitrate and fuel oil
- Other support facilities

The main access road and personnel transport facilities to the Roan Plateau would originate near the Mahaffey Ranch. Proposed activities in this area are indicated in Figure 3.1-3.

The 920-acre Main Elk property is located 4 miles northwest of New Castle, Colorado, on Main Elk Creek; it would be used for the Main Elk Dam and Reservoir. This 35,000-acre-foot reservoir would be the primary water supply for the project. Water would be released from the reservoir into the Colorado River via Main Elk and Elk creeks and withdrawn at a diversion point adjacent to the Mahaffey Ranch.

Surface disturbance associated with the project would be about 3540 acres. This includes approximately 1390 acres directly affected by process and support facilities, about 1610 acres affected by processed shale disposal, and about 540 acres disturbed by the Main Elk Dam and Reservoir. A breakdown of the acreage that would be disturbed is listed in Table 3.1-1.

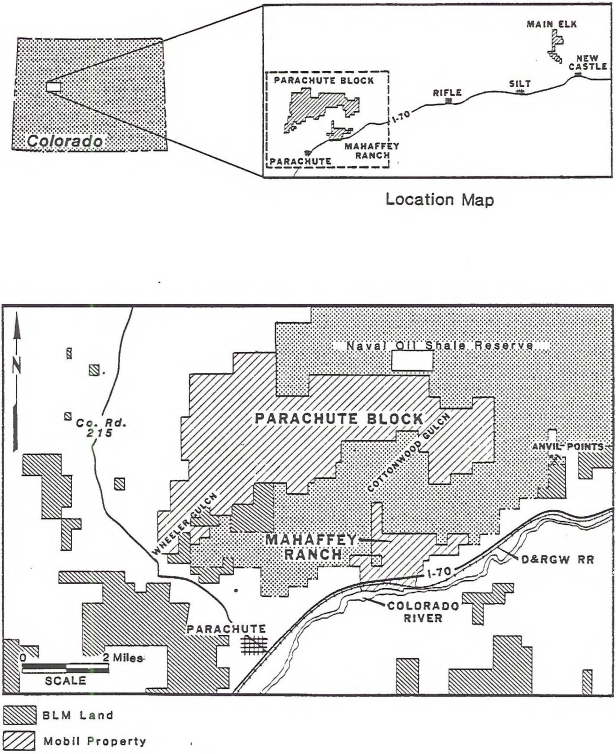
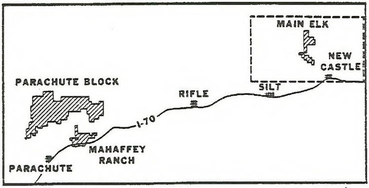
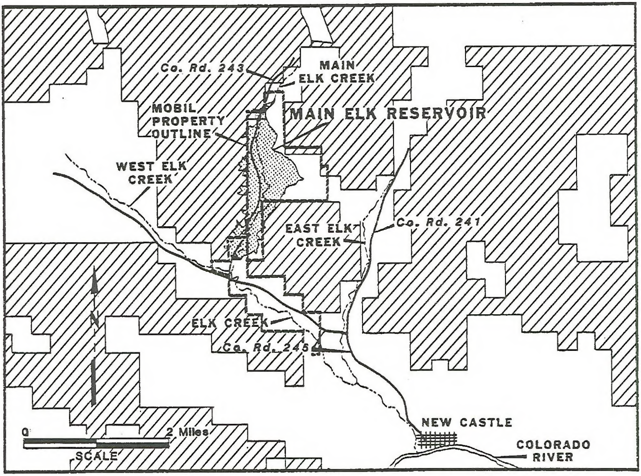


Figure 3.1-1. Mobil Project location map



Location Map



BLM Land

Figure 3.1-2. Main Elk Reservoir location map

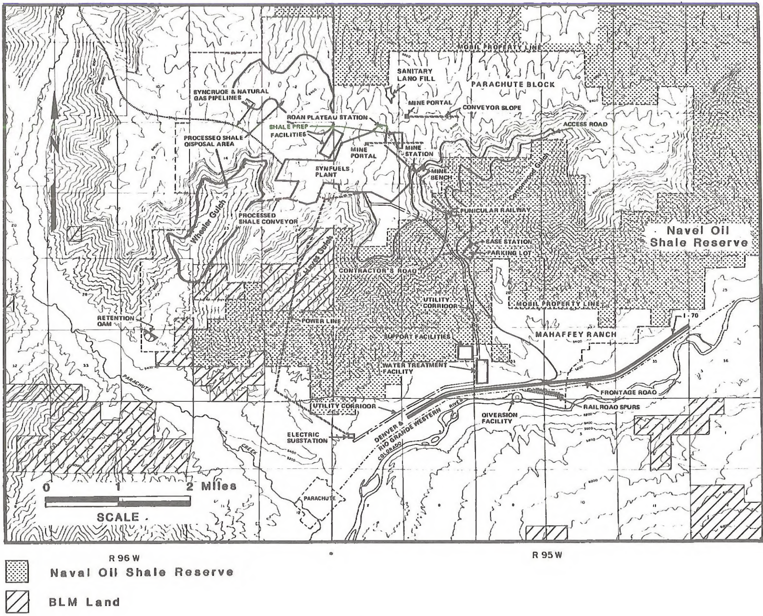


Figure 3.1-3. General arrangement

Table 3.1-1. Surface disturbance summary

	Approximate surface disturbance (acres)
Process facilities on the Parachute Block	681
Process facilities on the Mahaffey Ranch	44
Access roads	295
Utility corridor	74
Syncrude pipeline (feeder pipeline to LaSal)	120
Power line	21
Sanitary landfill	10
Staging areas	110
Material handling facilities	19
Railroad spur	15
Main Elk Dam and Reservoir	540
Processed shale disposal	1610
Total	3539

Project schedule

The project would have three major phases: construction, operation, and abandonment. Major activities in the construction phase are scheduled in Figure 3.1-4. The construction phase is proposed to begin in Year 1 (between 1985 and and 1988), with relocation of County Road 243 at Main Elk Creek, which would allow construction of the dam to begin in Year 3. Prior to this, in Year 2, major construction would begin at the Mahaffey Ranch with work on the contractor's road, followed by construction of the main access road. Major earth moving for site preparation would begin in Year 4, with major facility construction projected for Year 5. Construction would continue through Year 8, when the initial retort facility would be completed.

The operational phase would begin in Year 8, upon completion of the initial retort facility. This phase would overlap with the construction phase from Year 8 until Year 15, when the plant facility would be completed, and full production reached. The facility would ultimately have 14 retorts and be capable of producing 100,000 BPD. The full production rate would continue beyond Year 15 for the life of the mine, which is estimated to be about 30 years. Continued operation beyond Year 30 would be an economic decision based on the business environment and resource availability at the time.

The abandonment phase would begin when production ceased permanently. At this time, all salvageable equipment would be removed, buildings razed, and revegetation completed. This phase would continue for several years until stability of revegetation and drainage systems was assured.

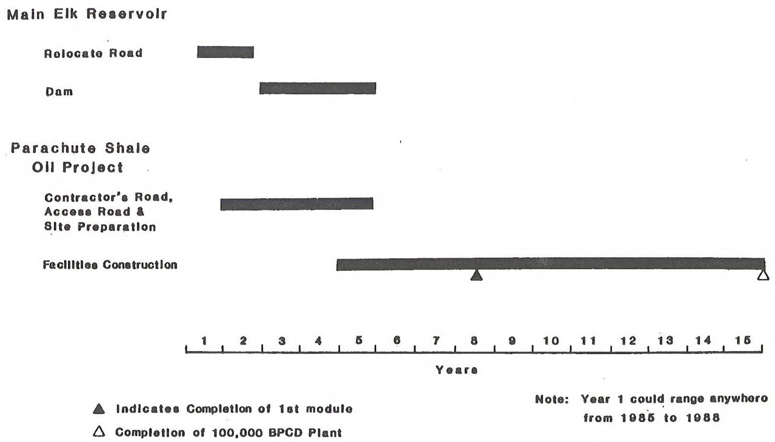


Figure 3.1-4. Mobil Project construction schedule 100,000 BPCD

3.1.1.2 Shale mining and preparation

Mining would start in the central portion of the property and advance toward the west. When production passed 80,000 tons per calendar day (TPCD), mining would advance toward the east while continuing to advance toward the west, until the maximum mining rate of 160,000 TPCD was reached. Figure 3.1-5 illustrates the progression of mining for the life of the mine.

Mining methodology

The lane-and-pillar technique would be used for mining. With this method, long, rectangular-shaped pillars and rooms would be connected by a minimum of crosscuts. The mining method would accommodate different overburden depths. Pillar dimensions would increase as overburden increased and decrease as overburden decreased. Figure 3.1-6 is a schematic plan view of the lane-and-pillar method.

The oil shale would be mined in sequence as follows: drilling, explosive loading, blasting, scaling, mucking, and roof bolting. Muck piles would be wetted as necessary to reduce dust during the mining cycle. Lanes would normally be 60 feet wide and vary from 60 to 80 feet high, depending on the thickness of the mining zone.

Mine features. The mine bench would be located in Cottonwood Gulch along the route of the access road. The bench would have an area of approximately 2.3 acres, would be approximately 850 feet long, and average 120 feet wide. The entire bench would be excavated at an elevation of approximately 7785 feet. The bench would be separated from the access road by a metal guard rail and post barrier.

Operational and safety-related facilities would be located on the mine bench. Parking areas would be provided for company vehicles, such as personnel transport vehicles, pickup trucks, dozers, snowplows, etc. No parking would be provided for private vehicles on the bench.

After the mine bench was constructed, four main entries, each 40 feet wide by 35 feet high, would be driven from the bench into the orebody at the bottom of the mining zone. These openings would provide access for personnel, machinery, and materials to the mine and would also be used for mine ventilation. During mine development, trucks would haul the mined material to the top of the Roan Plateau, where it would be crushed by feeder-breakers (portable crushers) to a size of 8 inches or smaller and stockpiled. After mine development, primary crushing would take place underground and the crushed shale would be transported to the surface via the slope conveyors described below.

Underground mine service facilities would be clustered in an area within the mine near the main entries. The facilities would include maintenance shops, warehouses, a changehouse, and an office building.

Slopes. Two slopes, one 14 feet high by 32 feet wide, and the other 14 feet high by 64 feet wide, would be developed from the mining horizon to the top of the Roan Plateau. These slopes would be used to transport the mined shale via belt conveyors to the surface transfer points. The second slope would also transport personnel and equipment into the mine.

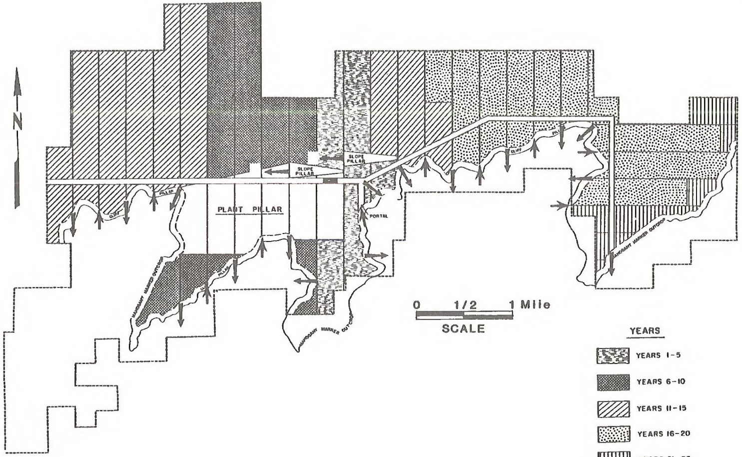


Figure 3.1-5. Mining progression

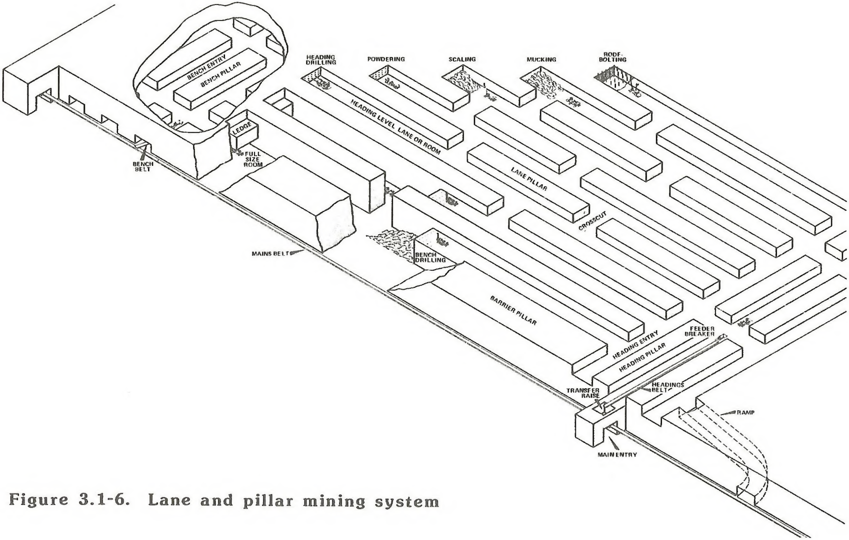


Figure 3.1-6. Lane and pillar mining system

Operational features. The blasting explosive to be used would be ammonium nitrate mixed with diesel fuel. Prilled ammonium nitrate would be received via rail cars, mixed with diesel oil, and transferred to explosive storage magazines on the mine bench.

An exhaust system would be used to ventilate the mine. The primary exhaust and intake points would be located along the Mahogany Zone outcrop, as shown on Figure 3.1-5. Only those exhausts located in active mining zones would be operated at one time. The exhaust fans would exhaust air out of the mine through openings approximately 40 feet wide by 25 feet high. Each intake airway would consist of three 25-foot-high by 40-foot-wide openings along the cliff face. At the maximum level of operation, six exhausts and four intakes would be operational.

Water encountered in the mine would be pumped or flow by gravity to an underground sump. It is estimated that, at full production, mine drainage inflow would be between 0 and 600 gpm. This recovered sump water would be used for dust control, drilling water, and other nonpotable uses within the mine. If the amount of water encountered exceeds the mining requirements, surplus water would be transported from the mine and treated for reuse in surface facilities or in processed shale cooling or compaction.

Air quality within the mine would be routinely tested for particulate and gaseous contaminants generated by mining activities. Dust and gas contaminant control and monitoring measures would be used to assure that contaminant concentrations were maintained below all established state and Federal standards for the mine environment.

Materials handling

Materials handling includes the crushing and transporting of raw shale, dust control, and raw shale stockpiling.

Raw shale processing. Mined shale must be crushed before it is retorted. The type of retort used determines the size to which the oil shale must be crushed and screened. There would be three stages of crushing operations before retorting. Primary crushing would take place near the mine face underground. The run-of-mine oil shale, which is the ore of various sizes left after blasting, would be crushed by feeder-breakers to pieces smaller than 8 inches. During pre-mine development, trucks would transport the mined shale to the top of the Roan Plateau. After slope development, belt conveyors would transport the mined shale from underground to a transfer point above ground, from which it would be fed directly to the secondary crushing plant or diverted to the reserve stockpiles.

On the surface, shale from the transfer point or the stockpiles would be processed first by secondary and tertiary crushing, and then by screening to separate the ore to appropriate feed sizes for the three types of retorts to be used.

Dust control. All the operations involved in processing raw shale would generate dust. Dust control systems used to reduce dust levels would include dry baghouse dust collectors or water-spray dust-suppression systems. Also, the belt conveyors used for outdoor service would be covered to minimize fugitive dust when raw shale was in transit.

Baghouse dust collectors would be used at conveyor-to-conveyor transfer points where necessary and at the entry points of bins and silos. Each transfer point would be enclosed to the extent practicable, and a slight negative air pressure would be maintained inside each enclosure so that the flow of air was inward through all enclosure openings. Where it is not practical to use baghouse dust collectors, such as when discharging the shale to open stockpiles, wet-suppression systems would be used to control the fugitive dust.

Raw shale stockpiling. After the access road to the top of the Roan Plateau was constructed, all ore-quality material that was removed from the mining zone would be stockpiled at the western shale-preparation facilities location. This stockpile would grow to a maximum size of 6 million tons during development and the early years of the project. Once shale retorting starts, the stockpile would be drawn down to a maximum of 1.7 million tons and a minimum of 500,000 tons. The reserve stockpile variation would be because of different operating, shutdown, and maintenance schedules for the mining and retorting operations. A second reserve stockpile for the eastern portion of the mine would be the same size.

3.1.1.3 Retorting

The retorting facilities would convert the solid kerogen in the raw shale to liquids and gases. The liquids would be processed and upgraded into syncrude oil and the gases would be treated and burned as fuel.

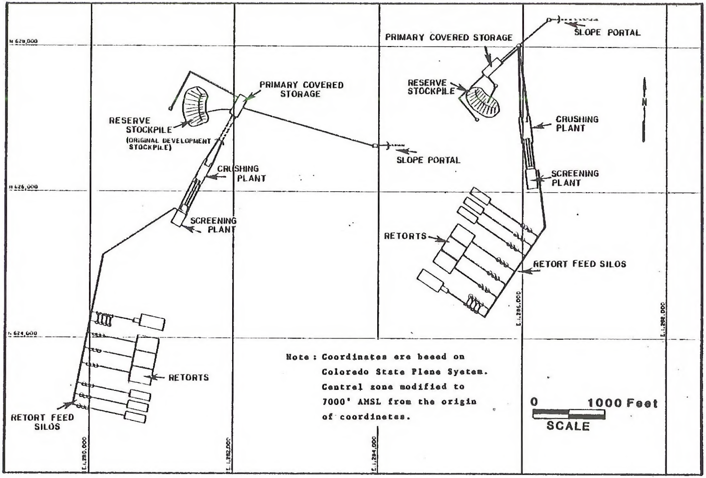
Retorting facilities location

At the 100-TBCD level, 14 retorts would receive crushed and sized shale from the crushing complex. Seven retorts would be in the west plant complex and the other seven would be in the east plant complex. Both complexes would pipe retort gas and oil products to the east and west upgrading complexes for processing into syncrude. Processed shale would be transported by conveyor for disposal after cooling. The layout of these facilities is shown on Figure 3.1-7.

Retorting method

Retorts may be classified in two ways: (1) fine or coarse feed, and (2) directly heated (DH) or indirectly heated (IH). In a DH type of retort, the energy required to operate the process is directly provided by combustion within the retort vessel. A DH retort produces low-British-thermal-unit (BTU) gas because of direct air injection into the retort vessel, causing nitrogen dilution of the retort gas. In an IH type of retort, the required energy is indirectly provided to the retort through external heating of a gaseous or solid heat-transfer medium. IH retorts produce high-Btu gas because air is not injected into the retort vessel.

The 14 retorts would consist of 6 TOSCO II retorts, 6 Union B retorts, and 2 Paraho DH retorts. The TOSCO II retorting system is a fine-feed and indirectly



NOTE: See Figure 3.1-3 for location within project site.

Figure 3.1-7. Feed preparation and raw shale transport layout heated process. The process uses a circulating system of ceramic balls that have been heated in a ball heater to supply heat to the retort. The 0.5 inch and smaller shale feed is preheated by flue gas from the ball heater, and further heated by the ceramic balls in a rotary retort drum prior to discharge into an accumulator. Retort oil and gas products exit the top of the accumulator as a vapor into the quench tower. A heavy oil liquid is condensed from the retort vapor. The processed shale particles are separated from the ceramic balls by a rotating cylindrical screen located within the accumulator.

The Union B retorting process is a coarse-feed and indirectly heated process. This process uses crushed-shale feed that ranges from 0.125 to 2 inches in size. The recycle gas that has been heated in a furnace supplies heat to the retort. Recycle gas and retort products flow downward. A piston-like "rock pump" forces the raw shale upward.

The Paraho DH retorting process is a coarse-feed and directly heated process. The process uses crushed-shale feed, ranging from 0.125 to 3 inches in size. The retorting heat is produced by burning both recycled gas and carbon residue on processed shale inside the retort vessel. Shale flows by gravity from the top to the bottom of the retort. Retort products and recycle gas flow upward. The retort products leave the retort as a gas stream carrying a product oil-mist.

3.1.1.4 Oil upgrading and gas utilization

The preferred location for the upgrading facilities is on the Roan Plateau adjacent to the retorting facilities. The objective of the upgrading facility would be to produce syncrude suitable as refinery feedstock from raw shale oil.

The primary product produced from upgrading would be approximately 100 TBCD of syncrude. After upgrading, the syncrude would be transported to a conventional refinery for further processing and the manufacturing of gasoline and distillates. By-products of upgrading would include:

- Treated high-Btu gas. Approximately 117 million standard cubic feet per day (MMSCFD) would be produced and used in the operation.
- Treated low-Btu gas. Approximately 190 MMSCFD would be produced and used in the operation.
- Ammonia. Approximately 270 TPCD of ammonia would be produced from hydrotreating the high-nitrogen-content raw shale oil. The ammonia would be recovered in a wastewater treating unit, purified to yield fertilizer-grade anhydrous ammonia, and then compressed and condensed within the unit before being routed to refrigerated low-pressure storage tanks. Ammonia would be transported from the Roan Plateau to the Mahaffey Ranch through a pipeline in the utility corridor, and stored until shipment by rail.
- Elemental sulfur. Approximately 250 long tons per calendar day (LTPCD) of sulfur would be derived from both the hydrogen sulfide in the retort off-gases and from hydrotreating the raw shale oil. Molten sulfur would

be produced in the sulfur recovery plant and initially stored in a covered, concrete-lined sulfur pit sized for one day of sulfur production. Sulfur would be transported by truck to storage facilities at the Mahaffey Ranch, and shipped by general rail service.

- Coke. Approximately 1800 TPCD would result from coking 850°F$^+$ material in a delayed-coking unit. The coke would be crushed to a size less than 2 inches and conveyed to a coke storage pile adjacent to the coking unit. All coke produced would be burned in the onsite power generation facilities.

3.1.1.5 Support facilities and services

Waste disposal

The disposal of waste would involve very large amounts of processed shale, some nonhazardous solid and liquid waste, and lesser amounts of hazardous waste.

Processed shale disposal. Mobil has not yet performed chemical analyses of processed shale. However, based on available information, it is estimated that the chemical composition of Mobil Project processed shale would be as indicated in Table 3.1-2. The moisture level in the processed shale would average about 14 percent by weight. Thus, the processed shale pile would have a capacity to absorb more water.

Mobil has studied the leachability of Mobil shale which had been retorted at the Anvil Points Paraho retort. These studies included: (1) the EPA approved 24-hour EP toxicity test, (2) determination of potentially toxic elements extracted from processed shale after leaching for up to 96 hours, (3) measurement of dissolution of toxic elements from processed shale by replacing the leaching solution every 24 hours with fresh solution, and (4) analysis for certain toxic organic materials in leachate. Results of analyses on the leaching solutions show that:

- EP toxicity test. Concentrations of heavy metals in the 24-hour extract were well below maximum levels allowable by the EPA. Therefore, the processed shale would not be classified as a hazardous waste according to the EPA test method.

- Leaching for longer periods of time. Potentially toxic elements in extracts of processed shale leached respectively for 24, 48, 72, and 96 hours were also well below the maximum allowable levels. Except for arsenic, the maximum amount of element leaching occurred within the standard 24-hour time frame.

- Repeated leaching with fresh solutions. After sequential extraction of a processed shale sample four times with fresh leaching solutions, approximate total amounts of arsenic, barium, and fluoride which leached from 100 grams of processed shale were 0.12, 31, and 100 mg, respectively. The levels of other EP toxicity metals, cadmium, chromium, lead, mercury, selenium, and silver were negligible in processed shale leachate.

Table 3.1-2. Estimated chemical composition of Mobil Project processed shale

	Weight Percent			
Components	Paraho DH	TOSCO II	Union-B	EIS Retort Mix Composite
SiO_2	28	33	31.5	31.4
CaO	18.3	15.8	19.6	17.9
MgO	6.5	5.31	5.7	5.7
Al_2O_3	6.9	6.8	6.9	6.9
Fe_2O_3	2.7	2.52	2.8	2.7
Na_2O	2.6	8.68	2.2	4.7
K_2O	6.6	3.28	1.6	3.2
SO_3	0.2[a]	N/A	1.9	1.38[d]
P_2O_5	N/A	N/A	0.4	0.4[d]
Mineral CO_2	15.2	20.9[b]	22.9	20.7
Organic Carbon	2.18	4.49	4.3	4.0
Inorganic Carbon	4.15	5.71	6.3[c]	5.7

[a]Reported as SO_4.

[b]Reported as 5.7 weight percent, which probably corresponds to inorganic carbon and a mineral CO_2 content of about 20.9 weight percent.

[c]Calculated from mineral CO_2 content.

[d]Based on incomplete data.

Source: EPA Pollution Control Guidance for Oil Shale Development (revised draft report, July 1979).

- Nontoxic elements. Relatively large quantities of calcium and magnesium were leached from processed shale. Calcium and magnesium salts contribute to the high pH of processed shale leachate.

- Organics. Small amounts of hydrocarbons were detected in the 96-hour processed shale leachate. No polynuclear aromatic hydrocarbons nor phenolics were detected. The data suggest toxic organics are either not present or do not leach from processed shale.

- Influence of pH. Lower quantities of arsenic, fluoride, calcium, magnesium, manganese, and other elements leached from processed shale when acetic acid was not added as required to control pH. This procedure more closely approximates the natural condition.

The processed shale from the retorts would be cooled and conveyed to the processed shale disposal areas. These areas would be designed to provide a stable and environmentally safe fill. This fill would be covered with surface material and revegetated to minimize erosion, and support plants and animals. The goal is to provide long-term embankment stability, zero-water discharge to natural drainages, and zero percolation through the embankment to ground water.

At maximum production, processed shale would be disposed at a rate of 150,000 TPCD. Processed shale disposal would take place in the drainage of greater Wheeler Gulch in two stages. During the first stage, when disposal rates were lower, the processed shale would be disposed on top of the Roan Plateau in Cabin Water and Middle Water gulches, which drain into Wheeler Gulch. During the second stage, disposal would be in the main portion of Wheeler Gulch, which lies about 2500 feet below the plateau (Figure 3.1-8).

The first stage would be monitored and studied by Mobil and interested regulatory agencies during and after construction so that information could be developed on embankment behavior, including stability, percolation, revegetation, and dusting. This information would be incorporated into the second-stage design.

The design includes the following:

- Prior to processed shale disposal, the topsoil and subsoil would be stripped to the point where the soil was too rocky to be used for revegetation. This topsoil and subsoil would be stored for later use in revegetation.

- A highly compacted 3- to 8-foot-thick layer of processed shale would be placed over the ground prior to the start of disposal operations. This layer would be designed to form an impervious barrier to seepage from the pile to ground water. Pile compaction would take place through the use of mobile equipment and the weight of overlying material. Pile moisture would be below saturation, so compression should not result in the expulsion of water, and percolation should be minimal. The slope of the face of the embankment would be 3.5:1. At vertical intervals of 50 feet, nearly horizontal benches, 25 feet wide, and sloped gently toward the pile, would be graded into the face of the embankment to control runoff and erosion. Diesel-fueled equipment would place and compact the processed shale. The sequence and method of processed shale disposal would be as follows.

  - Stage 1 would consist of filling Cabin Water and Middle Water drainages to an elevation of approximately 8600 feet. This would take approximately 11 years to be completed. At the completion of Stage 1, deposition would begin at the lower end of Wheeler Gulch at an elevation of approximately 5700 feet, and reach a maximum elevation of 7400 feet. During Stage 1, the processed shale would be conveyed on covered overland conveyors to the pile where it would be compacted to specifications.

  - During Stage 2, the processed shale would be moved to a point on the rim of the valley on covered overland conveyors. From there, the processed shale would be moved to the disposal area by conveyors down the steep cliffs in Wheeler Gulch to the pile.

- The amount of water coming into contact with the active pile would be minimized by preventing run-on from areas outside the embankment. In Stage 1, ditches adjacent to the embankment perimeter would intercept watershed runoff and divert water around the embankment and dams in Cabin

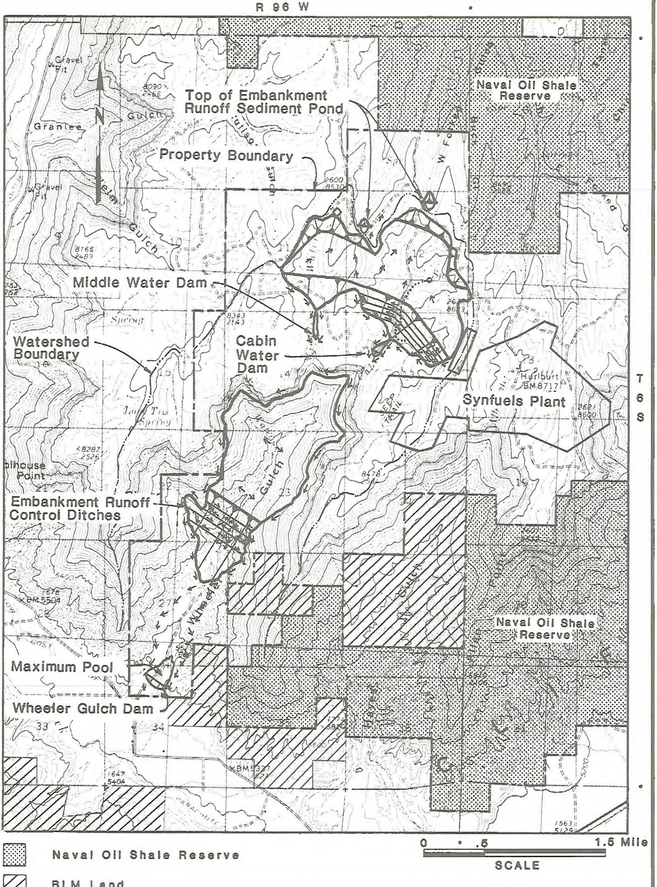


Figure 3.1-8. Processed shale embankments

Water and Middle Water gulches. In Stage 2, watershed runoff would be diverted around the embankment and Wheeler Gulch Dam. This system would be maintained until the embankment is completely reclaimed.

- When processed shale is disposed, its moisture content would be below the level of saturation. There would, therefore, be a minimal tendency for downward migration of precipitation. Furthermore, evaporation exceeds precipitation in the project area, further minimizing the amount of water traveling through the pile to ground water.

- Control of runoff from direct precipitation on the processed shale embankment would prevent it from reaching Parachute Creek. Embankment runoff would be collected in ditches on the embankment terraces and the working embankment surface. From the ditches, the water would be conveyed via channels, downchutes, and energy-dissipating structures to catchment ponds. This would be done in Stage 1, with dams in Cabin Water and Middle Water gulches. In Stage 2, a dam in Wheeler Gulch below the embankment would perform the same function. Water collected by these dams would either be evaporated or used for processed shale compaction and dust suppression. All dams would be designed as zero-discharge structures, and to contain the probable maximum precipitation event. After reclamation of the processed shale embankment in Cabin Water and Middle Water gulches, embankment runoff would be released to the natural drainages via riprapped and grouted channels. The dams would serve primarily as water control structures after embankment reclamation in Stage 1. After final revegetation of the Wheeler Gulch embankment, all dams would be removed.

- Springs present in Cabin Water Gulch would be controlled through the use of rock drains that would route the water to a point below the face of the embankment so it could be collected and used for revegetation. The rock drains would also prevent water from infiltrating the embankment and causing it to fail.

The moisture content of the processed shale would be such that fugitive dust would be minimized. To mitigate the dust created during operations, water sprays would be used at conveyor-transfer points. All haul roads would be watered and water trucks operating on the disposal pile would add sufficient water for final moisture content. After surface reclamation was complete, the vegetation would help minimize future dust production.

Solid waste disposal (nonhazardous). The proposed action is to dispose of nonhazardous solid wastes in a designated onsite sanitary landfill or in the processed shale embankment (see Tables 3.1-3 and 3.1-4). The exact location and design of the sanitary landfill will be as specified in the permitting process.

Liquid waste disposal (nonhazardous). All liquid wastes would be collected and treated onsite. There would be no discharge of liquids to natural streams or drainages (see Tables 3.1-5 and 3.1-6). The proposed disposal plan maximizes reuse of water, while minimizing treatment costs. Liquid sewage would be treated onsite in the central sewage treatment plant, and the treated water would then be recycled for processed shale moistening or dust control. Other nonhazardous industrial wastewaters would be reused for drilling, dust suppression, and

Table 3.1-3. Process plant construction nonhazardous solid waste inventory

Waste type	Description	Source	Amount	Disposal method
Site preparation	Slash/vegetation	Grubbing and site preparation	500,000 tons[a]	To be used as a soil conditioner for revegetation
	Waste rock and earth	Site preparation	30,000,000 tons[b]	To be used as fill for site leveling
Construction	Lumber and metal	Construction and shipping containers/ construction	13,200 TPY[c]	To be sorted, non-recoverable to be disposed in onsite sanitary landfill
Trash & garbage	Food, paper, etc.	Construction and employee facilities at mine and site	3,200 TPY[c]	To be disposed in onsite sanitary landfill
Sludges	Filter solids/ clarifier underflow	Raw water treatment plant	120 TPY[c] (dry)	To be disposed in onsite sanitary landfill

[a]Total waste generation during Years 4 and 5 of project construction.
[b]Total waste generation during Years 2 through 5 of project construction.
[c]Waste generation occurs each year of project construction.

Table 3.1-4. Process plant operations nonhazardous solid waste inventory

Waste type	Description	Source	Amount (TPY)	Disposal method
Raw shale	Dust	Secondary crushers and screens	8,100	
		Tertiary crushers	3,000	
		Product screens	28,000	To be disposed with processed shale
		Retort feed conveyors and transfer points	9,500	
		TOSCO II lift pipe system	280,000	
Processed shale	Dust	TOSCO II ball elutriators and TOSCO II processed shale moisturizer exhaust	100,000	To be disposed with processed shale
Trash & garbage	Food, paper, etc.	Employee and maintenance facilities, warehouse	1,300	To be disposed in onsite sanitary landfill
Sludges, floats	Silt, alum, lime, polymer, filter solids	Raw water treatment plant	4,200 (dry)	To be disposed in onsite sanitary landfill
	Digested biological sludges	Sanitary and process wastewater treatment plant	3,600 (dry)	Soil conditioner
	De-asher shale fines	Process wastewater treatment	36,000 (dry)	To be disposed with processed shale
	Dry gypsum	Power plant, FGD unit	20,000	To be disposed with processed shale
Other	Attrited alumina balls	TOSCO II retort	900	To be disposed with processed shale
	Fly ash	Power plant	9,800	To be disposed with processed shale

Table 3.1-5. Proposed disposition of waste liquids from mining, raw shale handling, and processed shale handling

Waste liquid	Disposition	Volume in gallons per minute
Mine water	Material handling makeup water	0 - 600 (variable)
Drilling water		
Crusher and conveyor washdown and dust suppression water	Process plant industrial water	1200
Storm water runoff		
Processed shale runoff water		
Runoff water		
Inadvertent liquid leaks from equipment	Process plant (slop system, reclaiming, and wastewater treatment)	40
Contaminated diesel fuel		
Wash bay drainage (water, soap, oil)		
Contaminated hydraulic fluid and turbine oil		
Used cleaning solvents		
Lubricating oil		
Sanitary sewage	Central sewage plant	60
Wash and rinse water		
Dirty coolant liquids	Waste removal contractor	0.83
Chemical toilet contents		
Miscellaneous industrial chemicals		
Hazardous liquid wastes	Truck to hazardous waste management facility	0.07

Table 3.1-6. Proposed disposition of waste liquids from process and support facilities

Waste liquid	Disposition	Volume in gallons per minute
De-ash water	• Arsenic removal • Oil and suspended solids • Biological oxidation • Processed shale quenching	480
Plant washdown water Storm runoff	• Oil and suspended solids removal • Biological oxidation • Processed shale quenching	280
Sour water	• Steam stripping • Biological oxidation • Processed shale quenching	1160
Blowdown water (cooling tower)	• Chromate removal • Processed shale handling, quenching, secondary crushing, or construction	760
Blowdown water (boilers) Ion exchange regenerant/ rinse streams	• Processed shale handling, quenching, secondary crushing, or construction	840
Sanitary wastewater (Roan Plateau)	• Suspended solids removal • Biological oxidation • Processed shale quenching	40
Sanitary wastewater (Mahaffey + Wheeler Gulch)	• Septic tank • Leachfield system	nil
Filter backwash	• Biological oxidation	180
Processed shale disposal Embankment runoff	• Processed shale handling, quenching, secondary crushing, or construction	130

processed shale moistening, as discussed previously. This moistening would include cooling or quenching with water to reduce the high temperature of the processed shale as it leaves the retorts.

The following is a summary of the treatment and use of the major wastewater categories:

- Water streams from the effluent processing plants, de-ashers, plant washdown, and contaminated storm runoff would be combined for initial removal of oil and suspended solids in an API Separator and dissolved air flotation unit before biological oxidation. Arsenic would be removed from de-ash water before streams were combined and disposed of offsite by a licensed contractor. The biologically oxidized wastewater would be used for processed shale quenching.

- Sour water generated from the retorting and upgrading processes would be steam stripped to remove H_2S and NH_3 before being combined with the oily water streams for biological oxidation of organic contaminants. The treated wastewater would be used for processed shale quenching.

- Cooling tower blowdown water would be treated for the removal of chromates, then combined with the steam system blowdown and ion-exchange streams. These streams might be reused in processed shale handling and quenching, secondary crushing, or construction.

- Runoff impounded in Wheeler Gulch would be reused, when available, for secondary crushing or processed shale management needs.

- Sanitary wastewater from the plant and mine areas would undergo treatment on the Roan Plateau. This water would undergo biological oxidation and solids removal. After treatment, this stream would be used to moisten processed shale. At Mahaffey Ranch and Wheeler Gulch, sanitary wastewater would be processed through septic tank and leachfield systems.

Hazardous waste disposal. The preferred alternative is offsite disposal at a local licensed facility. While such a facility is not yet available, it is expected that one would be developed in the region in order to centralize and better manage hazardous waste developed by several ongoing shale oil projects.

The hazardous wastes developed by this project would include sludges, floats, spent catalysts, oils, solvents, and other chemicals. The amounts that could be generated annually could be up to 3110 tons per year (TPY) of spent catalysts, 2230 TPY of sludges and floats, and 6000 TPY of waste oils and chemicals. Much of this waste might be reclaimed, so that the amount sent for disposal could be much less.

These wastes would be collected and temporarily stored in leakproof containers at the plant site. Periodically, when sufficient quantity was accumulated, a truck would pick up these materials for transport to the licensed hazardous waste site.

Water supply

A preliminary analysis of water needs indicates that approximately 10,160 gallons per minute (22.6 cubic feet per second) would be required to operate a 100-TBCD facility. The three major consumptive uses for this water, together requiring over half of the raw water needs, would be for evaporative cooling, processed shale quenching, and processed shale moisturizing. Other uses would include the process steam system, upgrading, and retorting.

Water source. Mobil owns adjudicated conditional water rights for direct diversion and storage of flows within the Main Elk Creek Basin. Development of these rights would fulfill total water demand for the project. A dam and reservoir would be located in Garfield County, Colorado, about 4 miles northwest of New Castle, and approximately 30 miles northeast of the Parachute Block. The proposed dam site for Main Elk Reservoir is located on Main Elk Creek, about 0.25 mile upstream of its confluence with West Elk Creek. The project would consist of an earth and rockfill embankment, side-channel spillway with flip bucket, outlet works, and access roads. Special discharge facilities would be used during construction and operation of the dam to ensure that existing water uses are maintained. A water supply site plan is shown on Figure 3.1-9.

The Main Elk Dam would be approximately 1100 feet in length and 180 feet in maximum height. The crest would be 25 feet wide to accommodate construction equipment and access after completion of the dam. The dam would consist of an impervious core down to bedrock. The pervious upstream shell and random-fill downstream shells would both have filter and drainage provisions. The slope of the dam would be 3:1 upstream and 2.25:1 downstream. The core would be sloped upstream and downstream at 1:1.5. A crest elevation would be 5940 feet and the reservoir's normal high water surface elevation would be 5929 feet.

The core material for the dam would be a silty soil, probably derived from the Maroon Formation or the Mancos shale. Potential source locations are within the proposed reservoir. The downstream filter would prevent particle migration and serve the additional purpose of transmitting seepage through the core to the seepage collection system, which would stabilize the downstream shell.

The source of the upstream and downstream shells is proposed to be Dakota or Maroon Sandstone, which is available at the site. This sandstone is expected to degrade during borrow and handling operations to a silty sand and cobbley material that is relatively free draining. The upstream riprap slope protection would be constructed of Leadville Limestone or Dakota sandstone. Existing borrow areas, or areas to be inundated, would be used for all source materials if possible.

An uncontrolled side-channel spillway would operate during flood conditions. Water from the reservoir would flow freely over the spillway crest as the reservoir rose under flood conditions. The spillway would be founded on bedrock on the west abutment. The control section, located at the downstream end of the side-channel section, would distribute the flow uniformly to the chute.

A tunnel would be excavated through the east abutment to provide a diversion for Main Elk Creek during dam construction, and ultimately, a permanent low-level

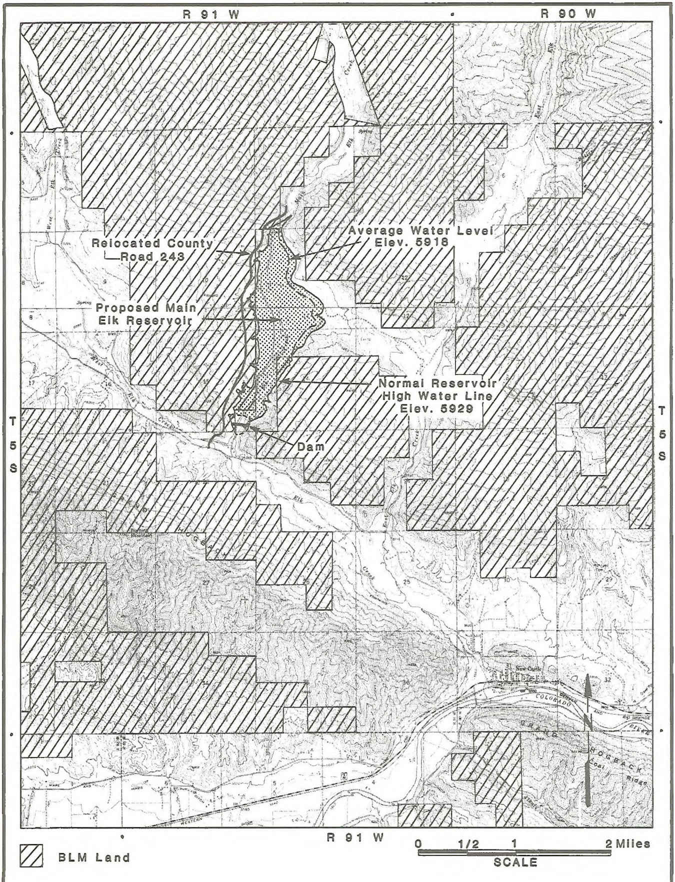


Figure 3.1-9. Main Elk Reservoir site plan

outlet. This diversion conduit is designed to pass the 25-year flood peak discharge of 1290 cfs. It would be 9 feet in diameter, and would be located in the east abutment with a control gate in the vertical gate shaft.

A total of five intake openings, spaced at regular vertical intervals, would be provided from the bottom to the top of the dam. This arrangement would allow regulation of water temperature as a downstream aquatic enhancement measure.

Relocated County Road 243. Portions of the existing County Road 243 would be relocated as shown in Figure 3.1-9 because they would be inundated by the Main Elk Reservoir. Construction standards would meet or exceed the current "Garfield County Road Specifications." For those criteria not specified by Garfield County, the recommended standards of the Colorado Department of Highways for Type F roads would be used. Because of changing widths of cut-and-fill, the right-of-way requirements would vary from 100 to 200 feet. The route would cross West Elk Creek over a drainage structure and would rejoin the New Castle-Buford Road (County Road 245) about 0.2 mile west of the present junction. West Elk Creek would be the only perennial stream crossed. Culverts will be used to allow water from small gulleys to drain under the road.

Dam access. Two roads would be built to provide necessary access to the dam crest and the outlet works control building below the dam. Both roads would be about 22 feet wide. The existing maintenance road to Trout Ditch would be improved and extended to about 500 feet to permit access to the outlet works control building.

The road to provide access to the dam crest would be about 0.75 mile in length. It would be constructed along the east bank of Main Elk Creek, downstream of the dam. This road would originate at County Road 245, on the north bank of Elk Creek, and terminate at the intake gate control house. The road would be built at an approximate 5 percent grade, and would require two bridges to maintain grade. The roadway would pass near the dam crest, permitting access to the dam and spillway. A maintenance bridge across the spillway would also be built.

Security fencing and locked gates would be provided in the dam area to limit public access to the dam and buildings.

Water conveyance from source. The proposed method for conveyance of project water from Main Elk Dam to the project facilities is use of natural stream channels. Project water would be released from the dam into Main Elk Creek. Natural streamflow would carry the project water down Main Elk and Elk creeks to the Colorado River and downstream to the Mahaffey Ranch. Project water would be diverted at that point and transported via pipeline to the facilities.

The use of natural streamflow would result in some water loss. These losses include evaporation, evapotranspiration, and bank seepage. In similar circumstances, projected losses have been assessed by the Colorado State Engineer's Office at a rate of 7 percent per 100 miles of conveyance. Estimates of project water loss, based on the State Engineer's figure and the distance between Main Elk Dam and the Mahaffey Ranch diversion point, are projected to be 3 percent.

Water diversion system. The planned diversion structure would be located 4 miles northeast of Parachute and would consist of a concrete overflow weir. The structure would be approximately 8 feet high, and provide a minimum pool level for the pump station intake on the north bank of the river. The structure would also serve to stabilize the river banks and channel bottom. A sluiceway would be provided to remove sediment buildup from the front of the pump station intakes. Normal high-water flow would cause increased water velocities to scour most of the remaining sediment away. The pump station would consist of a wet-well and four vertical turbine pumps of sufficient capacity to lift and transport the required water supply to a sedimentation basin, located on the Mahaffey Ranch to the north.

Water diversion location. The preferred diversion location is at the midpoint of the Mahaffey Ranch river frontage. It has good hydraulic and geomorphic characteristics for a diversion structure, and is preferred for those reasons.

Raw-water treatment facilities. All water withdrawn from the Colorado River would be pumped to the Mahaffey Ranch sedimentation basin where gross solids removal would occur. A small amount would be further treated and provide sanitary use at the Mahaffey Ranch facilities. To eliminate supply shortages to senior downstream users, water equivalent to impounded runoff would be made available to honor senior water rights, as needed.

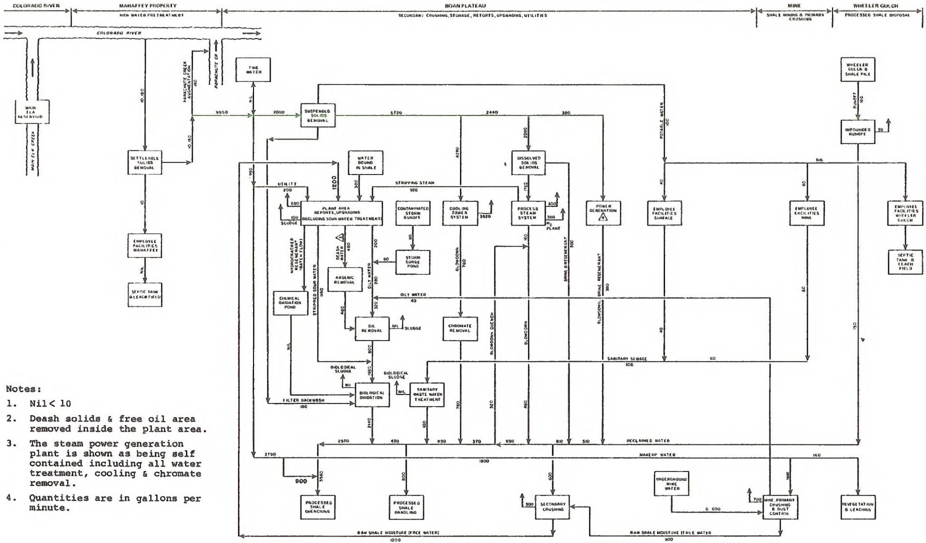
The bulk of the water, approximately 9990 gpm, would be pumped to the Roan Plateau. Most of this water (approximately 7000 gpm) would go directly to water treatment facilities and be subjected to coagulation, clarification, and filtration for suspended solid removal. Approximately 100 gpm would receive further water treatment for use as the potable water supply for the project; the remainder would receive additional treatment for use in the processing facilities, cooling towers, or power generation systems. Approximately 2790 gpm of raw water would be used either in the mine for drilling, primary crushing and dust suppression, or at the processed shale disposal area for dust suppression or shale compaction. The remaining 200 gpm pumped to the Roan Plateau would be used without further treatment for miscellaneous process uses. Figure 3.1-10 provides a water balance diagram for the entire project.

Water conveyance route from treatment facilities. A pipeline would route water from the Mahaffey Ranch to the Roan Plateau. A route through Cottonwood Gulch in the utility corridor is the preferred alternative (see Figure 3.1-3). Approximately 2.4 miles of this 3.4-mile corridor are across Naval Oil Shale Reserve (NOSR) land.

Other support features

A wide variety of additional facilities and systems are needed to operate and maintain a shale oil operation. These are collectively termed "support systems," and their role in the operation is described in this section. They include: the contractor's road, access road, electrical power generation and transmission, product shipment, feeder and natural gas pipeline routes, the utility corridor, railroad facilities, personnel transportation, and operational support facilities.

Contractor's road. The contractor's road to the Parachute Block would be required to provide early access to the Roan Plateau for site preparation work and access road construction. As shown on Figure 3.1-3, approximately 1.3 miles of this 2.3-mile corridor are across NOSR land.



Notes:

1. Nil< 10
2. Deash solids & free oil area removed inside the plant area.
3. The steam power generation plant is shown as being self contained including all water treatment, cooling & chromate removal.
4. Quantities are in gallons per minute.

Figure 3.1-10. Water balance diagram

The road would be built along portions of the existing Mahaffey Jeep Trail through Cottonwood Gulch. The design standards used would enable the safe transportation of equipment, fuel, supplies, and personnel to the top of Roan Plateau. The following design criteria would be applicable:

- On existing trails and roads, the maximum acceptable grade would be 15 percent. Wherever the 15 percent maximum grade is exceeded, a new alignment would be developed to reduce the grade to a 10-percent maximum. The minimum radius of curves would be 100 feet.

- The traveled roadway width would be 22 feet of surface with 1-foot shoulders. The roadway surface would be 6 inches of well-graded and compacted gravel.

Access road and mine portal location. This road would provide permanent access to the mine bench and the process plant. The road would begin at the frontage road for Interstate 70, approximately 3.8 miles east of Parachute, would be 12 miles in length, and would follow a route that provides a favorable grade (see Figure 3.1-3). Approximately 5.2 miles of this 11.7-mile route would be across NOSR land.

The following design criteria would be applied to the access road:

- Maximum grade would be 6 percent.

- Minimum radius of curves would be 100 feet.

- The roadway surface would be 6 inches of well-graded and compacted gravel.

- The roadway travel surface and shoulder widths would vary, depending on the section of the road.

The access road would be built using ripping and drilling and blasting methods. Adequate safety berms or barriers would be provided. Retaining walls would be built where required to prevent slides.

Electrical power supply. Onsite power production is proposed, using coke produced in the delayed coke plant as a base fuel to generate 184 megawatts (MW). The peak power requirement is projected to be 213 MW for 100 TBCD production, requiring purchase of 29 MW. This power would be generated adjacent to the processing facilities on the Roan Plateau (see Figure 3.1-3), using eight power-plant boiler/steam turbine units. Natural gas, at a rate of approximately 10 percent (on a Btu basis) would provide startup, flame stabilization, and makeup fuel.

Electrical power transmission line route. An electric power transmission line with a capacity of at least 60 MW would be used to accommodate construction, startup, and some production needs. It would also provide a means for sale of excess energy. An electric transmission line from the Parachute substation would extend up through Hayes Gulch (see Figure 3.1-3). Approximately 4.2 miles of this 4.7-mile corridor are across NOSR land.

A 100-foot right-of-way would provide adequate clearance for construction and maintenance of the H-frame wooden support structures. The support structures would be approximately 70 feet high with 20 feet between conductors. Minimum line clearance would be 30 feet. The average span length would be 700 feet. Helicoptor construction would be used to place the structures.

Power for Mahaffey Ranch would be supplied via a standard "T" pole system extending east from the Parachute substation to the Mahaffey Ranch.

Product shipment. Participation in an industry pipeline is anticipated for shipment of syncrude to the Midwest or Gulf Coast. A product feeder pipeline connection to the LaSal Pipeline route (Figure 3.1-11) is currently proposed for this project. The most probable destination of the syncrude would be a Midwest refinery that would be reached via interconnecting common-carrier pipelines. Shipment by unit train might be used in early stages, when production was lower, or until an industry pipeline was available. After a pipeline was available, some oil might be shipped by unit train to special markets.

Product feeder pipeline route. Syncrude would be transported from the production facilities on the Roan Plateau to the origin of the LaSal Pipeline via two parallel 8-inch pipelines. The pipeline would originate at the Parachute pump station, located near the product storage tanks on the Roan Plateau. The Parachute pump station and support facilities would require approximately 1 acre of land. The pipeline would proceed westward from the plant site approximately 1.5 miles, then veer to the northwest and drop into the Parachute Creek valley at a point just southwest of Helm Gulch (see Figure 3.1-3). The route would then join a utility corridor and proceed in a northerly direction to end on Davis Point at a pipeline terminal with adequate storage, located adjacent to the LaSal Pipeline. This route would be approximately 10 miles long.

Natural gas pipeline route. This natural gas supply line is projected to come from an approved line in the north and along either the SOPS or LaSal routes to the Colony property. From there, it would proceed down the syncrude pipeline corridor to the plant site (see Figure 3.1-3).

Utility corridor. A utility corridor is proposed through Cottonwood Gulch to carry materials in underground pipelines both to and from the Mahaffey Ranch to the plateau (see Figure 3.1-3). This corridor would be used for a water pipeline from the Mahaffey Ranch up to the plateau treatment facilities, a separate ammonia line from the plateau to the ranch, and a separate line for syncrude or raw shale oil. The corridor could also be used for pipeline transport of other materials, such as sulfur, as an alternative to truck transport, which is presently the preferred method. Approximately 2.4 miles of this 3.4-mile corridor are across NOSR land. As shown in Figure 3.1-11, an alternative route for the feeder pipeline would be in this corridor.

Railroad facilities. Railroad terminal facilities would be required to load and ship products and to receive and unload materials and supplies required for plant construction and operation.

The terminal would be located approximately 4 miles northeast of Parachute on the Mahaffey Ranch, adjacent to the D&RGW tracks (see Figure 3.1-3). It would use approximately 15 acres.

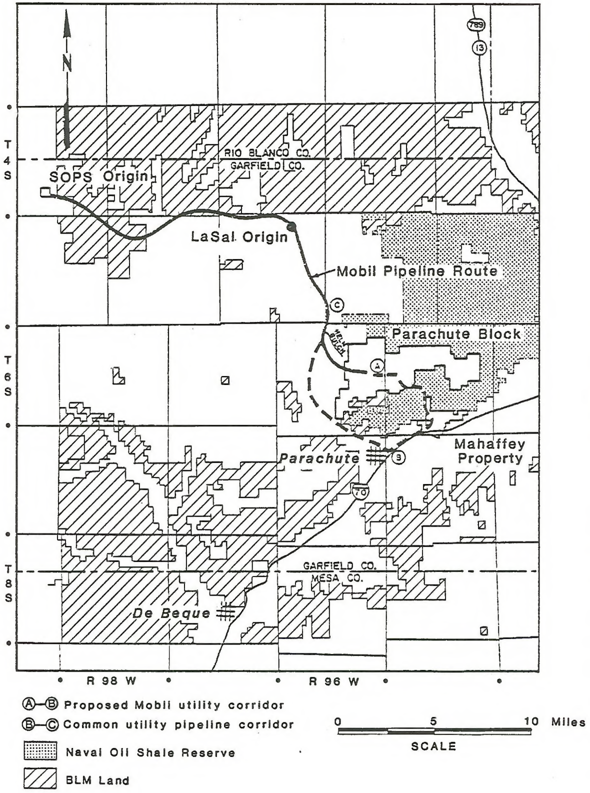


Figure 3.1-11. Syncrude pipeline route alternatives

The terminal would consist of a six-track rail yard. It would be equipped with loading/unloading facilities and would be connected to the D&RGW tracks which run east and west. The estimated railroad traffic is shown in Table 3.1-7.

Personnel transportation. The three key elements of the personnel transportation system would be: parking in Cottonwood Gulch, the access road for buses, and the funicular railway.

A parking lot would be constructed in Cottonwood Gulch at an elevation of about 6000 feet. This facility would be on NOSR land and adjacent to the access road (see Figure 3.1-3) to accommodate the parking of employee cars and company buses.

The busing system would use 48 heavy-duty transit buses. Carrying up to 45 passengers per trip, the buses would make up to 140 round-trips each day from the base of Cottonwood Gulch to the top of Roan Plateau. At an average of 20 miles per hour, the 12-mile, one-way journey would take 36 minutes. This system would provide adequate transportation until the funicular railway became operational.

The funicular railway (see Figure 3.1-3) would have its base station at the Cottonwood Gulch parking lot, at an elevation of about 6000 feet. An intermediate station in the mine would allow loading and unloading. The Roan Plateau station would be located near the process facilities at approximately 8500 feet. Approximately 0.9 mile of the 2.1-mile funicular railroad would be on NOSR land.

Table 3.1-7. Estimated railroad traffic

Commodity	Estimated production/consumption per calendar day	Rail car Type	Rail car Capacity	Estimated annual carloads
Outbound railroad traffic:				
Shale oil	25,000 BBL[a]	Tank	23,150 gal	16,600
Naphtha	10,000 BBL[a]	Tank	28,400 gal	5,400
Ammonia, anhyd	270 tons	Pressure tank	33,600 gal	1,140
Sulfur, molten	250 long tons	Tank	13,250 gal	920
Inbound railroad traffic:				
Diesel fuel	48,000 gallons	Tank	26,000 gal	670
Ammonium nitrate	52 tons	Covered hopper	100 tons	190

[a]This capacity would be used while an industry pipeline was being developed; after that, use would be intermittent based on market demands.

The 11,500-foot railway would be a single-track tunnel system with a widened portion at the midpoint to allow trains to pass each other. About 8000 feet would be underground and pass through a 13-foot-diameter tunnel. Trains would average nearly 25 miles per hour, make the trip in under 7 minutes, and carry up to 4285 passengers per hour in four-car trains. The railway is more energy efficient than buses and can operate more reliably, especially in severe weather. After construction of the railway is completed, the bus system would be used only as a backup.

Operational support facilities. Operational support facilities include: natural gas, inert gas generation and distribution, a relief-and-blowdown pipe network, steam generation and distribution, water for fire fighting, cooling systems, tankage, and materials shipment.

Natural gas would be consumed by the process and support facilities at an average rate of about 2500 million (MM) Btu/hr. The mining and crushing facilities would consume 0 to 600 MM Btu/hr, depending on seasonal requirements. Gas would be supplied by a public utility or through a collection system from wells in Colorado. The supply line is planned to follow Parachute Creek from the north to the syncrude pipeline route described above, and then follow that syncrude pipeline route to the Roan Plateau.

The inert-gas requirements are estimated to be about 320,000 standard cubic feet per hour (SCFH) on a continuous basis and about 500,000 SCFH as a periodic maximum. The continuous gas requirement would be for the Union B and Paraho DH systems. The maximum requirement would be for purging of retorting and other process equipment during startup and shutdown operations. The inert gas would be flue gas from the combustion of natural gas in an onsite inert-gas generator. In addition, high-purity nitrogen would be required for hydrotreater and hydrogen-plant catalyst regeneration. Sixty tons of nitrogen storage would be located in the utility area on the Roan Plateau. The nitrogen would be purchased from commercial suppliers and delivered by tank truck.

A relief-and-blowdown pipe network would carry hydrocarbons released from pressure-vessel pressure relief valves to a flaring stack. There would be two relief-and-blowdown facilities, one low-pressure system for the TOSCO II retorts, and one higher-pressure system for all other process facilities. The flare for the relief facilities other than the TOSCO II retort would be designed for smokeless burning of the gas released upon outage from the unsaturate gas plant compressor, saturate gas plant compressor, or the hydrotreater recycle gas compressors.

Steam for process uses would be supplied from a steam plant, which would consist of four equally sized conventional boilers. Boiler fuel would be low-Btu gas supplemented with high-Btu gas for flame stabilization. Steam-turbine drivers have been specified for several services to provide reliability and flexibility. Services which would have steam drivers for normal operations include air blowers, compressors, and some pumps.

An emergency water supply for fire-fighting would be stored in tanks on the Roan Plateau and at Mahaffey Ranch. Water would be pumped by an electrically driven fire-water pump or diesel driven spare pump through a network of underground fire-water lines to strategically located fire hydrants, monitors, and water spray systems. Fire trucks, chemical foam, and other fire-fighting equipment would be stored in the firehouse and at other locations throughout the facilities.

The cooling requirements of the retort and upgrading facilities would be met by a combination of air, conventional-water, and tempered-water (water kept at a controlled temperature) cooling systems. In general, air cooling would be used to reduce process-stream temperatures. Further cooling would result from use of two conventional cooling towers and a circulating water system. The towers would consist of five cells, each 55 feet high and housing a 30-foot-diameter fan. Process streams having a high pour point would be cooled by tempered water.

Tankage for intermediate and finished products, by-products, and other materials would be provided as required on both the Roan Plateau and at the Mahaffey Ranch (Table 3.1-8). Tankage on the Roan Plateau would handle storage of the raw shale oil, naphtha, distillate, heavy-oil hydrotreater feeds, delayed-coke plant feed, hydrotreated products, butanes, slop, sour water, ammonia, sulfur, nitrogen, diesel fuel, and other miscellaneous items. Tankage on the Roan Plateau would require approximately 100 acres. Tankage at the Mahaffey Ranch would accommodate molten sulfur, ammonia, naphtha, shale oil/syncrude, and diesel fuel. Product tankage would be required during early levels of production to allow shipment by unit train. In later stages of project life, the tankage would be used on an as-needed basis. Tankage on Mahaffey Ranch would require approximately 5 acres.

Table 3.1-8. Major tankage requirements

Roan Plateau	Storage volume (in BBLS)	Type[a]
Fines retort effluent processing	86,000	CFR
Coarse retort effluent processing	263,000	CFR
Delayed coke feed	1,810,000	CR
Heavy-oil HDT feed	1,050,000	CR
Distillate HDT feed	1,050,000	CR
Stabilized unsaturate naphtha	859,000	CFR
Stabilized saturate naphtha	435,000	CFR
Butanes	74,000	SPH
Naphtha product	604,000	CFR
Distillate product	439,000	CR
Heavy-oil product	482,000	CR
Sulfur	4,000	DR
Ammonia	15,000	DR
Heavy-slop oil	12,000	CFR
Light-slop oil	12,000	CFR
HDT sour water	325,000	CFR

[a]CFR - Covered floating roof
CR - Cone roof
SPH - Pressure spheres
DR - Dome roof

Between five and eight trucks would deliver supplies at Mahaffey Ranch daily from Interstate 70 and its north and south access roads. Truck traffic on the Cottonwood Gulch access road from the Mahaffey Ranch to project facilities would average 15 trucks per day.

3.1.1.6 Site development, reclamation, and decommissioning

Site development

Initial plant site development work would consist of road construction, surficial soil stripping, earthwork, and construction of drainage systems. Mine facility development would include construction of the mine portal bench, ventilation openings, and the explosives storage area. Site development activities would include those for Main Elk Reservoir, the shale disposal embankment, processing facilities and service buildings, upgrading facilities, and other support facilities for the project.

Reclamation

The project site would be reclaimed for livestock grazing and wildlife habitat. Disturbed areas, with the exception of the access road and the mine bench, would be graded to blend with the surrounding topography. Topsoil removed and stockpiled prior to disturbance would be reapplied to the graded surface. A mixture of native and non-native grasses, forbs, and shrubs would be established to control erosion and supply forage and cover for livestock and wildlife.

Processed shale reclamation. Topsoil, subsoil, and other unconsolidated material that is suitable to support vegetation would be removed in advance of processed shale laydown. The topsoil, subsoil, and other regolith would be stored in separate stockpiles in Wheeler Gulch. To the extent possible, the cover material would be applied directly to a completed portion of the graded and compacted processed shale embankment immediately after being removed in front of an advancing section of the embankment. When the processed shale is covered, the poorer quality regolith would be applied first and then topped with better-quality soil. If available, waste rock from construction of various facilities would provide part of the cover material. Other treatments, including plowing and harrowing, would be used as needed to provide a proper seedbed. To provide additional erosion control while vegetation is becoming established, the surface soil would be contour-furrowed prior to seeding and mulching. A sound fertilization program would be instituted and would continue as appropriate.

The soil-covered processed shale embankment would be drill seeded with adapted native and non-native grasses, forbs, and shrubs. Tentative seed mixtures have been developed for both the level portions of the processed shale embankment and for the drier southwest-facing embankment slopes. These mixtures are based on current revegetation studies in the basin, but could change in the future, depending on seed availability and new developments in reclamation technology. Following seeding, the area would be adequately mulched. The seeding would be augmented by planting dormant container-grown or bare-root native shrub seedlings. Seeding and planting would be done primarily in the fall and spring. Up to 20 inches of irrigation water would be applied during the first growing season to aid plant establishment.

Other disturbed area reclamation. An average of 12 inches of topsoil and subsoil would be removed from disturbed areas and stockpiled. Graded surfaces would be ripped, and 12 inches of soil would be spread over the ripped surface. Fertilizing, seeding, mulching, and shrub transplanting would be done in the same manner as described for the processed shale pile. Different seed mixtures have been prepared for high and low elevations. Wherever possible, pads of vegetation and soil would be transplanted directly from one site to another.

The goal of the revegetation program is to achieve a cover of native and/or naturalized vegetation equal to or better than the existing vegetation, for all disturbed areas, as soon as possible after abandonment.

Surface drainage control. Sediment settling ponds would be constructed in drainages below major disturbed areas. The ponds would be sized to contain runoff from a 10-year, 24-hour precipitation event, plus at least 3 months of sediment storage. The sediment ponds would have riprapped or concrete-lined spillways, as needed, to minimize the possibility of pond washout. Following final reclamation of disturbed areas, the sediment ponds would be removed, regraded, and revegetated.

Storm-water runoff from undisturbed areas would be diverted with berms and ditches around facilities and soil stockpiles and fed back into natural drainages. That from the Wheeler Gulch watershed would be diverted around the processed shale disposal embankment by lined ditches to a point below the catchment dam at the mouth of Wheeler Gulch. Lined ditches would also serve as the permanent drainageways for Wheeler Gulch after final reclamation. Minor ditches and berms around facilities would be regraded when sites undergo final reclamation.

Decommissioning

When production permanently ceases, all salvageable equipment would be removed from the project and either sold, transferred to another operation, or scrapped. Any equipment or structure that has no sale or scrap value would be disposed in an environmentally acceptable manner. All substances that could pollute the ground water would be removed. All openings to the mine would be securely and permanently sealed, unless use of the mine for storage or other uses is approved. Tanks, foundations, and buildings having no further benefit to the ultimate use of the land would be razed and the foundations removed down to acceptable depths. The disturbed areas would be covered with the previously stockpiled topsoil and revegetated in a manner which would support the ultimate use of the land.

3.1.1.7 Net energy analysis

The energy factors determined to be significant for the Mobil Project are:

- Direct External Energy Input

  Included as direct energy input are 29 megawatts of purchased electrical power, 270 MM Btu/hr of diesel fuel, and 2500 MM Btu/hr of natural gas.

- Recovered Resource

  Raw shale at 30 gallons per ton will be mined at a rate of 175,400 TPSD (dry), which is equivalent to 40,920 MM Btu/hr.

- Product Energy

  Syncrude will be produced at a rate of 117,600 barrels per day which is equivalent to 27,050 MM Btu/hr. Sulfur will be produced at a rate of 280 long tons per day which is equivalent to 110 MM Btu/hr. Ammonia will be produced at a rate of 300 tons per day which is equivalent to 250 MM Btu/hr.

The project trajectory has been divided into four modules as described below:

- Power Generation

  Coke from the delayed coking unit in the upgrader is the primary fuel, supplemented by fuel gas and natural gas at a rate of 10 percent. The power generation facilities produce 184 megawatts of power for use in the project and they are 23 percent energy efficient.

- Mining, Crushing, Conveying, and Processed Shale Disposal

  The direct energy inputs are diesel fuel and natural gas. Electrical power is supplied by the Power Generation facilities. Shale resource is mined at the rate of 175,400 TPSD (dry). Included in this module are mining activities, raw shale transport, crushing, screening, processed shale transport, and processed shale disposal. Together, these activities are 99 percent efficient.

- Retorting

  The direct energy input is natural gas. The natural gas is used to produce inert gas for the retort seal operations. Electrical power is supplied by the power generation facilities. The additional energy required to fuel the process is supplied by fuel gas generated in the retorts from the primary energy supply (oil shale). Included in the module are units for retorting, fines removal, gas separation, and shale quenching. Together, these activities are 75 percent energy efficient and they produce raw shale oil and fuel gas.

- Upgrading

  The direct energy inputs are natural gas and electrical power. The natural gas is used as hydrogen plant feedstock. Electrical power is input at a rate of 29 megawatts to supplement the electrical power input from the power generation facilities. Raw shale oil and fuel gas are input as primary energy from the retort module. Included in the module are units for delayed coking, hydrotreating, hydrogen generation, fuel gas treating, sulfur production, ammonia production, gas separation, water treating, and off-plot activities. Together, these units are 89 percent efficient and they produce syncrude, ammonia, and sulfur as primary products and coke and fuel gas for power generation.

The overall project trajectory is 62 percent energy efficient. The energy balance, modules, and trajectory are shown on Figure 3.1-12.

3.1.2 Description of alternatives

This section describes reasonable alternatives to the proposed action. In all cases, alternatives for this project would remain under review. As technology for the oil shale industry develops, the preferred design would be subject to continuing evaluation.

3.1.2.1 Selection of alternatives for detailed consideration

Table 3.1-9 lists all alternatives identified during scoping and those that were eliminated from further consideration. The reason for the rejection of alternatives considered unreasonable after initial analysis is noted in the table. Additional supporting material is on file and available from the BLM.

In the remainder of this section, only the reasonable alternatives that were identified are discussed. Alternative descriptions are presented only to the level required to understand the differences among the alternatives and the proposed action.

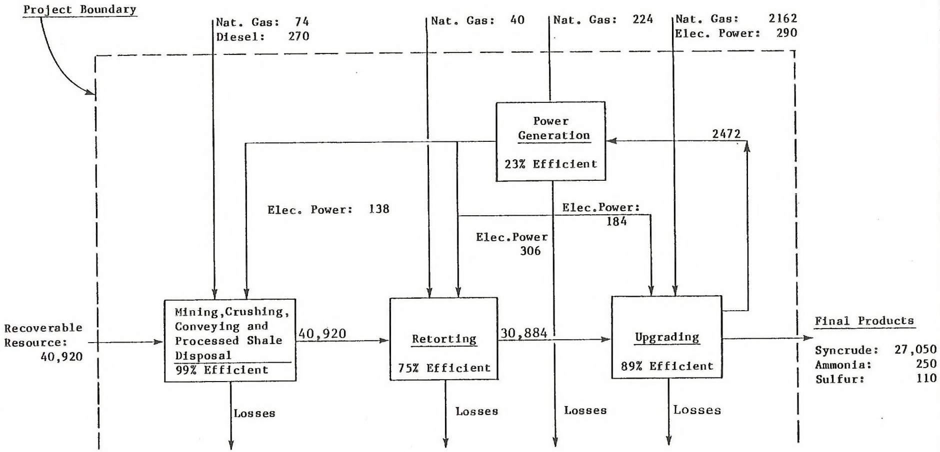
3.1.2.2 Mining

Mining methodology

There is no reasonable alternative mining method to the lane-and-pillar technique. This is a minor variation of room-and-pillar mining, a proven and efficient mining method in oil shale and other horizontal tabular deposits.

3.1.2.3 Main plant site locations

Separating the upgrading complex from the retorts and locating the upgrading portion on the Mahaffey Ranch was considered reasonable. The only reasonable alternative to upgrading on the Roan Plateau would be upgrading at the Mahaffey Ranch. The Mahaffey upgrading location would require an approximate 160-acre site and is shown on Figure 3.1-13. Raw shale oil would be transported to the Mahaffey Ranch upgrading facility by a pipeline in the utility corridor. Syncrude oil would be transported by pipeline via route B-C in Figure 3.1-11. Raw shale oil and syncrude oil storage tanks would be on the 160-acre site.



Note:
1) All energy input expressed in MM Btu/hr.
2) Overall energy efficiency is 62 percent.

Figure 3.1-12. Mobil Project net energy analysis

Table 3.1-9. Components and alternatives considered for the Mobil Project

Category/ component	Alternatives	Reasonable (R) or Unreasonable (U)	Reason for elimination from further analysis
<u>Mining and Handling</u>			
Mining Methodology	Lane-and-pillar	R	
	Long wall	U	Unsuited to oil shale
	Block caving	U	Unsuited to oil shale
	In situ	U	Technology not sufficiently advanced
	Surface	U	Greater surface disturbance, economically infeasible
Materials Handling	Underground and surface crushing	R	
	Roan Plateau (Prep West)		
	Roan Plateau (Prep East)		
	All surface crushing	U	Economically unreasonable; would require trucking
	Roan Plateau (Prep West)		
	Roan Plateau (Prep East)		
	All underground crushing	U	Economically unreasonable; multiple conveyors required
<u>Main Plant Site Locations</u>			
Retorting Facilities Location	Roan Plateau	R	
	Mahaffey Ranch	U	High materials handling cost
	Wheeler Gulch (mouth)	U	Limited area available; poor atmospheric dispersion
	Mine adit site (head of gulch)	U	High cost; poor atmospheric dispersion
	In situ	U	Technology not sufficiently advanced
Upgrading Facilities Location	Roan Plateau	R	
	Mahaffey Ranch	R	
	Remote	U	Pipeline unavailable for raw shale oil
<u>Retorting and Upgrading</u>			
Retorting Method	Union B	R	
	TOSCO II	R	
	Paraho DH	R	
	Chevron STB	R	
	Lurgi	R	
	Circular Grate	R	
	In situ	U	Technology not sufficiently advanced
<u>Waste Disposal</u>			
Processed Shale Disposal Location (including routes and roads)	Wheeler Gulch (upper and lower)	R	
	Wheeler Gulch (lower only)	R	
	Hayes Gulch	U	Visibility from Colorado River Valley
	Cottonwood Gulch	U	Visibility from Colorado River Valley
	Roan Plateau	U	Greater surface disturbance; higher air quality effects; negative effect on shale recovery
	Underground	U	Technological and economic problems
Processed Shale Transportation (including steep descent)	Belt conveyor plus	R	
	Truck plus	R	
	Slurry pipeline	U	Large power and water requirement
	Pneumatic conveyor	U	Large power requirement

Table 3.1-9 (continued)

Category/ component	Alternatives	Reasonable (R) or Unreasonable (U)	Reason for elimination from further analysis
Waste Disposal			
Solid Waste Disposal (nonhazardous)	Sanitary landfill plus processed shale	R	
	Processed shale alone	R	
	Sanitary landfill alone	R	
	Offsite	R	
Liquid Waste Disposal (nonhazardous)	Treat and reuse onsite	R	
	Treat and discharge	U	Greater water demand, more expensive
	Underground disposal of untreated water	U	Incompatible with safe mine operations, potential contamination of ground water
Hazardous Waste	Offsite	R	
	Onsite	R	
Processed Shale Reclamation	30-inch cover	R	
	12-inch cover plus leaching	R	
	No cover plus leaching	R	
Water Supply			
Water Supply	Main Elk Reservoir	R	
	Ruedi Reservoir	R	
	Onsite ground water	R	
	Green Mountain Reservoir	U	Availability uncertain
	Blue Mesa Reservoir	U	Expensive pipeline necessary
	Piceance Basin water rights	U	Source for other future oil shale projects
	Azure Reservoir	U	Only in conceptual stage, limited supply
	Iron Mountain Reservoir	U	Only in proposal stage
	Una Reservoir	U	Only in proposal stage
	West Divide Project	U	Only in proposal stage
	Colorado River mainstem	U	Unreliable supply
Relocated County Road 243	Western route	R	
	Eastern route	U	Local opposition, difficulty of improving existing road
Dam Access	Main Elk Dam access road	R	
Water Conveyance from Source	Stream flow	R	
	Pipeline	R	
Water Diversion System	Overflow weir	R	
	Crib	R	
	Side-channel inlet	R	
	Alluvial wells	U	Insufficient rate of supply due to insufficient permeability
Water Diversion Location (Conveyance from Pump Station to Treatment Facility)	Mahaffey Ranch 1	R	
	Mahaffey Ranch 2	R	
	Parachute	R	

Table 3.1-9 (continued)

Category/ component	Alternatives	Reasonable (R) or Unreasonable (U)	Reason for elimination from further analysis
Water Supply			
Raw Water Treatment Facilities	Mahaffey Ranch	R	
Water Conveyance Route to Roan Plateau	Cottonwood Gulch	R	
	Wheeler Gulch	R	
Support			
Access Road and Mine Portal Location	Cottonwood Gulch	R	
	Wheeler Gulch	R	
	East Fork	U	Higher construction and maintenance costs
	Granlee Gulch	U	Higher construction and maintenance costs
	JQS Trail	U	Excessive distance
Contractor's Road	Mahaffey Ranch	R	
	Anvil Points	R	
	Cow Creek	R	
	JQS Trail	R	
	Colony Access	R	
Electrical Power Supply	Roan Plateau	R	
	Offsite	R	
	Mahaffey Ranch	U	High fuel (coke) handling cost
Electrical Power Transmission Line Route	Hayes Gulch	R	
	Cottonwood Gulch	R	
	Wheeler Gulch	R	
Product Shipment	Tie-in to the LaSal Pipeline	R	
	Tie-in to the SOPS Pipeline	R	
	Unit Train	R	
Product Feeder Pipeline Route	Helm Gulch	R	
	Cottonwood Gulch	R	
Natural Gas Pipeline Route	Helm Gulch	R	
	Cottonwood Gulch	R	
Utility Corridor	Cottonwood Gulch	R	
	Wheeler Gulch	R	
Railroad Facilities	Mahaffey Ranch	R	
	Wheeler Gulch	U	Too far from access road and utility corridor
Personnel Transportation	Funicular Railway	R	
	Bus	R	
	Cable Suspended Gondola	U	Limited personnel capacity, and lower reliability
Support Facilities	Mahaffey Ranch	R	

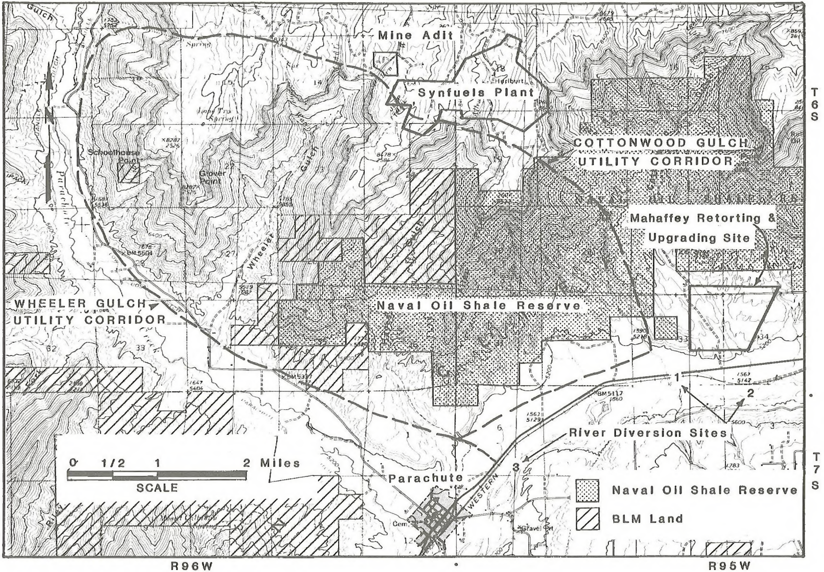


Figure 3.1-13. Alternative utility corridor routes, river diversion sites, and retorting and upgrading locations

3.1.2.4 Retorting and upgrading

The proposed action calls for a mix of three types of retorts: Union B, TOSCO II, and Paraho DH. Mobil also wishes to consider the Chevron STB, Lurgi, and Circular Grate retorts for possible use in this project.

Offsite upgrading is considered unreasonable for the fully developed 100 TBCD project, based on lack of transportation for large volumes of raw shale oil. If cost competitive transport of raw shale oil becomes available, remote upgrading will be reconsidered. Shipment of lesser quantities of raw shale oil by unit train is a reasonable alternative; therefore, use of unit trains will make offsite upgrading at existing refineries a possibility during early stages of development.

3.1.2.5 Waste disposal

Processed shale disposal location

The lower Wheeler Gulch alternative would emplace all processed shale in this large gulch below the Mahogany Zone as shown in Figure 3.1-14. Total surface disturbance would be about 1140 acres.

Processed shale transportation

The proposed action is the transport of processed shale by covered conveyor. As an alternative, processed shale could be transported by truck. During Stage 1, trucks could move over the fill as it is constructed; thus, no further surface disturbance would be required. However, during Stage 2 a haul road would be required down the steep cliffs of Wheeler Gulch as shown in Figure 3.1-15. The design criteria for the road would be the same as for the Cottonwood Gulch access road.

Solid waste disposal (nonhazardous)

The proposed action is to dispose of garbage and wastes that could not be readily transported by conveyor in a designated onsite sanitary landfill occupying about 10 acres. Waste transportable by conveyor would be mixed with the processed shale and disposed in the processed shale embankment. Prior to retort startup, construction wastes would also be disposed in the sanitary landfill.

A reasonable alternative would be disposal of all solid wastes in the processed shale embankment, with no separate landfill for garbage and similar wastes. Such a procedure would require specially constructed and managed portions of the embankment.

Another reasonable alternative would be disposal of all nonhazardous solid wastes in a separate landfill in the eastern portion of the Roan Plateau. Such a landfill would cover about 40 acres, or four times the acreage of the proposed action landfill; if it included all the solid wastes, it would require a storage volume 20 times as large.

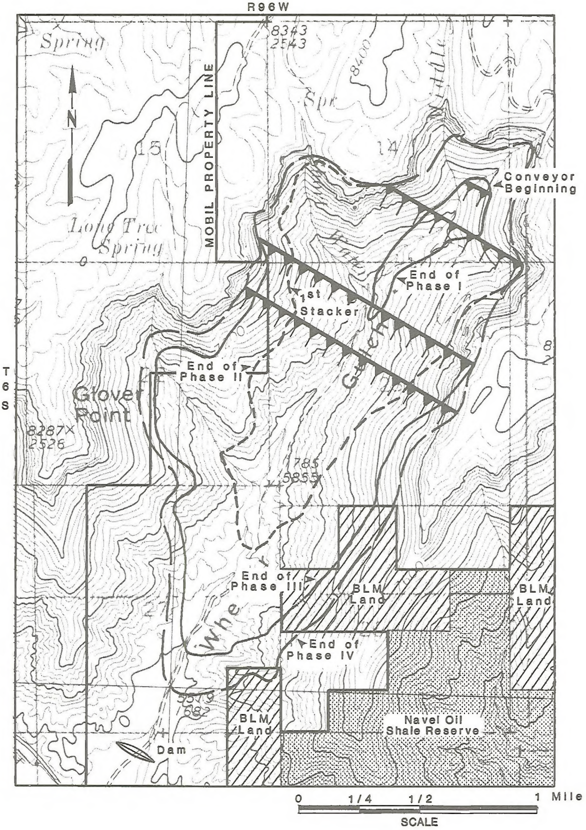


Figure 3.1-14. Alternative processed shale location

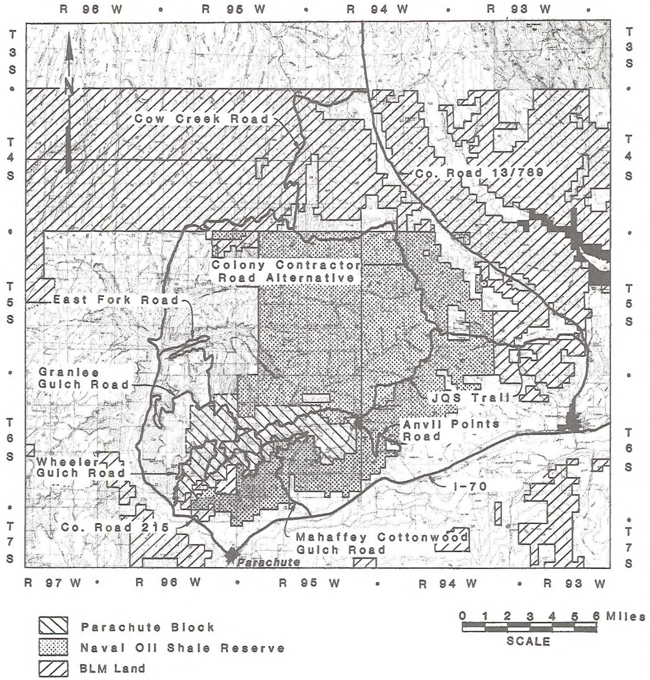


Figure 3.1-15. Access and contractor road alternatives

Finally, offsite disposal of nonhazardous waste is considered to be feasible. This alternative would use trucks to haul the waste to local landfills.

Hazardous waste disposal

The proposed action is offsite disposal at a local licensed facility. Reasonable onsite hazardous waste disposal alternatives would include placement in a remote mine panel or placement in a conventional onsite hazardous waste site on the Roan Plateau. If an onsite location were used, a 5-acre facility would be established on the Parachute Block east of the plant site and other facilities (see Figure 3.1-3). The same initial storage and packaging procedures would be used as described earlier. Trucks would be used to transport the material to the final storage location on the plateau or in the mine.

3.1.2.6 Water supply

Water source

Reasonable alternatives to the Main Elk Reservoir are onsite ground water and Ruedi Reservoir.

Consideration has been given to use of onsite ground water from dewatering activities within the mining block and wells located on the Mobil property. This alternative appears to have insufficient quantity for total water supply. Preliminary testing on the site indicated that only limited water would be available from this source, far less than necessary to supply the oil shale operations. However, reliable supplies could be used as a supplemental source, and this option is being considered.

Another alternative examined was Ruedi Reservoir. It is an existing U.S. Bureau of Reclamation project on the Fryingpan River, approximately 100 miles upstream of Mobil's shale oil facilities. This reservoir has a storage capacity of 102,400 acre-feet, with a firm annual yield of approximately 87,300 acre-feet. Of this firm annual yield, 28,000 acre-feet are reserved for replacement purposes, leaving 59,300 acre-feet per year available to be sold and delivered pursuant to contract. Mobil is presently pursuing a water service contract with the Bureau of Reclamation for purchase of Ruedi water as a secondary or supplemental source. As in the proposed action, water would be released at the dam and an intake would be constructed in the Colorado River at Mahaffey Ranch.

Water conveyance from source

Utilization of the natural water courses of Main Elk Creek and the Colorado River to transport water to a diversion point at the Mahaffey Ranch is the proposed action.

The alternative of using a pipeline system to transport project waters from source to point of use has been considered. Mobil presently has a decreed conditional water right for diversion and conveyance of 40 cfs of water by pipeline from Main Elk Creek to the Parachute Block. A buried prestressed concrete pipeline from the source to the Mahaffey Ranch is being considered. This route would parallel existing road rights-of-way (see Figure 3.1-16).

Figure 3.1-16. Water pipeline route

Water diversion system

A diversion system would be required to remove water from the river for conveyance to the point of use. The proposed action is the overflow weir. An alternative would involve the construction and use of a concrete crib or inflow structure, located in a deep pool at mid-river. This structure would be similar to existing cribs used elsewhere in the Colorado River. The crib would be approximately 34 feet long, 15 feet wide, and from 12 to 14 feet high. Approximately 5 feet would protrude above the existing channel bottom, with an additional 7 to 9 feet constructed below channel bottom. The diversion would be an elongated hexagonal- or diamond-shaped structure with inlet screens on each side for water entry into a wet-well and intake pipes.

Another alternative being considered would be to use the side-channel intake associated with the proposed action but without the overflow weir.

Water diversion location

Two alternative locations to the proposed action for diversion structures were considered (see Figure 3.1-13).

Water conveyance route from treatment facilities

A buried pipeline along the Cottonwood Gulch utility corridor is the proposed action. The alternative is a buried pipeline through Wheeler Gulch (see Figure 3.1-13). The Cottonwood Gulch pipeline would be about 6 miles long while the Wheeler Gulch pipeline would be about 9 miles long.

3.1.2.7 Support facilities and locations

Contractor's road

The routes shown in Figure 3.1-15 are alternative routes to the proposed Cottonwood Gulch Road. All are existing roads.

The four alternative routes are as follows:

- Anvil Points. This route would proceed up an existing road to the existing Anvil Points mine bench. From there, a new road would be constructed along the steep cliff to the top of the plateau. While not long, this new construction would be substantial. Approximately 9.7 miles of this 13.7-mile route would be on NOSR land.

- Cow Creek. This dirt road connects to the Piceance Creek Highway and goes south across the Roan Plateau. It is about 32 miles from the highway to the Parachute Block. Approximately 15.5 miles are across NOSR land.

- JQS Trail. This dirt road connects to State Highway 13 north of Rifle, goes west and climbs to the top of the Roan Plateau, where it joins the Cow Creek Road. It is about 20 miles to the Parachute Block from the highway. Approximately 10.5 miles are across NOSR land.

- Colony Access. This dirt road starts on the plateau portion of the Colony property and goes east to join the Cow Creek Road. It is about 55 miles from I-70 at Parachute to the Parachute Block. Approximately 16 miles are across NOSR land.

Access road and mine portal location

An access road would be required from the Colorado River valley to the Parachute Block. The Cottonwood Gulch road is the proposed action.

The only reasonable alternative would be an access route and mine bench in Wheeler Gulch. If this alternative were used, the road would begin along the western side of the Gulch, gain altitude, and then cross over to the eastern escarpment where the mine bench would be located. The route is shown in Figure 3.1-15. The design criteria would be the same as for the proposed action.

Electrical power supply

A reasonable alternative to the proposed Roan Plateau electric power generation site would be offsite purchase of power from an outside source. In this case, coke would be sold, and high- and low-Btu gas would be consumed on site.

Electrical power transmission line route

The proposed action is for purchased power to be delivered to the facilities on the Roan Plateau via a power line ascending Hayes Gulch from the Parachute substation. Alternative routes are shown on Figure 3.1-17. Design features of support structures would be the same as described for the proposed action.

Product shipment

The proposed action is for a product pipeline to tie into the LaSal pipeline. An alternative is to tie into the pipeline developed by the Shale Oil Pipeline Study (SOPS) managed by Marathon. Figure 3.1-11 shows the location of the tie-in point, about 15 miles west of the LaSal tie in. This route and its impacts were described in the Colony EIS (BLM, 1976).

A reasonable alternative to pipeline shipment of product that has been identified is shipment by unit train from the Mahaffey Ranch.

Product feeder pipeline route

There are two alternate feeder pipeline routes from the project facilities on the Roan Plateau to the LaSal and/or SOPS Pipelines (Figure 3.1-11). The proposed action is through Helm Gulch.

The Cottonwood Gulch alternative route from the plant site would go through the Cottonwood Gulch utility corridor and then parallel Interstate 70 to the southern end of the common utility corridor at Parachute Creek. From this point, it would proceed northerly until it intersected the Helm Gulch route. This route would be approximately 14 miles longer than the proposed action.

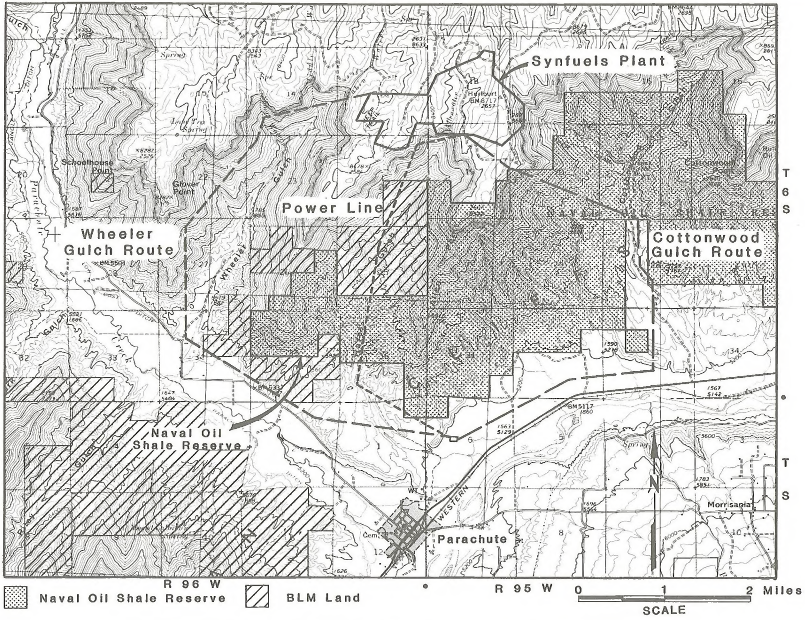


Figure 3.1-17. Alternative transmission line routes

Natural gas pipeline route

The only alternative to the proposed Helm Gulch route is the Cottonwood Gulch route described in the preceding paragraph for the product feeder pipeline.

Utility corridor

The proposed action is a buried utility corridor along a 3-mile route through Cottonwood Gulch. A reasonable alternative route would be through Wheeler Gulch as shown in Figure 3.1-13. This route would be over three times as long (10.6 miles), would parallel I-70 from the water treatment facility, then cross into Wheeler Gulch, and then head northeasterly to the plant site.

Personnel transportation

A funicular railway system is the proposed action for ultimate transportation of personnel. The bus alternative would require 48 heavy-duty transit buses. The buses would make up to 140 round trips each day from the base of Cottonwood Gulch to the top of the Roan Plateau, carrying up to 45 passengers per trip.

3.1.2.8 Reclamation and decommissioning

Processed shale reclamation

If sufficient material is practically available, the proposed action is to cover processed shale with an average of 30 inches of substrate suitable for vegetation. A second alternative would be to cover the processed shale with approximately 12 inches of cover, followed over a 1- to 2-week period by application of 40 inches or more of irrigation water to leach growth-inhibiting soluble salts from the upper portions of the processed shale. A third alternative would be leaching with no soil cover at all. In the latter two alternatives, vegetation would be planted in the same manner as in the proposed action. In addition, the leaching alternatives would require approximately 20 inches of irrigation water throughout the first, and perhaps the second growing season to keep most of the salts below the root zone while plants became established. In these leaching alternatives, processed shale that had its salinity level reduced would comprise all or a large portion of the plant growth medium, whereas, in the proposed action, root contact with processed shale would be minimal.

3.1.2.9 No action

The No-Action alternative must be considered in an EIS, along with all other feasible alternatives to the proposed action. This is required by the CEQ Regulations (1502.14d). The No-Action alternative means that construction of the shale oil facility would not take place, no shale would be mined, and no shale produced. Thus, none of the projected impacts described in this EIS would take place. No action could take place as a result of (1) a decision by Mobil not to proceed with the project, or (2) the denial of requested Federal actions or other permits and approvals.

3.2 AFFECTED ENVIRONMENT

3.2.1 Climate and air quality

Baseline conditions and input data for meteorology and air quality dispersion modeling were documented with four onsite meteorological monitoring stations, two of which also served as air quality monitoring stations; the four stations were operated from November 21, 1980 to May 15, 1982. The stations were located on the Roan Plateau, at Cabin Water Gulch, Wheeler Gulch, and Mahaffey Ranch to monitor dispersion conditions near proposed emission sources. Meteorological data from these stations are representative of both valley and plateau patterns. The Roan Plateau station was on top of the plateau, the Cabin Water Gulch station was in a small canyon high on the slopes of the plateau, the Wheeler Gulch station was at the bottom of the deep canyon at its junction with Parachute Creek, and the Mahaffey Ranch station was in the Colorado River valley. Details regarding the monitoring program and results are described in Mobil (1983a, 1983b) and in the technical air quality report (Dames & Moore, 1984).

3.2.1.1 Meteorological measurements

Winds were measured at 10-, 60-, and 100-meter levels on the Roan Plateau, at 10 and 60 meters at the Mahaffey Ranch, and at 10 meters in Cabin Water Gulch and Wheeler Gulch. Measured wind patterns were consistent with regional, synoptic, and local terrain influences.

The Roan Plateau 60-meter level had prevailing winds from the south-southwest and the southwest; flow from all other directions was minimal. Average wind speeds were 4.2 m/s at 10 meters, 5.2 m/s at 60 meters, and 5.8 m/s at 100 meters. Seasonal distributions indicate prevailing southwest and south-southwest flow throughout the year; however, there is considerably greater variation in wind direction during the spring and summer months than during fall and winter. Diurnal distributions indicated slightly more variation during the nighttime than the daytime, but the prevailing directions remained essentially the same. This is in sharp contrast to the valley gulch data described below, which indicate a diurnal reversal in wind flow.

The prevailing wind in Cabin Water Gulch is along the axis of the canyon. Nighttime drainage is from the east-northeast; daytime flow is upslope and from the west-southwest. The average recorded wind speed was 2.0 m/s, much less than at the exposed Roan Plateau site.

The prevailing flow in Wheeler Gulch is downslope from the north-northeast and associated with drainage down this steep canyon. However, there is also a prominent flow from the west-northwest, reflecting that along the Parachute Creek valley. Recorded wind speeds were low, averaging 2.0 m/s, like those of Cabin Water Gulch.

The Mahaffey Ranch prevailing flows at 60 meters are from the east-northeast and west-southwest, parallel to the Colorado River valley at this point. There was little alteration of this pattern during spring and summer. Diurnal distributions show approximately equal wind frequencies up and down the Colorado River valley; however, under nighttime drainage conditions, the dominant flow is down the valley from the east-northeast and there is a northerly drainage component off of the Roan Plateau. Wind speeds at the Mahaffey Ranch, in the broad Colorado River valley, are consistently lower than at the plateau site, but those recorded at 10 meters averaged slightly stronger, 2.8 m/s, than at the more sheltered Wheeler Gulch and Cabin Water Gulch sites.

Atmospheric stability categories were determined by taking sigma-theta measurements at the four locations where winds were recorded (see Section 2.1 for explanation of categories and methods of measurements). Delta-T measurements (10 to 60 m) were also taken on the plateau and at the Mahaffey Ranch. Based on sigma-theta data, the prevalent stability on the Roan Plateau was neutral (Class D), with a 46.9 percent frequency. Stable conditions (mostly in Class E) occurred 27.3 percent of the time, and unstable conditions 25.8 percent. These results, reflecting generally good dispersion, are similar to other data for highly exposed locations in the region.

The sigma-theta measurements for the valley-canyon sites all showed similar patterns, with strong distributions in both the stable (Class F) and the unstable (Class A) categories, again reflecting strong diurnal variations. The high frequency of stable cases is not unexpected since the sheltered canyon conditions are conducive to reduced surface heating, light winds, and frequent inversion conditions.

Onsite precipitation was measured at the Roan Plateau and Mahaffey Ranch stations, and temperature at all four monitoring locations. The heaviest precipitation occurred on the plateau. The 12-month accumulation was 16.63 inches, compared to 9.68 inches at the valley site. The heaviest monthly precipitation on the plateau was 3.51 inches in May, while that in the valley was 2.42 inches in October.

July 1981 was the warmest month and January 1982 the coldest month recorded at both the plateau and valley sites during the 18-month monitoring program (Mobil, 1983b). The winter of 1981-1982 was considerably colder than the winter of 1980-1981. The highest average daily maximum by month (average monthly maximum) recorded at the higher elevations was 21.8°C (71.2°F), in Cabin Water Gulch, the coldest average monthly minimum was -8.1°C (17.4°F) recorded on the Roan Plateau. The highest average monthly maximum recorded at lower elevations was 30.2°C (86.4°F) in Wheeler Gulch; the coldest average monthly minimum was -5.4°C (22.3°F), also in Wheeler Gulch.

3.2.1.2 Air quality monitoring results

Gaseous air quality parameters monitored included SO_2, CO, O_3, nitric oxide (NO), NO_2, and total oxides of nitrogen (NO_x). These were measured for a 7-month period from November 1981 through May 1982 for both the Roan Plateau site and the Mahaffey Ranch site. All concentrations were below NAAQS and mostly typical of background concentrations for remote sites of western Colorado. Average annual values measured on the Roan Plateau were: SO_2, 11.8 $\mu g/m^3$; NO_2, 20.3 $\mu g/m^3$; CO, 1091 $\mu g/m^3$; and O_3, 76 $\mu g/m^3$. Maximum short-term values measured are: SO_2 (3-hour), 41.9 $\mu g/m^3$; SO_2 (24-hour), 34.1 $\mu g/m^3$; CO (1-hour), 7664 $\mu g/m^3$; CO (8-hour), 5003 $\mu g/m^3$; and O_3 (1-hour), 135.2 $\mu g/m^3$. O_3 concentrations were somewhat higher a percentage of the ambient standard than other pollutants;

however, the values are typical of remote background concentrations experienced at the higher elevations of Colorado and Wyoming. NO_2 values on the Roan Plateau were higher than expected in the region because of the influence of the monitor-supporting generator (Mobil, 1983a, 1983b). Therefore, an annual NO_2 concentration of 4 $\mu g/m^3$ as measured at the Clear Creek Shale Oil Project (BLM, 1983b) is assumed as a more representative background. The Mahaffey Ranch average NO_2 concentration was 11.7 $\mu g/m^3$.

Total suspended particulates (TSP) were measured at the Roan Plateau and Mahaffey Ranch sites from November 1980 through May 1982. The annual geometric means for 1981 were 12 $\mu g/m^3$ on the plateau and 25 $\mu g/m^3$ at Mahaffey Ranch. TSP concentrations on the Roan Plateau were very low, especially during the winter season when the plateau was covered with snow. Concentrations in the river valley were slightly higher and more uniform throughout the year, but typical of remote background levels. The highest recorded 24-hour concentrations were 100 $\mu g/m^3$ on the plateau and 91 $\mu g/m^3$ at Mahaffey Ranch. These were likely associated with natural, windblown dust during very strong wind situations.

Visibility was not measured for the Mobil Project but visual ranges should be similar to those measured at other regional sites, 150 to 200 kilometers (Dietrich et al., 1983).

3.2.2 Topography, geology, and mineral resources

3.2.2.1 Topography

Much of the Parachute Block is on the moderately dissected Roan Plateau. Its southern and western sides are bounded by the steeply incised valleys of Cottonwood, Hays, and Wheeler gulches. Elevations range from 5400 feet in the lower reaches of Wheeler Gulch to more than 8600 feet on the plateau.

About 10 percent of the Mahaffey Ranch is on the gently sloping floodplain of the Colorado River at an elevation of 5150 to 5200 feet. Most of the remainder of the block is on the floodplain of the lower reaches of Cottonwood Creek between 5200 and 5700 feet in elevation.

Most of the Main Elk Reservoir site is along the gently sloping stream valley. This is bounded on the east and west by the steep valley walls of Main Elk Creek. The lowest elevation is 5700 feet, near the juncture of Main Elk and Elk creeks; the highest is 6400 feet on the ridge between Elk and Main Elk creeks, along the western boundary of the block.

3.2.2.2 Geology

The upland areas of the Roan Plateau that occupy most of the Parachute Block are underlain by tuffaceous sandstone and siltstone of the Uinta Formation. This is rimmed by precipitous cliffs consisting mainly of organic rich marlstone in the Parachute Creek Member. The steep slopes below the cliff, in most of the area, are developed on clay shales, limestones, and siltstones and sandstones of the Anvil Points Member. The Anvil Points grades laterally into the Douglas

Creek and Garden Gulch members on the west side of Wheeler Gulch. The badlands topography at the base of the steep slopes is formed on the varicolored siltstones, claystones, and channel sandstones of the Shire Member of the Wasatch Formation. The Mahaffey Ranch is entirely underlain by the Shire Member.

On the Mahaffey Ranch, the Shire Member is almost completely covered by poorly sorted, unconsolidated alluvium, alluvial fan, and pediment deposits of Quaternary age. In places, talus, colluvium, and landslide material cover the steeper slopes of the Parachute Block. Alluvium, alluvial fans, and pediments cover the lower slopes and stream valleys.

The Parachute Block and Mahaffey Ranch are in the southeast part of the Piceance Creek structural basin. The bedrock inclines, to the northwest in the eastern half of the area and to the north in the western half, at the rate of about 150 feet per mile. No faults have been discerned in the area. However, three dominant fracture sets have been noted in the Green River Formation, N75°W, N, and N75°E (Mobil, 1982a).

The access road and the Main Elk Reservoir area are underlain by sandstone beds of the Paleozoic Maroon, Weber, and Statebridge formations, and the Mesozoic Chinle, Entrada, Morrison, and Dakota formations. A west-plunging anticline and syncline cross Main Elk Creek near the center of the reservoir site. A southeast-trending fault traverses the reservoir site about 0.25 to 0.5 mile north of the syncline (Mobil, 1982a). There was no preferred orientation noted in the joints that were mapped in all formations. The majority of the reservoir site is covered with alluvium, colluvium, and alluvial fan deposits.

3.2.2.3 Oil shale resources

The Parachute Block contains about 4 billion barrels of oil in an oil shale sequence which is about 450 feet thick and averages 15 or more gallons of oil per ton. The following are estimated in-place shale oil resources of the various oil shale zones in this block.

R-6 Zone

The R-6 Zone, which underlies the Mahogany Zone, thickens from about 190 feet along the western margin of the Parachute Block to about 220 feet in the eastern part. Much of the increase in thickness is from an increase in clastic material from the east. The entire R-6 Zone ranges in average grade from 5 gallons per ton along the southern margin to about 12 gallons per ton in the northwest corner (Pitman, 1979). This is probably submarginal for any future commercial production. However, the upper part of the zone, the L-1, in a 6-square mile area in the western part of the Parachute Block, is estimated to average more than 15 gallons of oil per ton through a thickness of more than 90 feet, and to contain a shale oil resource of 120,000 barrels per acre (Smith et al., 1979). The total contained resource in the 6-square mile area is about 460 million barrels.

Mahogany Zone

The Mahogany Zone on the Parachute Block averages about 105 feet in thickness and 25 gallons per ton in grade; it contains about 200,000 barrels per acre (Pitman and Johnson, 1978). The Mahogany Zone is estimated to contain a shale oil resource of 1.5 billion barrels.

Mine Zone

Mobil's Mine Zone, the richest part of the Mahogany Zone, is estimated by Mobil to average 30 gallons of oil per ton through an interval of 80 feet and to contain a resource of 165,000 barrels per acre. The estimated thickness, average grade, and resources of the mine zone are based on data from Mobil Oil Corporation, corehole D. The total resource on the Parachute Block is 1.2 billion barrels. A total of 740 million barrels can be produced, assuming a 60 percent recovery factor.

R-8 Zone

The R-8 oil shale zone overlies the Mahogany Zone. It generally is regarded as the approximate interval between the top of the big 3 and the top of "A" groove. The estimated thickness, average grade, and resource of the R-8 Zone are also based on data from corehole D. The zone is 246 feet thick, averages 15.4 gallons per ton in grade, and has a resource of 285,000 barrels per acre. The R-8 Zone is estimated to contain a total of 2.138 billion barrels on the Parachute Block.

3.2.2.4 Other mineral resources

Noncommercial quantities of nahcolite are in the Mahogany Zone and in a 100-foot interval near the top of the oil shale sequence in the Parachute Block.

Coal deposits underlie both the Parachute Block and Mahaffey Ranch at depths greater than 3000 feet. No oil or gas has been produced on any of the Mobil properties; however, elsewhere in northwest Colorado, there has been production from sedimentary rocks that are the lateral equivalent of those that underlie these properties.

Uranium and vanadium have been produced from the Entrada Formation a few miles to the north of the Main Elk Reservoir area. Uranium has also been produced from the Chinle and Morrison formations elsewhere in Colorado.

3.2.3 Paleontology

The stratigraphy of the Mobil properties is comprised of the three early Tertiary formations known to be fossiliferous in the Piceance Basin: the Wasatch, Green River, and Uinta. Quaternary deposits are sparse (Lucas and Kihm, 1982; Wallace, 1983).

Lucas and Kihm (1982) sampled a roughly rectangular area bounded by lines between DeBeque and Rangely on the west, Rangely and Meeker on the north, Meeker and Rifle on the east, and Rifle and DeBeque on the south. This area includes the Mobil Project areas along its southeastern margin. No samples were taken on the Mobil properties; however, sampling throughout the study area was sufficient to confirm the presence of certain formations and obtain sufficient data to determine whether or not they are fossilferous. The sampling areas closest to the Mobil properties were one between DeBeque and Parachute and one just north of Rifle. Both locations yielded fossils from Wasatch Formation outcrops and data which are sufficient to afford at least a rough assessment of the potential paleontological resources of the Mobil Project areas.

The Wasatch Formation, locally containing crocodilian and garfish remains (Wallace, 1983), is considered significant because of its potential as a quarry site for small mammals (rodents and insectivores).

3.2.4 Soils

A total of 65 soil mapping units occur on the Parachute Block, Wheeler Gulch, Mahaffey Ranch, and Main Elk Reservoir areas (Mobil, 1982a). These units comprise five categories on the basis of topsoil suitability for reclamation. Topsoil suitability is judged on the basis of soil properties that encompass pH, salinity, saturation percentage, calcium-magnesium-sodium proportions, toxic element concentrations, and soil depth. Slope is a factor when steepness interferes with practical recovery of soil by earth-moving equipment. The soil characteristics affiliated with reclamation potential include depth, texture, percentage of coarse fragments, permeability, available water capacity, drainage, flood hazard, salinity, sodicity, erosion hazard, and steepness of slope. These five categories are as follows:

Category 1 - Soils and map units with good suitability as sources of topsoil.

Category 2 - Soils with reasonable potential to respond favorably to reclamation treatment.

Category 3 - Soils having little (if any) value for providing topsoil or having minimal potential to respond to reclamation treatment.

Category 4 - Soils having severe water erosion hazard. This is based on the inherent erodibility of a soil combined with gradient and length of slope.

Category 5 - Soils having severe wind erosion hazard. This is based on the inherent erodibility of a soil as determined by texture, clay content, calcium carbonate content, and soil aggregate size.

The total acreages of the Mobil properties, segregated by category according to reclamation potential and suitability, are listed in Table 3.2-1.

Table 3.2-1. Environmental and reclamation summaries for soils of the Mobil properties

Area	Acreage by category[a]				
	1	2	3	4	5
Parachute Block					
Total acres	2676	2676	83	2554	995
Percentage of the 2858 acres in the study area within each category	94	94	3	89	35
Wheeler Gulch					
Total acres	26	1137	1828	1060	0
Percentage of the 2965 acres in the study area within each category	<1	38	62	36	0
Mahaffey Ranch					
Total acres	169	169	1420	728	597
Percentage of the 1607 acres in the study area within each category	11	11	88	45	37
Main Elk Reservoir					
Total acres	482	513	808	607	211
Percentage of the 1571 acres in the study area within each category	31	33	51	39	13

[a]These categories are not mutually exclusive.

3.2.5 Ground water

The following descriptions are based primarily on Mobil (1982a).

3.2.5.1 Parachute Block

A multiple-layer aquifer system, similar to that described for the Piceance Basin by Robson and Saulnier (1980), underlies the Parachute Block (Figure 3.2-1). Eight water-bearing zones have been identified above the base of the B-Groove (BG) unit of the Parachute Creek Member (from youngest to oldest): hydrostatic unit (HSU) 6 (Uinta), 5, 4, 3, 2, 1 (A-Groove), and MA (Mahogany Zone).

The aquifers generally conform with the structure of the Mahogany marker bed, a kerogen-rich marlstone in the MA, which displays a gentle northwest-plunging syncline passing through the central portion of the study area. The strike of the marker bed is due east in the western portion of the study area and northeast in the eastern portion. Structural dips of the bed are to the north-northwest and range from one to two degrees in the western portion to four degrees along the eastern portion. The areal extent of the aquifers are generally limited by the dissection of the Roan Plateau by surface-water drainages.

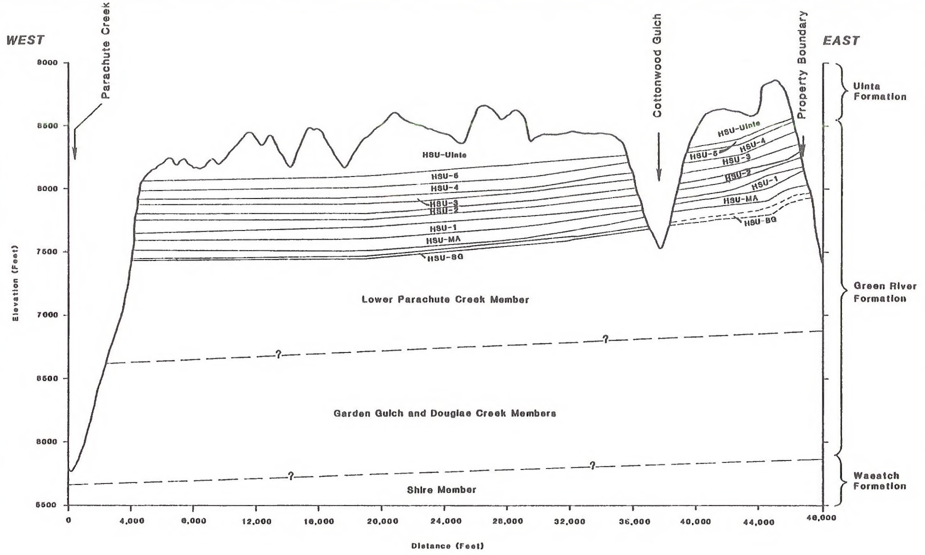


Figure Figure 3.2-1. Schematic hydrogeological cross section of the Mobil Project site

Permeabilities and porosities within the six aquifers above the MA are variable, being controlled primarily by the degree of development of dissolution and fracture zones. Transmissivities within the aquifers range from less than 1 to 883 gallons per day per foot (gpd/ft), with the highest transmissivities reported for HSU 3 and 4. In most aquifers, the transmissivities are not dependent on the saturated thickness but on the wide range of permeabilities within the units. Ground-water flow is to the north-northwest in all aquifers except for HSU 1, where flow is to the west-southwest because of confined conditions of the aquifer in the eastern portion of Parachute Block.

The remaining two aquifers (MA and BG) are nonwater-bearing in the eastern portions of the study area. Transmissivities for MA range from 1 to 600 gpd/ft and from 12 to 14 gpd/ft for BG. The range in transmissivity values for HSU-MA is dependent on the development of secondary permeabilities within the unit. Ground-water flow for both aquifers is probably to the north-northwest.

Ground-water recharge is primarily through infiltration of surface waters and the subsequent downward migration into underlying units. Discharge generally occurs to the north and northwest as seeps and springs on the East Fork of Parachute Creek, and Parachute Creek itself.

Ground-water quality is variable, controlled primarily by the dissolution of minerals in the units. The majority of the ground water is classified as sodium or sodium-calcium bicarbonate type. Total dissolved solid concentrations within the upper four units (Uinta, HSU 5, HSU 4, and HSU 3) are generally less than 700 milligrams per liter (mg/l). The lower four units (HSU 2, HSU 1, MA, and BG) contain ground water with elevated concentrations of fluoride; total dissolved solid concentrations vary from 433 to 11,600 mg/l.

3.2.5.2 Wheeler Gulch

Water-bearing units in Wheeler Gulch are limited to the quaternary alluvial deposits in the gulch and the upper weathered sections of the Wasatch Formation underlying the alluvium.

The alluvial fans and stream deposits of the alluvial aquifer consist of poorly sorted clay, silt, sand, and gravel, and range in thickness from zero near the head of the gulch to more than 100 feet near the base. Water levels vary seasonally, commonly ranging between 40 and 60 feet below ground surface. The aquifer is recharged by surface runoff and discharges into the underlying Wasatch Formation and to the Piceance Creek drainage to the southeast. Transmissivities range from 80 to 444 gpd/ft, with permeabilities in the north averaging 16 gpd/ft^2 (2.14 x 10^0 ft/day) and in the south 10 gpd/ft^2 (1.34 x 10^0 ft/day). The ground water is classified as a mixed cation sulfate-bicarbonate type, with total dissolved solids ranging from 1311 to 1637 mg/l. Total dissolved solid concentrations, along with high sulfate concentrations, limit the use of the aquifer as a potable water source.

The Wasatch Formation underlies the alluvium and is approximately 1800 feet thick in this area. The formation is an aquitard and limits downward ground-water migration. Sandy claystone and siltstone in the upper 100 feet of the formation contain some ground water. Transmissivities are reported to be less than 1 gpd/ft. The ground water is classified as a sodium sulfate-bicarbonate type and contains elevated levels of total dissolved solids, with concentrations ranging from 2486 to 4890 mg/l.

3.2.5.3 Mahaffey Ranch

Ground water occurs in alluvial and bedrock aquifers in the Mahaffey Ranch area. The alluvial aquifer consists of poorly sorted clay, sand, and gravel in the vicinity of Cottonwood Gulch and well-sorted gravels near the Colorado River. The aquifer is unconfined and is recharged by surface runoff and springs. Ground-water flow is to the south toward the Colorado River, where discharge occurs. Transmissivities average about 1600 gpd/ft with permeabilities ranging from 4 to 80 gpd/ft^2 (5.35×10^{-1} to 1.07×10^{1} ft/day). The water is classified as a mixed cation sulfate-bicarbonate type with total dissolved solids ranging from 1427 to 6640 mg/l.

The Wasatch Formation underlies the alluvial deposits and typically acts as a barrier to downward ground-water flow. In this area, nearly 900 feet of the formation have been removed by erosion, exposing claystone and shale with lenses of siltstone and sandstone. Only the upper 100 feet of the formation below the alluvium were monitored. The transmissivity for the section is approximately 430 gpd/ft with an associated permeability of 4.8 gpd/ft^2 (6.42×10^{-1} ft/day). The ground water is classified as a sodium sulfate-bicarbonate type; reported total-dissolved-solid concentrations range from 1510 to 1638 mg/l.

3.2.5.4 Springs and seeps

The locations of known springs and seeps in the Parachute Block, Wheeler Gulch, and Mahaffey Ranch areas are shown in Figure 3.2-2. Water quality information gathered in 1981 and 1982 during the baseline investigation (Mobil, 1982a) were used to determine the water classification for each of the springs (Table 3.2-2).

Springs both above and below the Roan Cliffs have discharges that are generally less than 0.01 cfs. Some of the springs situated above the cliffs provide base flow for perennial creeks (Allenwater and Cabin Water creeks). As such, these springs are not important contributors to surface-water quality but, rather, are surface expressions of mesa-top ground water and contributors to canyon area alluvial ground water. The measured (Mobil, 1983) concentrations of lead (0.20 to 0.90 mg/l) and cadmium (0.02 mg/l) in September 1981 samples from three mesa-top springs (on Allenwater Creek, Forked Gulch, and Deep Gulch) are notable since they exceed Primary Drinking Water Standards (0.05 and 0.01 mg/l, respectively). These levels were not repeated in analyses of downstream surface waters, ground water, or subsequent spring samples.

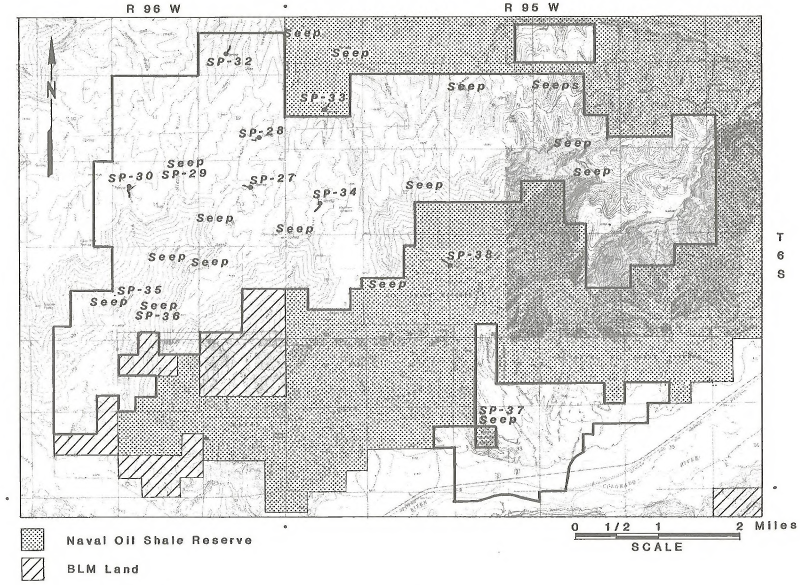


Figure 3.2-2. Locations of springs and seeps

Table 3.2-2. Summary of spring and seep data

Area	Spring/seep number	Aquifer Source	Water type[a]	Discharge (cfs)	
				Fall 1981	Spring 1982
Parachute Block	SP-26	Not reported	Mixed cation bicarbonate	0.004	0.007
	SP-27	Not reported	Mixed cation bicarbonate	0.008	0.014
	SP-28	Not reported	Calcium bicarbonate	0.001	0.001
	SP-29	Not reported	Mixed cation bicarbonate	0.0	0.002
	SP-30	Not reported	Mixed cation bicarbonate	0.008	0.011
	SP-32	Not reported	Mixed cation bicarbonate	0.007	0.01
	SP-33	Not reported	Calcium bicarbonate	0.01	0.015
	SP-34	Not reported	Calcium bicarbonate	0.002	0.007
Wheeler Gulch	SP-35	Not reported	Mixed cation bicarbonate	--	0.007
	SP-36	Lower Green River	Sodium sulfate	--	0.0002
Mahaffey Ranch	SP-37	Not reported	Not determined	--	0.0
	SP-38	Not reported	Mixed cation bicarbonate	--	0.1

[a]Based on trilinear diagram analysis; method described by Hem (1970).

Source: Mobil, 1982a.

3.2.6 Surface water

3.2.6.1 Surface-water quantity

East- and south-flowing surface-water streams anticipated to be impacted by the Mobil Project are listed in Table 3.2-3. The characteristics of the watersheds of these streams, locations of gaging stations, period for which streamflow data are available, and the method of flow measurement for each stream are also tabulated.

The estimated mean monthly flows of the Colorado River at Parachute and New Castle, and of Main Elk and East Elk creeks near New Castle, are shown in Table 3.2-4 together with single-day measurements for Elk Creek. The mean monthly flows for other drainages listed in Table 3.2-3 are shown in Table 3.2-5.

In addition to the streams listed in Table 3.2-3, peak flows have been estimated from limited crest-stage records for northward- and westward-flowing tributaries of Parachute and East Fork creeks that may be impacted by mine dewatering operations (Table 3.2-6).

3.2.6.2 Surface-water quality

Annual average water quality data for the 1981-1982 water year are shown in Table 3.2-7 for stations on each of the streams expected to be impacted by Mobil-Parachute Oil Shale Project activities. Numerous metal species are not listed in Table 3.2-7, since they were always below detection limit concentrations. Included in this list of nondetectible parameters are Federal drinking water standards metals: arsenic, cadmium, chromium, copper, lead, manganese, mercury, selenium, and silver.

Water quality monitoring of the Colorado River just above Elk Creek and downstream of Mahaffey Ranch above Parachute Creek shows consistent quality. Salt content varies inversely with streamflow in the range of 250 to 800 mg/l total dissolved solids (TDS), while ionic make-up is that of a mixed typed water. No pesticides or radiological parameters were detectable at the downstream station.

Surface waters of the Mobil properties are sharply divided, with respect to their quality characteristics, between the Main Elk Reservoir area and the Parachute Block/Mahaffey Ranch areas.

Perennial streams in the Parachute Block/Mahaffey Ranch areas include spring-fed, small drainage area creeks above the Roan cliffs (Sheep Hollow Gulch and Allenwater and Cabin Water creeks) which become intermittent stream reaches below the cliffs due to infiltration in streambed alluvium-colluvium. There are also gulch streams flowing through canyon alluvium with larger drainage areas (Wheeler and Cottonwood gulches), and Parachute Creek, with a drainage area of 185 square miles above Wheeler Gulch. Despite these characteristic differences, all of the streams are alkaline (pH 8-9) and are of the mixed cation-bicarbonate type.

Table 3.2-3. East- and south-flowing surface water streams in the Mobil Project

Stream	Watershed characteristics: Area (sq mi)	Watershed characteristics: Slope (ft/mi)[a]	Gaging station: Designation	Gaging station: Location	Period of record
PARACHUTE BLOCK					
Lower Hayes	5.04	428	PB-4	SW1/4 Sec. 6	11/81-8/82[b]
Middle Hayes	3.56	457	PB-5	NW1/4 Sec. 36	11/81-10/82[c]
Allenwater	0.49	281	PB-6	SW1/4 Sec. 36	8/81-9/82[d]
WHEELER GULCH					
Lower Parachute	192	180	WG-7	SE1/4 SW1/4 Sec. 34	11/81-9/82[b]
Upper Parachute	185	180	WG-8	SW1/4 SW1/4 Sec. 34	11/81-9/82[b]
Lower Wheeler	6.69	268	WG-9	NE1/4 NW1/4 Sec. 34	8/81-9/82[b]
Middle Wheeler	3.82	208	WG-10	NE1/4 NW1/4 Sec. 23	8/81-9/82[d]
Cabin Water	1.08	469	WG-11	SE1/4 NW1/4 Sec. 13	8/81-9/82[d]
MAHAFFEY RANCH					
Lower Cottonwood	8.79	423	MR-1	SW1/4 Sec. 34	8/81-9/82[b]
Middle Cottonwood	6.86	412	MR-2	NW1/4 Sec. 28	7/81-9/82[d]
Upper Cottonwood	4.32	423	MR-3	NW1/4 Sec. 21	8/81-10/82[c]
MAIN ELK CREEK					
Elk Creek at mouth	177	190	EC-22	NW1/4 Sec. 31	7/81-present[e]
Main Elk	100	240	EC-23	NE1/4 Sec. 22	12/64-present[f]
East Elk	28	490	EC-24	NE1/4 Sec. 6	10/66-present[e]
West Elk	29	310	EC-25	NE1/4 Sec. 22	7/81-present[g]
COLORADO RIVER					
Colorado River at Parachute	7,270	14	CR-50	NW1/4 Sec. 7	11/81-9/82[b]
Colorado River at New Castle	6,308	15	CR-51	SE1/4 Sec. 31	10/66-present[h]

[a]Determined from elevations at points 10 and 85 percent of distance along the channel.
[b]Measurement by rating curve with water-level recorder.
[c]Measurement by crest stage gage.
[d]Measurement by flume with water-level recorder.
[e]Measurement by rating curve with water-level recorder and DEFCO data.
[f]Measurement by The David E. Fleming Co. data (DEFCO).
[g]Measurement by Current meter or portable flume.
[h]Measurement by adjustment from Glenwood Springs.

Source: Mobil (1982a).

Table 3.2-4. Mean monthly flows (cubic feet per second) of the Colorado River, Main Elk Creek, and East Elk Creek

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Colorado River at Parachute												
1981											1700	1500
1982	1520	1520	1630	2480	6600	11,800	6800	2050	1450			
at New Castle												
1980										1934	1866	1660
1981	1275	1095	1110	1922	3183	5,416	2621	1928	1970			
Main Elk Creek above confluence with Elk Creek												
1964												11.3
1965	10.2	9.2	9.1	17.3	287.0	429.1	78.5	30.3	25.0	28.8	20.1	16.8
1966	13.6	12.1	13.0	76.3	309.4	97.5	26.8	16.4	12.7	12.8	11.6	9.9
1967	8.8	8.3	9.1	17.7	287.8	234.5	48.4	24.1	14.4	11.1	10.6	7.9
1968	7.3	6.9	8.3	13.1	191.5	534.8	79.9	37.4	27.6	—[a]	—	—
1969	—	—	—	—	—	—	—	—	—	19.9	17.5	14.6
1970	12.0	12.0	11.7	14.2	388.4	242.2	43.0	22.8	16.4	13.1	11.0	9.3
1971	8.4	7.9	7.8	39.3	223.6	286.1	42.0	22.8	18.5	17.1	14.0	12.1
1972	11.5	10.4	13.3	25.2	214.6	151.8	23.9	13.2	11.1	13.4	13.2	10.3
1973	7.8	7.5	8.1	8.6	322.5	358.7	60.2	24.6	15.0	11.5	9.2	6.8
1974	5.6	4.6	5.5	14.1	294.8	103.8	24.9	14.6	10.6	9.6	8.7	8.2
1975	8.2	8.1	8.1	8.4	115.0	472.3	149.3	27.5	13.7	16.8	13.6	11.3
1976	10.3	10.1	10.0	17.9	284.5	154.0	35.1	20.5	16.9	16.0	12.1	10.5
1977	9.6	9.5	9.2	16.4	66.1	41.3	19.2	13.8	11.2	12.5	10.6	9.0
1978	9.6	9.7	11.0	49.9	244.2	541.7	94.2	29.4	21.0	18.3	16.3	13.9
1979	14.3	13.7	13.9	35.1	370.4	462.9	96.3	32.1	22.5	18.3	16.5	14.6
1980	14.7	13.8	14.0	35.0	284.3	425.0	63.3	24.2	19.7	18.5	16.7	14.8
1981	13.6	13.1	13.3	43.6	155.1	131.3	41.3	22.2	19.8			
East Elk Creek near New Castle												
1966										7.4	5.6	5.6
1967	4.9	4.3	5.6	9.5	134.1	188.6	31.9	11.9	8.6	9.4	8.7	6.9
1968	6.3	5.4	6.1	10.3	74.3	280.0	34.4	12.8	7.6	—	—	—
1969	—	—	—	—	—	—	—	—	—	11.9	10.4	8.4
1970	6.6	6.2	6.6	9.2	153.2	219.2	43.1	16.1	15.3	12.0	9.3	8.1
1971	7.5	6.9	7.1	25.9	80.0	249.3	45.9	11.8	7.5	6.3	4.9	4.1
1972	3.3	4.2	6.1	13.0	111.9	148.7	23.1	11.8	8.8	18.3	15.1	10.6
1973	8.9	6.3	6.8	10.3	128.5	243.7	44.8	12.3	6.0	4.2	4.8	3.8
1974	3.2	2.0	2.7	7.3	175.5	143.5	45.5	27.4	11.0	10.6	9.4	8.2
1975	17.4	16.9	17.8	24.5	85.1	282.6	159.4	24.7	11.0	10.6	9.4	8.2
1976	7.6	7.0	6.9	12.2	116.0	128.4	43.6	14.0	11.9	9.9	8.7	8.6
1977	7.9	7.4	7.1	13.5	59.1	53.7	16.9	10.2	8.6	10.4	7.4	7.9
1978	7.6	7.5	9.7	32.1	115.2	355.0	100.1	53.2	22.1	22.5	21.0	19.3
1979	17.7	17.2	18.6	28.7	123.6	277.5	79.3	18.6	11.8	9.2	11.3	9.3
1980	8.4	8.5	8.1	21.7	93.3	269.0	67.0	19.3	12.5	9.3	9.6	7.6
1981	6.4	5.9	6.0	28.4	93.9	109.5	32.3	15.0	10.6			
Elk Creek[b] at mouth												
1981							20	5	3	—	45	39
1982	33	35	36	72	744	320	59	32	40	54		

[a]— indicates records not available.
[b]Single day measurements from Mobil (1982a).

Table 3.2-5. Mean monthly flows of other east- and south-flowing drainages (cubic feet per second)

Stream	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Hayes	0.004	0.015	0.04	0.07	0.3	0.09	0.02	0.4	–	–	–	–
Middle Hayes[a]	2.1	2.1	0.5	1.1	1.3	3.3	–	–	–	–	0.1	0.5
Allenwater	0.01	0.013	0.047	0.24	0.41	0.19	0.11	0.13	0.12	0.035	0.04	0.033
Lower Parachute	18	15	14	38	145	41	17	8.8	7.4	–	–	16
Upper Parachute	18	15	20	41	155	48	22	10	8.4	–	12	16
Lower Wheeler	0	0.0025	0.00	0.16	1.1	0.5	0.1	0.07	0.06	0.006	0	0
Middle Wheeler	0.05	0.07	0.14	0.58	2.1	0.82	0.22	0.09	0.08	0.08	0.04	0.05
Cabin Water	0.01	0.015	0.12	0.36	0.62	0.23	0.11	0.09	0.09	0.03	0.02	0.01
Lower Cottonwood	0.003	0.004	0.008	0.004	0.04	0.005	0.03	0.5	0.005	0.02	0.0	0.001
Middle Cottonwood	0.2	0.2	0.521	1.3	3.6	1.3	0.4	0.9	0.01	0.4	0.18	0.17
Upper Cottonwood	–	–	0.6	2.6	2.6	2.6	1.7	0.8	0.4	2.3	–	–

[a]The values pertain to crest-stages recorded at random intervals.

Table 3.2-6. Peak flows (cubic feet per second)[a] for north- and west-flowing drainages

	Period	Peak flow
Granlee Gulch (D.A. = 2.1 sq mi)	6/17/82 to 7/15/82	0.1
Forked Gulch (D.A. = 6.25 sq mi)	3/16/82 to 4/21/82	1.5
	4/21/82 to 6/17/82	3.0
	6/17/82 to 7/15/82	1.8
	7/15/82 to 8/27/82	1.0
	8/27/82 to 9/28/82	1.4
	9/28/82 to 10/15/82	1.4
Deep Gulch (D.A. = 1.14 sq mi)	3/17/82 to 4/19/82	0.1
	4/19/82 to 6/16/82	1.3
	6/16/82 to 7/13/82	1.3
	7/13/82 to 8/26/82	0.8
	8/26/82 to 9/29/82	1.1
	9/29/82 to 10/13/82	1.3
West Forked Gulch (D.A. = 0.72 sq mi)	3/17/82 to 4/19/82	0.1
	4/19/82 to 6/16/82	1.4
	6/16/82 to 7/13/82	1.1
	7/13/82 to 8/26/82	0.2
	8/26/82 to 9/29/82	0.4
	9/29/82 to 10/13/82	0.3
East Forked Gulch (D.A. = 1.82 sq mi)	1/29/82 to 3/26/82	0.01
	2/26/82 to 3/17/82	0.1
	3/17/82 to 4/19/82	0.3
	4/19/82 to 6/16/82	2.3
	6/16/82 to 7/13/82	0.2
	7/13/82 to 9/29/82	0.4
	9/29/82 to 10/13/82	0.5
Sheep Trail Hollow (D.A. = 0.78 sq mi)	7/15/81 to 8/5/81	0.2
	8/5/81 to 9/22/81	0.1
	9/22/81 to 10/9/81	0.1
	10/9/81 to 11/18/81	0.3
	11/18/81 to 2/26/82	0.1
	2/26/82 to 3/17/82	0.1
	3/17/82 to 4/19/82	0.2
	4/19/82 to 6/16/82	1.5
	6/16/82 to 7/13/82	0.3
	7/13/82 to 8/26/82	0.2
	8/26/82 to 9/29/82	0.3
	9/29/82 to 10/13/82	0.4

[a]Based on crest-gage records.

Table 3.2-7. Baseline water quality data impacted surface waters, Mobil Project 1981-1982 water year

Parameters[b]	MR-1 Lower Cotton-wood Gulch	MR-2 Middle Cotton-wood Gulch	PB-4 Lower Hayes Gulch	PB-6 Allen-water Creek	PB-20 East Forked Gulch	PB-21 Sheep Trail Hollow	WG-7 Lower Para-chute Creek	WG-9 Lower Wheeler Gulch	WG-10 Middle Wheeler Gulch	WG-11 Cabin Water Creek	EC-22 Elk Creek Near Mouth	EC-23 Main Elk Creek	CR-50 Colorado River at Para-chute	CR-51 Colorado River at New Castle	Federal Drinking Water Standards
Discharge (cfs)	0.027	0.653	0.010	0.103	0.076	0.028	25.3	0.15	0.27	0.135	132	127	3555	3582	
pH (standard units)	8.4	8.5	8.4	8.4	8.5	8.3	8.4	8.5	8.5	8.3	8.2	8.3	8.2	8.2	6.5-8.5
Alkalinity (as C_aCO_3)	183	354	209	232	229	226	322	186	257	245	180	183	123	116	
Barium[c]	--	--	<0.1	<0.2	--	--	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2	1.0
Chloride	11	8.7	5.8	1.2	1.4	0.85	32	8.0.	4.3	2.1	5.1	1.8	122	131	250
Hardness (as C_aCO_3)	190	340	455	191	189	190	410	240	286	206	328	204	239	194	
Iron (total)	1.18	0.33	0.68	0.10	0.49	0.24	<0.31	0.75	0.12	0.29	<0.89	<0.06	0.29	0.13	0.3
Nitrate (as N)	1.5	0.7	1.8	1.3	1.1	0.8	1.4	1.4	2.2	1.1	1.2	0.7	0.6	0.6	10
Solids, Total Dissolved	825	947	1066	440	446	410	907	680	668	479	550	330	573	555	500
Sulfate	332	253	516	36	45	31	253	265	160	38	176	25	110	93	250
Zinc[c]	--	--	0.15	0.19	--	--	0.14	0.18	0.17	0.14	0.15	0.12	0.18	0.13	5.0
Chemical Oxygen Demand	32	19	29	60	62	44	47	43	29	37	19	16	27	31	
Fecal Coliform (MPN/100 ml)	9	6	<2	5	9	3	<3	<2	<2	10	4	7	<4	<2	

[a]Annual arithmetic means averaged from daily grab (and some composite) samples collected monthly.
[b]Units are mg/l unless otherwise noted.
[c]Data from 1982-1983 water year (July and August 1982, samples only).

Some water quality variability exists among the various drainages. Sulfate concentrations are markedly higher in the canyon gulch streams and Parachute Creek than in other drainages because of contact with Wasatch Formation alluvium/colluvium. Water temperature varies with air temperature in the low-flow canyon and spring-fed streams. Parachute Creek, with a mean annual flow of 32 cfs, varies over a narrower range of temperature. More chloride is present in the perennial reach of Cottonwood Gulch above Mahaffey Ranch than in other perennial streams. Sampling of both Parachute Creek and Wheeler Gulch for pesticides and radiological parameters showed no detectable concentrations.

Ephemeral stream reaches in the Parachute Block/Mahaffey Ranch areas show some spatial variation in water quality. North-flowing tributaries of East Fork Parachute Creek (Pete Spring, Cherry, Grassy, Deep, and Forked gulches) generally have TDS values less than 500 mg/l and low sulfate contents, while the south- and west-flowing gulches (Lower Cottonwood, Hayes, Granlee, and Helm) have generally higher TDS and sulfate concentrations. All canyon drainages, including Parachute Creek, are highly erosive and characterized by high sediment discharges associated with snowmelt runoff and summer thunderstorms.

Main Elk and East Elk Creek each have high water quality and substantial mean annual and base streamflows, with TDS less than 400 mg/l, a calcium-bicarbonate water type, and low sodium, sulfate, and chloride concentrations. In contrast, West Elk Creek is highly saline and has a low, less variable flow, with TDS in the range of 2000 to 5000 mg/l. Because of the effects of West Elk Creek and irrigation in the low valley area, Elk Creek at its mouth is degraded during low-flow periods in winter and the summer/fall irrigation season. Salt content increases to as high as 1000 mg/l TDS and sulfate sometimes exceeds the drinking water standard of 250 mg/l. No pesticides or radiological parameters were detected in Elk Creek.

3.2.7 Aquatic ecology

Aquatic habitats associated with the Mobil Project consist of small headwater (montane) streams draining the Roan Plateau, the foothill Elk and Parachute creeks, and the Colorado River. For describing existing aquatic conditions, habitats potentially affected by the project have been divided into four groups: Parachute and Cabin Water creeks in the Wheeler Gulch area; Allenwater and Cottonwood creeks on the Mahaffey Ranch; Main Elk and Elk creeks; and the Colorado River from New Castle to Parachute.

Fish species inhabiting Parachute Creek near Wheeler Gulch include rainbow trout which are stocked by the Colorado Division of Wildlife, flannelmouth sucker, bluehead sucker, and speckled dace. Colorado River cutthroat trout inhabit small streams in the upper Parachute Creek drainage (Behnke and Zarn, 1976). No fish were found in Cabin Water Creek during recent surveys (Mobil, 1982a). Streambed characteristics, cover, and bank-side vegetation provide more suitable habitat for fish production in Parachute Creek upstream from Wheeler Gulch than downstream. Benthic macroinvertebrate standing crops in Parachute Creek are generally lower downstream from Wheeler Gulch than upstream, presumably due to reduced flows from irrigation diversion. Benthos in Cabin Water Creek are similar to those of Parachute Creek but greater in diversity, reflecting the more favorable physical and chemical characteristics of the water.

Low to intermittent flows coupled with high water temperatures during the summer create unsuitable conditions for fish in Cottonwood and Allenwater creeks on the Mahaffey Ranch (Mobil, 1982a); these conditions could also explain why no fish were found in Cabin Water Creek. Periphyton in Cottonwood Creek are restricted by low flows and the deposition of organic detritus. Macroinvertebrates inhabiting Cottonwood Creek include those capable of surviving low-flow conditions. Allenwater Creek supports limited macroinvertebrate and periphyton communities, but only during periods of snowmelt runoff.

Elk and Main Elk creeks are inhabited by brown trout, rainbow trout, brook trout, mountain whitefish, mottled sculpin, and speckled dace. Brown trout are more numerous upstream; however, both lower Elk Creek and Main Elk Creek include favorable spawning habitat for this species. Periphyton occurring in Elk and Main Elk creeks are numerous and highly diverse, characterizing productive communities. Relatively poor water quality and substrate conditions result in lower diversity and numbers of macroinvertebrates and periphyton in West Elk Creek as compared to Main Elk and Elk creeks.

The Colorado River segment from New Castle downstream to below Parachute is inhabited by the more abundant mountain whitefish, rainbow trout, brown trout, roundtail chub, fathead minnow, speckled dace, carp, white sucker, bluehead sucker, and flannelmouth sucker and the less abundant mottled sculpin, green sunfish, yellow bullhead, black bullhead, and brown bullhead. Based on baseline sampling (Mobil, 1982a), larval stages of fathead minnows, speckled dace, and roundtail chub inhabit areas adjacent to the proposed water intake structure. This segment of the Colorado River also provides suitable rearing habitat for juvenile minnows and suckers (Mobil, 1982a). The standing crop of periphyton is relatively high throughout most of this river segment. Seasonal fluctuations in benthos diversity and abundance portray the relatively unpolluted nature of the river.

Recent surveys for threatened or endangered species in the Colorado River have not verified the presence of humpback chubs or Colorado squawfish within this segment. However, two adult razorback suckers, a species being reviewed for Federal listing, were collected by the USF&WS in July 1981 near Parachute (Mobil, 1982a). Suitable habitat for humpback chubs is not found within this segment. Although potentially suitable habitat for Colorado squawfish exists in limited amounts near the confluence of Cottonwood Creek, upstream movement from downstream populations is blocked by an irrigation diversion dam at Palisade, Colorado (Mobil, 1982a).

3.2.8 Vegetation

Vegetation on the Parachute Block and Mahaffey Ranch differs from that in the Main Elk Reservoir area. The former is characteristic of the southern portion of the Piceance Basin, while the latter is more characteristic of the foothills of the west slope of the Rocky Mountains. Altogether, it comprises 17 vegetation types which reflect a variety of environmental factors (Mobil, 1982a). All of these types have been mapped at a scale of 1:6000 (1 inch = 500 feet). Detailed sampling data and quantitative descriptions of the mapped types are included in Mobil (1982a).

Topography, elevational gradients, available moisture, soils, bedrock characteristics, slope, and aspect are all important factors governing the distribution and extent of the different vegetation types. The types which occur in these different topographic areas are listed in Tables 3.2-8 and 3.2-9. All of the types are characteristic of the region. The patterns and distribution of the different vegetation types on the Mobil properties are typical of those seen elsewhere within the region.

Three special status plant species which have been considered for listing as being threatened or endangered by the USF&WS (1980b) occur on the Mobil property. These species are dragon milkvetch (Astragalus lutosus), Barneby's columbine (Aquilegia barnebyi), and sedge fescue (Festuca dasyclada). These species have also been observed on other nearby properties in the Piceance Basin (BLM and Colorado Natural Heritage Inventory Program unpublished records). Even though these species have no official threatened or endangered status, the BLM and Colorado Natural Heritage Inventory Program consider these species rare enough to merit special concern.

3.2.9 Wildlife

Baseline wildlife investigations on the Mobil property were conducted between July 1981 and January 1983 (Mobil, 1982a).

The three most extensive wildlife habitat types identified on the Parachute Block are mountain shrub, aspen, and sagebrush (Mobil, 1982a). No critical wildlife habitats were identified, but four important ones were described: 1) aspen (fawning habitat for deer, preferred blue grouse habitat, high density songbird habitat); 2) moist meadow and 3) conifer forest (both limited habitats that support some of the less common wildlife species); and 4) cliffs (raptor nesting habitat). Mule deer were observed on the Parachute Block only during the snow-free period. The area is primarily summer range, but deer could be present in small numbers during moist winters. Habitats of particular importance to deer include aspen (late spring and summer), and mountain shrub (fall). Elk were observed, but were far less numerous than deer. Other big game believed to be present on the Parachute Block include mountain lion and black bear. Only two raptors were seen regularly on the plateau; the red-tailed hawk and goshawk. Blue grouse were commonly observed near aspen, conifer, and moist meadow habitats. The only other gamebird identified was the mourning dove. Each major habitat type supported a characteristic assemblage of small birds. Prominent species were the house wren, warbling vireo, and several species of flycatchers (aspen habitat); ruby-crowned kinglet, pine siskin, and hermit thrush (conifer forest); green-tailed towhee and mountain bluebird (mountain shrub); vesper sparrow and Brewer's sparrow (sagebrush). Important habitat for small mammal prey species were conifer forest, aspen, mountain shrub, and moist meadow. Characteristic small mammal species include the mountain cottontail, least chipmunk, deer mouse, and red-backed vole. The western toad, western chorus frog, and wandering garter snake were the only amphibians and reptiles observed.

Shadscale is the major habitat type in Wheeler Gulch. Other important wildlife habitats include pinyon-juniper, mixed riparian (upper elevation), and greasewood (lower elevation). Three important physiographic areas are: 1) lower slopes and valley floors (important deer wintering habitat), 2) headwall cliffs

Table 3.2-8. Vegetation types which occur on the Parachute Block and Mahaffey Ranch

Vegetation type	Major species: Common name	Major species: Scientific name	Areal extent hectares/percent
Roan Plateau			
Mixed brush	Utah serviceberry	(*Amelanchier utahensis*)	1340/17.5
	Big sagebrush	(*Artemisia tridentata*)	
Aspen	Quaking aspen	(*Populus tremuloides*)	1100/14.4
	Mountain snowberry	(*Symphoricarpos oreophilus*)	
Sagebrush/ grassland	Big sagebrush	(*Artemisia tridentata*)	483/6.3
	Letterman needlegrass	(*Stipa lettermannii*)	
Grassland	Columbine needlegrass	(*Stipa columbiana*)	170/2.2
	Letterman needlegrass	(*Stipa lettermannii*)	
Conifer forest	Douglas fir	(*Pseudotsuga menziesii*)	215/2.8
	Mountain snowberry	(*Symphoricarpos oreophilus*)	
Moist meadow	Sedges	(*Carex* spp.)	1/<0.1
		Subtotal	3309/43.2
Escarpments and Slopes			
Pinyon-juniper/ woodland	One-seeded juniper	(*Juniperus monosperma*)	936/12.2
	Pinyon pine	(*Pinus edulis*)	
Mixed brush/ rocky slope	Mountain snowberry	(*Symphoricarpos oreophilus*)	628/8.2
	Utah serviceberry	(*Amelanchier utahensis*)	
Pinyon-juniper/ mixed brush	One-seeded juniper	(*Juniperus monosperma*)	155/2.0
	Utah serviceberry	(*Amelanchier utahensis*)	
Badlands	Shadscale	(*Atriplex confertifolia*)	1449/18.9
	Big sagebrush	(*Artemisia tridentata*)	
		Subtotal	3168/41.3
Bottomland Areas			
Saltbush/ grassland	Shadscale	(*Atriplex confertifolia*)	216/2.8
	Indian ricegrass	(*Oryzopsis hymenoides*)	
Bottomland/ greasewood-sagebrush	Black greasewood	(*Sarcobatus vermiculatus*)	541/7.1
	Big sagebrush	(*Artemisia tridentata*)	
Riparian	Narrow-leafed cottonwood	(*Populus angustifolia*)	28/0.4
	Skunkbush sumac	(*Rhus trilobata*)	
Saltbush	Shadscale	(*Atriplex confertifolia*)	144/1.9
	Plains pricklypear cactus	(*Opuntia polyacantha*)	
Sagebrush	Big sagebrush	(*Artemisia tridentata*)	125/1.6
	Cheatgrass	(*Bromus tectorum*)	
Hardwoods	Plains cottonwood	(*Populus sargentii*)	2/<0.1
	Narrow-leafed cottonwood	(*Populus angustifolia*)	
Agricultural/ pasture	Orchard grass	(*Dactylis glomerata*)	113/1.5
	Crested wheatgrass	(*Agropyron cristatum*)	
Disturbed lands	Clasping peppergrass	(*Lepidium perfoliatum*)	4/0.1
	Russian thistle	(*Salsola kali*)	
		Subtotal	1173/15.4
		Parachute and Mahaffey Total	7650/99.9

Table 3.2-9. Vegetation types which occur on the Main Elk Reservoir area

Vegetation type	Major species: Common name	Major species: Scientific name	Areal extent hectares/percent
Bottomlands			
Riparian	Plains cottonwood	(Populus sargentii)	47/7.4
	Narrow-leafed cottonwood	(Populus angustifolia)	
Sagebrush	Big sagebrush	(Artemisia tridentata)	75/11.8
	Cheatgrass	(Bromus tectorum)	
Hardwoods	Gambel's oak	(Quercus gambelii)	15/2.4
	Narrow-leafed cottonwood	(Populus angustifolia)	
Agricultural/ pasture	Orchardgrass	(Dactylis glomerata)	177/27.9
	Crested wheatgrass	(Agropyron cristatum)	
Disturbed lands	Clasping peppergrass	(Lepidium perfoliatum)	1/0.2
	Russian thistle	(Salsola kali)	
		Subtotal	315/49.7
Side Slopes			
Mixed brush	Utah serviceberry	(Amelanchier utahensis)	79/12.4
	Mountain mahogany	(Cercocarpus montanus)	
Pinyon-juniper/ woodland	One-seeded juniper	(Juniperus monosperma)	57/9.0
	Pinyon pine	(Pinus edulis)	
Pinyon-juniper/ mixed brush	One-seeded juniper	(Juniperus monosperma)	184/28.9
	Utah serviceberry	(Amelanchier utahensis)	
		Subtotal	320/50.3
		Main Elk Creek Total	635/100.0

(potential nesting sites for raptors), and 3) the mixed riparian (comparatively high wildlife diversity). Mule deer were most commonly observed during winter, especially in pinyon-juniper and shadscale habitats. A small resident deer population apparently uses Wheeler Gulch as winter range and a mountain lion was seen during an aerial count in February 1982. No other big game species were identified. Characteristic small mammal habitats are mixed riparian and pinyon-juniper. Game birds and raptors of the area include chukar, golden eagle, Cooper's hawk, and kestrel. No active nests of golden eagles were located. Among the more common small birds were the western flycatcher, warbling vireo, Virginia's warbler, house wren, lazuli bunting, and rufous-sided towhee, with riparian habitat supporting the most diverse avifauna. The northern plateau lizard and collared lizard (rocky areas), sagebrush lizard (sagebrush habitat), and the wandering garter snake (riparian habitat) were the only reptilian species observed in the Wheeler Gulch area. No amphibians were seen.

The major habitat types on the Mahaffey Ranch are the same as described for Wheeler Gulch but more subtypes are present, which create a greater spatial diversity. Five important habitats were described: 1) pinyon-juniper and 2) agricultural meadows (winter deer habitat), 3) the mature cottonwoods along the Colorado River (bald eagle perch sites), 4) headwall cliffs (potential raptor nest sites), and 5) the mixed riparian in upper Cottonwood Gulch (deer wintering area and an area of high wildlife diversity). Mule deer abundance and distribution in the area were similar to Wheeler Gulch. The area is primarily winter range. Important habitat for wintering deer are pinyon-juniper and hay meadows. Small mammal, bird, and reptile populations were very similar to those described for Wheeler Gulch. The turkey vulture and marsh hawk were also seen in the area. The only nesting raptor identified was the Cooper's hawk. The most common waterfowl species identified along the Colorado River included the common goldeneye, mallard, common merganser, and Canada goose.

Major habitat types of the Main Elk Reservoir area include pinyon-juniper, mountain shrub, sagebrush, and mixed riparian. Habitats of special interest are: 1) pinyon-juniper, 2) mountain shrub (deer winter range), and 3) the mixed riparian habitat along Main Elk Creek (general biological diversity). The greatest number of wintering deer was observed west of Main Elk Creek in pinyon-juniper and mountain shrub habitats. Small mammal, bird, reptile, and amphibian populations were observed to be similar to those described previously. Raptors observed and believed to nest in the area include great horned owls, sharpshinned hawks, turkey vultures, golden eagles, red-tailed hawks, and kestrels. Elk are more numerous here than in the three previously described areas. The entire area of Main Elk Creek has been mapped as "critical winter range" for elk (CDW, 1983; Boyd, 1970).

The only endangered wildlife species observed on Mobil Project areas during baseline surveys was the bald eagle (Haliaeetus leucocephalus); (Mobil, 1982a). The endangered black-footed ferret (Mustela nigripes) and peregrine falcon (Falco peregrinus) may potentially occur in the project region.

Bald eagles were seen hunting in the Main Elk Reservoir area only during winter. Bald eagles have also been known to occasionally hunt in Wheeler Gulch during winter. The extreme southern edge of the Mahaffey Ranch is an important bald eagle winter use area (Mobil, 1982a; Fisher et al., 1981) and cottonwood trees are the most important habitat component. There are presently 15 confirmed communal nocturnal roost sites used by bald eagles between DeBeque and New Castle, all of which are in riparian cottonwood stands along the Colorado River (CDW, 1983).

Cliffs along the southern edge of the Parachute Block provide potential nest sites for the peregrine falcon. However, the most recent report of a peregrine falcon near the Mobil Project areas was an unconfirmed sighting near the mouth of Clear Creek Canyon (Lockhart, 1983). Based on the presence of cliffs for breeding and open areas for hunting, the Main Elk Reservoir area is mapped by CDW (1978a) as suitable habitat for peregrine falcons and there is a potential of their occurrence (Bio/West, Inc., 1983).

Unconfirmed sightings of black-footed ferrets have been reported in Rio Blanco, Delta, and Mesa counties, but there is no known viable population in Colorado (Bio/West, Inc., 1983). The possibility of this species occurring in the Mobil Project vicinity is almost nonexistent (Bio/West, Inc., 1983).

3.2.10 Cultural resources

Cultural resource studies were conducted in 1981 and 1982 (Mobil, 1983). These studies included a literature search for the overall project areas, a Class II (random sample-oriented) survey of 10 percent of the portions of the project areas likely to be indirectly impacted, and an intensive survey (100 percent coverage) of areas proposed to have direct impacts. As a result of the field surveys, a total of 3905 acres was inspected. The literature review completed prior to the field survey included prehistoric and historic aboriginal data, Euro-American history and sites, and paleoenvironmental information for the project areas. All of the work undertaken complies with extant historic preservation laws and BLM cultural resource guidelines.

Altogether, 26 prehistoric sites, 12 historic sites, and 10 isolated artifacts were identified by field surveys (Table 3.2-10). The prehistoric sites yielded evidence of Paleo-Indian, Archaic, Fremont, and Ute use of the areas. Higher elevations were used for summer plant gathering and animal hunting. The lowlands were used for winter food-gathering activities. A final determination by the BLM and State Historic Preservation Officer (SHPO) has been made; three prehistoric sites (5GF893, 895, and 905) were judged to be significant in terms of National Register of Historic Places' criteria. An additional five may be significant, but additional work is necessary before this determination can be made.

Historic sites include locations where logging, mining, homesteading, and ranching activities, have occurred during the past 100 years. No historic sites were judged to have National Register of Historic Places significance, as determined during the Section 106/2b consultation process.

Table 3.2-10. Cultural resources identified on Mobil properties

Project area	Sites: Prehistoric	Sites: Historic	Isolated finds
Main Elk reservoir[a]	4	1	0
Parachute Block	7	5	6
Wheeler Gulch	7	4	0
Mahaffey Ranch	8[b]	2	4

[a]Data from Lutz and Muceus, 1978.
[b]Includes one site with both prehistoric and historic components.

3.2.11 Visual resources

The process used to inventory visual resources involves the inventory of scenic quality (landscape quality) and visual sensitivity/distance zones (viewer conditions). These are combined to determine classes that identify the degree of visual modification allowed. The following discussion of the visual resource baseline is presented according to the primary inventory component: scenic quality and visual sensitivity/distance zones.

3.2.11.1 Parachute Block-Mahaffey Ranch area

Scenic quality - The Parachute Block and Mahaffey Ranch areas are located in a highly varied and scenic setting (Mobil, 1982a). The Colorado River, in a narrow valley with scattered cottonwood trees, is a dominant water feature and unusual in this area, so the river was rated as "A" (highest) scenic quality. Above the Colorado River valley is a relatively narrow terrace of sloping sage along which highway I-70 is located. This area lacks distinctive scenic features and contains scattered cultural modifications including I-70, towns, and the Denver & Rio Grande railroad; it was rated "C" (lowest) scenic quality.

Above the terrace are intermittent lower mesas and the Roan Cliffs. The mesa formations form a transition zone when they occur between the Colorado River terrace and the Roan Cliffs. Where there are no lower mesas, the cliffs begin as steep vegetated talus slopes directly above the terrace. The mesas and talus slopes contain a mixture of pinyon-juniper, scrub oak, and grassland. These extend steeply up to the nearly vertical Roan Cliffs which are exposed, horizontal bedded rock formations, often yellow and reddish color. The cliffs themselves extend some 3000 feet above the adjacent terrace and are largely unvegetated except for pockets of scattered pinyon-juniper vegetation. There is no visible sign of modifications except to the east where the Anvil Points oil shale facility is located. The Roan Cliffs and lower mesa formations, including the Anvil Points area, were rated "B" (medium) scenic quality.

Above the Roan Cliffs is the Roan Plateau which, in this area, is a rolling landscape broken by deeply incised drainages. Vegetation consists of a mixture of alpine meadow, shrub, conifer, and aspen. Modifications here are virtually absent. The Roan Plateau was rated "A" (highest) scenic quality.

At the western end of the Parachute Block is the Parachute Creek valley, which is a relatively narrow valley bounded on both sides by the Roan Cliffs. The valley bottom contains a mix of natural shrub and agricultural vegetation. The Union oil shale upgrading facility and man-camp are located near the mouth of this valley. The man-camp is well sited in an inconspicuous location (set back from the road and masked by trees), while the upgrading facility is a visual focal point. This area was rated "B" (medium) scenic quality.

Visual sensitivity/distance zones - Visual sensitivity and distance zones have to do with consideration of the number of viewers, viewer attitudes about scenic quality, and their distance from the lands they observe from important viewpoints.

Interstate 70 is a heavily used highway which carries a high proportion of recreation-oriented and scenery-conscious travelers. As a result, all lands that can be seen from this route (up to a maximum of 5 miles) are judged to be highly sensitive. This includes most of the study area except for the Roan Plateau. Other highly sensitive viewpoints include the Parachute Creek Road and the communities of Battlement Mesa, Morrisania, and Parachute.

The large number of highly sensitive viewpoints involved in rating most of the land below the Roan Plateau resulted in a foreground-high visual sensitivity. A few areas not seen from any of these viewpoints as well as areas of lower viewer concern, such as Sharrard Park and Parachute Valley, resulted in a moderate visual sensitivity rating. The Roan Plateau was rated low because of a lack of visibility from the sensitive viewpoints listed above.

Visual resource management (VRM) classes - There are five VRM Classes. Class I is for areas with existing special protective management designations such as wilderness areas and national natural landmarks. VRM Class V is also a special designation applied to areas needing rehabilitation to bring them back to compatibility with the visual character of the surrounding lands. The three intermediate VRM Classes (II, III, and IV) are defined through the inventory process by various combinations of scenic quality and visual sensitivity/distance zones. Each of these classes has management guidelines for the allowable degree of visual modification allowed. These are briefly defined as follows:

VRM Class II - Modifications (contrasts) may be seen but should not be evident or attract attention.

VRM Class III - Visual contrasts may be evident and begin to attract attention but should remain subordinate to the existing characteristic landscape.

VRM Class IV - Visual contrasts may be a dominant feature in terms of scale but should repeat the surrounding elements of form, line, color, and texture in the characteristic landscape.

Based on high scenic quality alone, the Colorado River and Roan Plateau were rated as VRM Class II. Except for Anvil Points and some unseen areas, the Roan Cliffs were also rated VRM Class II because of the combination of moderate scenic quality and high visual sensitivity.

The terrace on which I-70 is located and the Parachute valley were rated VRM Class III. The I-70 corridor received the Class III rating because of high visual sensitivity combined with low scenic quality; whereas, the Parachute valley was rated Class III because of its moderate scenic quality and sensitivity.

VRM Class IV areas include Sharrard Park, because of low scenic quality and moderate sensitivity, and unseen portions of Hayes Gulch and Wheeler Gulch. Anvil Points is the only area to receive a Class V designation because of the extensive manmade modifications in that area.

3.2.11.2 Main Elk reservoir area

Scenic quality - The valleys of Main Elk Creek and East Elk Creek contain a mix of dense riparian and agricultural vegetation plus water features. The surrounding lands are made up of mountainous uplands and the Grand Hogback. Uniform, steep slopes with sparse vegetative cover characterize the Grand Hogback; the mountainous uplands are dominated by pinyon-juniper and scrub oak associations among the irregular sandstone outcrops. The river valleys were rated "A" (highest) scenic quality, while the remainder of this area was rated "B" (moderate) scenic quality.

Visual sensitivity/distance zones - The entire Main Elk reservoir area was designated as a moderate visual sensitivity landscape, based on a moderate rating for both user volume and user attitudes. Viewers in this area are a combination of local drivers and recreationists.

There are a few scattered areas of land unseen from any of the key observation points in the area; these include Buford Road, Main Elk Creek Road, and East Elk Creek Road. The majority of the area, however, is designated as being in the foreground distance zone.

Visual resource management (VRM) classes - The Main Elk Creek and East Elk Creek valleys were rated VRM Class II because of the high scenic quality, high sensitivity, and foreground conditions. With the exception of the unseen and background areas which rated VRM Class IV, the Grand Hogback and mountainous uplands rated VRM Class III because of a combination of moderate scenic quality and sensitivity in a foreground distance zone.

3.2.12 Noise

Baseline noise was monitored at four sites with a total of 13 day and night observations to obtain background noise levels on and surrounding the Mahaffey Ranch and the proposed plant site. Six sites were used to obtain 40 observations of the background noise levels along roadways in the vicinity of Wheeler Gulch and Main Elk Creek. The equivalent sound level (L_{eq}) was based on composited measurements over 15-minute intervals during day (0700-2200) and night (2200-0700) during the periods November 5-11, 1981; February 23-25, 1982; and July 14-19, 1982. No seasonal differences were apparent. Table 3.2-11 provides information on the distribution of measured noise levels. Day/night noise levels (L_{dn}) were calculated from the L_{eq} values.

For comparison, typical street traffic noise at 100 feet has an L_{eq} of 70 dBA while normal conversation has an L_{eq} of 60 dBA. A typical suburban residential area has an L_{eq} of 53-57 dBA (Vesilind, 1975).

Table 3.2-11. Distribution of noise (L_{eq}) and day/night noise levels (L_{dn}) within specific dBA ranges on the Mobil properties

	On tract			Along roadways		
	L_{eq} Number of observations			L_{eq} Number of observations		
dBA[a]	Day	Night	L_{dn} average[b]	Day	Night	L_{dn} average
>70	0	0	0	2	0	2
60-70	1	0	1	7	4	10
50-59	3	0	2	7	7	6
40-49	3	1	3	3	7	2
30-39	0	5	0	0	3	0
<30	0	0		0	0	

[a]dBA is a measure of sound pressure level. dB (decibels) is a logrithmic scale, thus dB values are not additive. The A scale corresponds most closely to the frequency and loudness response of the human ear.

[b]L_{dn} is obtained by energy averaging the 24-hour noise levels with a 10 dB penalty applied to the nighttime noise levels.

Source: Mobil, 1982a.

3.2.13 Land use and recreation

3.2.13.1 Land use

The Mobil property (Parachute Block/Mahaffey Ranch) includes approximately 11,950 acres. The dominant use is livestock grazing on rangeland which varies widely in productivity as a function of slope, aspect, and elevation. Higher areas on the Roan Plateau provide good summer range (June through October), and the lower areas are used for the remainder of the year. Although no site-specific data are available, data from a nearby site (Pacific) suggest that the site is capable of supporting an average stocking rate of 1 animal unit month (AUM) per 5 acres. On this basis, and assuming that approximately 20 percent of the site is steep slopes and cliffs which are not suitable for grazing, the site is capable of supporting approximately 1827 AUMs. A small portion of the site (100 acres) is cultivated hay. With the exception of about 3 acres of oats in Wheeler Gulch, the cultivated acreage is located on the south unit of the Mahaffey Ranch and probably produces from 1 to 3 tons per acre per year. Two residences are located at the Mahaffey Ranch.

The Main Elk Reservoir site encompasses approximately 920 acres. The site includes four residences, and the dominant use is ranching-related activities, including livestock grazing and hay production. About 437 acres (48 percent) of the Main Elk Reservoir site is cultivated hay.

3.2.13.2 Recreation

The Mobil properties are in the Glenwood Springs Resource Area. As defined in the Recreation Opportunity Spectrum (ROS) system, the Parachute Block and Main Elk Reservoir are in the roaded natural class, while the Mahaffey Ranch lies both in the semiurban and roaded natural classes. A description of experience, setting, and activity opportunities for these classes can be found in BLM (1983b).

The roaded natural class is characterized by a generally natural environment with moderate evidence of man. The semiurban class includes areas that are substantially modified from the natural environment.

The Mobil property is totally private land and, thus, current recreational use is limited. Much of the property is bordered by the Naval Oil Shale Reserve, which is heavily used by big game hunters.

3.2.14 Socioeconomics

Technically, the Mobil workers will be employed and earn their income for their onsite activities. However, it is only when the company or these workers interact in the regional communities, either directly or through the behavior of their household members, that significant socioeconomic effects will be generated. The major socioeconomic consequences of the projects are expected, therefore, to take place at the regional level. The socioeconomic environment which would be changed is basically the same for all major projects in this immediate area. In order to avoid redundancy, the regional environment, which applies equally to the Mobil and Pacific projects, is described in detail in Chapter 2 (Section 2.14).

The purpose of this section is to describe only those socioeconomic aspects of the affected environment that are site-specific for the Mobil Project.

There are three major properties that are included in Mobil's Project. The "Parachute Block" of oil shale reserves is approximately 10,600 acres in area and is located north and northeast of Parachute. The Mahaffey Ranch, about 1350 acres, straddles Interstate 70 and the Denver & Rio Grande Western Railroad, and fronts the Colorado River; it is less than 4 miles northeast of Parachute. The Main Elk Reservoir site, a 920-acre tract, is the proposed location of a dam and a 35,000-acre-foot reservoir, and is 4 miles northwest of the town of New Castle. At the present time, Mobil owns, manages, and supervises these properties. There are some leases on them which include rights to graze livestock, some of which are operable year-round, and some of which are seasonal. The Main Elk Reservoir site will require about 3 acres in the Main Elk Creek valley in addition to the 920 acres that Mobil currently owns (see Section 1.2.1.4).

There are two separate leases on the Main Elk tract, and six separate leases on the Mahaffey and Parachute tracts. Except for a 7-acre lease to XYZ-TV, leaseholders are engaged in ranching. Counting a number of summer hands used in these operations, the total average annual employment is probably between 15 and 20 workers. The average annual wage for workers in the agricultural sector of Garfield County in 1980 was $6256. Therefore, the total annual labor income produced on the Mobil properties is probably between $90,000 and $125,000.

The six households who occupy residences on the Mobil properties total between 15 and 25 persons. In addition, there are the summer hands who assist in the ranching work.

There is a total of five occupied housing units on the three tracts, two of which are mobile homes. The other three units are owned by Mobil and occupied by the leaseholders as part of the lease terms.

The current residents of the Mobil properties receive county services at the same level as people in the other unincorporated areas. Other than roads, there are no public facilities located on the properties.

All real estate and mineral rights taxes on the Mobil holdings are paid by the Company. Individual leaseholders pay personal property, sales, and use taxes, and are counted as regular residents for purposes of intergovernmental transfers.

All of the regular human services programs available to people in this area of southcentral Garfield County are extended to the leaseholders on the Mobil properties. There are no data on levels of use by the Mobil property residents.

The leaseholders belong to the Garfield County agriculturalist group. In some cases, the property was leased back to the original owners after it was purchased by Mobil, or it was leased to other local ranchers. Therefore, Mobil ownership of the property has not yet made any significant change in the social structure of the community.

3.2.15 Transportation

The only transportation network on the Parachute Block and Mahaffey Ranch consists of dirt roads and unimproved trails. The main access to the project will originate on the Mahaffey Ranch. The existing Interstate Highway 70 (I-70) and the frontage road for I-70 will be the principal routes to the access road from Rifle and Parachute. These roads and the Denver & Rio Grande Western Railroad cross Mobil's water pipeline corridor between the intake structure and the Mahaffey Ranch.

A two-lane rural public road, County Road 243 passes through the center of the Main Elk Reservoir site, connecting ranchers to the north with the New Castle-Buford Road (County Road 245) to the south.

3.3 ENVIRONMENTAL CONSEQUENCES

In this section, the environmental consequences of the proposed action and reasonable alternatives are discussed, including the impact on the affected environment (3.3.1), unavoidable adverse impacts (3.3.2), irreversible and irretrievable commitments of resources (3.3.3), relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity (3.3.4), and suggested mitigation measures (3.3.5). The impacts of alternatives would be relatively the same except as differences are discussed below and in Section 3.4.

3.3.1 Impact on affected environment

An evaluation of the environmental impacts throughout the life of the proposed project is presented in this section, including activities occurring during construction, operation, and abandonment. The discussion follows the same discipline-oriented arrangement of topics as presented in Section 3.2, Affected Environment.

This analysis has evaluated the magnitude, intensity, duration, and incidence of changes in the environment that would be caused by the project, and has also duly considered each of the issues raised during the scoping process.

3.3.1.1 Climate and air quality

Mobil Project air emissions would include particulate matter (PM), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), and hydrocarbons (HC). Emissions would occur during construction, mining, retorting, upgrading, power generation, and processed shale disposal. An increase in regional population would also contribute to increased air emissions.

In order to determine the air quality impact of the Mobil Project, a number of analytical steps were undertaken. These include: (1) determination of point and area source emissions from the proposed activities; (2) determination of meteorological parameters (based on site-specific data) suitable for dispersion modeling; (3) application of air quality modeling for project-specific and cumulative impacts to nearby and more distant, sensitive Class I and Category I areas; (4) comparison of maximum predicted concentrations with an appropriate regulatory standard (i.e., NAAQS, PSD increments, etc.); (5) determination of Air Quality Related Values (AQRV) at sensitive areas and evaluation of impacts; and (6) analysis of appropriate alternative and mitigative actions. This section describes the results of these analyses.

Construction

Various construction activities would extend over a 15-year period until full production capacity of the plant would be reached. However, major construction activities, including those of the Main Elk Reservoir dam, relocation of County Road 243, the contractor's access roads, the funicular railway, land clearing, and major mine and oil shale facilities, will be more intensive during the initial 5 or 6 years of the project. Principal pollutants from these activities would be fugitive dust from heavy equipment, and from ripping, drilling, blasting, and ground clearing. Construction activities would be intermittent and spread over all project facility areas. Occasionally, localized high levels of particulate matter, which would be controlled by appropriate mitigative activities, may be anticipated.

Projected emissions from operations

The Company has identified approximately 280 separate emission sources based on mining, processing, and plant facilities design. A summary of emissions by operating activities and facilities is provided in Table 3.3-1. The emissions data and ground-level ambient concentrations reflect full production for a 100,000-bpd plant. During the operations phase, from plant completion to full production, emissions would steadily increase proportional-to-production rates.

Table 3.3-1. Estimated Mobil Project emissions (g/s) for various mining and shale oil processing operations

	Pollutant				
	SO_2	TSP	NO_x	CO	HC
Materials handling (crushers, conveyors, transfers, storage piles, etc.)	0	18.3	0	0	0
Retorting	36.1	23.9	143.5	9.0	38.5
Upgrading	24.7	2.4	66.5	16.2	22.5
Power generator	33.4	4.8	220.7	10.0	0.0
Steam generation (on Roan Plateau and Mahaffey Ranch)	48.3	1.7	34.5	20.8	1.2
Mine ventilation	0.1	6.2	58.2	12.2	9.6
Process shale disposal		6.3			
Total	142.5	63.6	523.4	68.2	71.8

The emissions data provided by Mobil for this assessment are based on the application of normally accepted emissions factors that are compatible with facility design and operational requirements. The determination of emissions is described in the air quality technical report (Dames & Moore, 1984). Emissions estimates for some specialized retort process-related equipment (such as the TOSCO shale preheater scrubber) were based on existing PSD permits or PSD permit applications for other oil shale facilities. Emission rates were extensively reviewed by the BLM and found to be consistent with values established for similar activities of proposed oil shale operations of comparable size and scope.

There are no existing oil shale processing facilities comparable in size to the proposed Mobil plant. The effectiveness of emission control technology has not been firmly established, except for smaller prototype activities. Consequently, some emissions identified in this evaluation, especially for shale oil retorting operations, are estimates based on related industrial experience and design projections.

The following discussion assumes the proposed retort method, which is a worst-case scenario for air emissions. The following also assumes the proposed Roan Plateau upgrading facilities location. The alternative Mahaffey Ranch location for upgrading facilities would cause a greater impact on air quality in the Colorado River valley because atmospheric emissions from the Roan Plateau location would be subject to greater dispersion than if the upgrading facilities were at the Mahaffey Ranch location.

The emissions that could potentially result from malfunctioning air pollution control equipment cannot be quantified. However, during process upsets the facility will be shut down, minimizing uncontrolled releases. Also, air permit regulations will likely forbid extended operation of the process with control equipment inoperative.

The current level of design does not allow for precise estimates of potentially toxic or hazardous emissions. However, available design information does indicate that emissions of asbestos, mercury, and vinyl chloride will be below the significant emission rates specified in PSD regulations (Mobil, 1983c). Based on estimates from other oil shale projects, emissions of beryllium could exceed the significance rate (0.0004 ton/year) by an order of magnitude (Mobil, 1983c). There is currently no basis for estimating benzene, radionuclide, or inorganic arsenic emissions, although these emissions are expected to be low (Mobil, 1983c).

Recent studies have shown that exposure of untreated shale oil wastewaters to the atmosphere can result in the emission of large quantities of aromatic nitrogen-containing compounds, ketones, nitriles, and phenols (Hawthorne, 1984). Since some compounds within these classes are known to be carcinogenic, this could pose a risk to worker and public health. Hawthorne (1984) showed that emissions of organic pollutants from untreated wastewaters exposed to air might amount to the following for a 100,000 bpd facility:

Compound	Emissions (gm/sec)
Nitrogen-heterocycles	145 - 158
Ketones	6 - 30
Nitriles	7 - 11
Phenols	4 - 8
Total organics	177 - 264

"By contrast, wastewaters stored in closed systems emit approximately three orders of magnitude lower amounts of organic compounds into the static air above the wastewater" (Hawthorne, 1984). Containment, followed by treatment of the wastewaters as proposed in the project design is an effective control for volatile organic emissions.

Meteorological data

Meteorological data essential for computer modeling and impact assessment were obtained from Mobil's 18-month onsite monitoring program discussed in Section 2.2.1. There was an overlap of two winters and the applied data may be considered to contribute to a slightly conservative assessment of air quality impacts.

Modeling and methodology

There are no universally accepted or approved models available for complex terrain or regional-scale modeling. The methodology selected uses a multiple model approach to assess primary, secondary, and cumulative impacts of pollutant emissions from the proposed synfuel facilities. An attempt was made to select screening models that are most appropriate for the particular sources, locations, distances, and topography evaluated. Models were selected for conservatism as well as consistency with recent evaluations in the oil shale development areas. For example, the Complex I model was selected for evaluation of projected impacts close to the source. This model calculates ambient ground level concentrations from fixed point sources in complex terrain and has been widely used by EPA, Region VIII, and state environmental agencies for air quality impacts in the Rocky Mountain area. The model has been employed for most of the recent oil shale project EISs and PSD permitting assessments.

The receptor locations used for modeling with the Complex I model are shown in Figure 3.3-1.

For receptors farther than 25 kilometers from emission sources, the Topographic Air Pollution Analysis System (TAPAS) was employed. TAPAS is a system composed of several air quality-related models (principally WINDS and CITPUFF). These models predict ground level concentrations by taking into account topography, ground cover, surface roughness, wind speed and direction, and industrial plant emissions characteristics. The TAPAS model uses a trajectory concept for the transport of pollutants. More detailed discussions of TAPAS are provided in Dames & Moore (1984).

For special situations such as persistent inversion conditions at valley locations, several box-model applications were also made. These models characterize impact from drainage down canyons and gulches close to the source operations, as well as secondary impacts from several towns and locations along the Colorado River Valley. These models are described in Dames & Moore (1984).

Modeling results

Figure 3.3-2 shows the location of predicted maximum pollutant concentrations with respect to the Mobil Project facility and boundary locations. Table 3.3-2 shows maximum predicted particulate and gaseous concentrations close to the Parachute Block study area for both short-term and annual averages. None of the predicted pollutant levels exceeded the NAAQS or the PSD Class II increments for SO_2 and TSP. The concentration closest to the PSD increment was the Class II 24-hour average TSP concentration. A concentration of 25.7 micrograms per cubic meter ($\mu g/m^3$) was predicted at the Parachute Block boundary immediately downwind of particulate ground level sources; this value was approximately 69 percent of

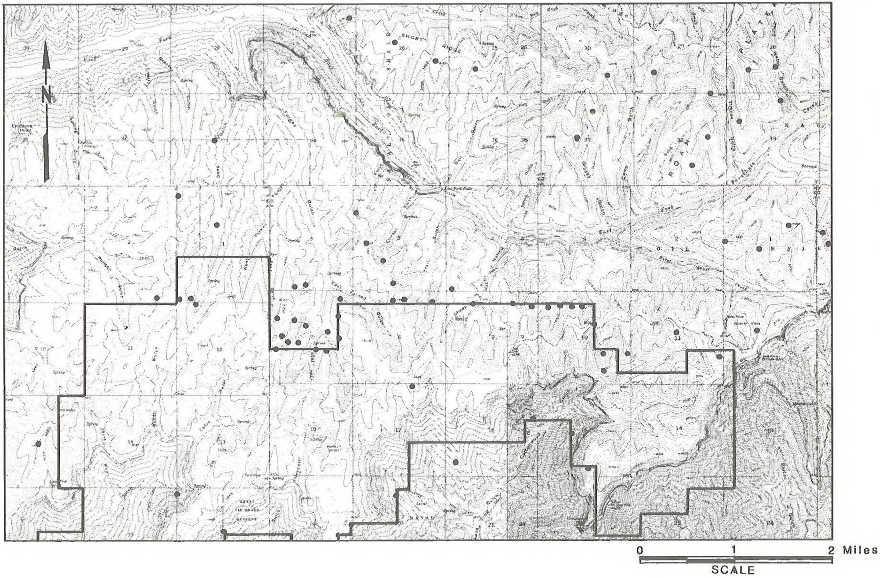


Figure 3.3-1. Receptor locations for Complex I modeling of emissions

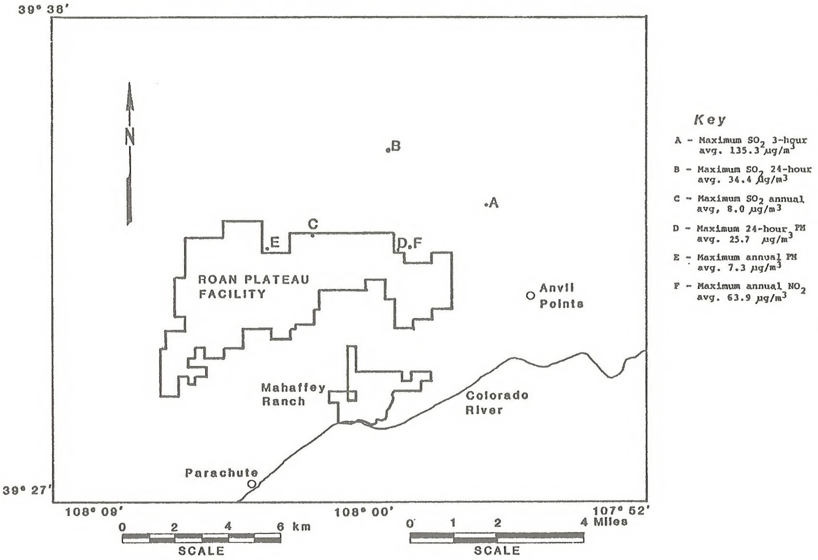


Figure 3.3-2. Location of maximum concentrations near Parachute Block

Table 3.3-2. Maximum predicted ambient concentrations ($\mu g/m^3$) resulting from Mobil Project operations

Pollutant	Averaging time	Concentration[a]	Percent Class II increment	Measured background	Percent NAAQS[b]
SO_2	Annual	8	40	11.8	25
	24-hour	34	38	34.1	19
	3-hour	135	26	41.9	14
Particulate matter	Annual	7	38	12	32
	24-hour	26	69	100	83
NO_x	Annual	64	--	4[c]	68[d]
CO	1-hour	367	--	7664	20
	8-hour	93	--	5003	51

[a]Predicted concentration from project operations.
[b]Based on assumed background plus concentration from project.
[c]Annual concentration measured at Clear Creek Shale Oil Project (BLM, (1983b); Mobil data biased by propane-fired generator.
[d]As NO_2.

the allowable Class II increment. The predicted annual TSP concentration was 7.3 $\mu g/m^3$, or 38 percent of the annual Class II increment.

The maximum 3-hour SO_2 concentration predicted was 135.3 $\mu g/m^3$; the maximum 24-hour SO_2 concentration was 34.4 $\mu g/m^3$; the maximum annual SO_2 concentration was 8.0 $\mu g/m^3$. These are 26, 38, and 40 percent of the allowable SO_2 Class II increments, respectively. The maximum 3- and 24-hour values would occur on higher terrain northeast of the Parachute Block. The highest annual SO_2 concentration would also occur at the boundary border downwind from the largest sources.

The maximum annual NO_x concentration predicted using Complex I was 63.9 $\mu g/m^3$. In this assessment, it was conservatively assumed that all nitrogen oxides emitted are immediately converted to NO_2. Concentrations greater than 50 percent of the NAAQS would be limited to a small area near the Parachute Block boundary, immediately downwind of two mine vents. When added to the measured background NO_2 concentration of 4.0 $\mu g/m^3$, the total predicted NO_2 concentration is about 68 percent of the NAAQS. Maximum predicted CO concentrations from the Parachute Project are very small, as shown in Table 3.3-2.

Concentrations in the Colorado River Valley near Mahaffey Ranch emission sources were also modeled using Complex I. The maximum predicted 24-hour SO_2 concentration was 0.8 $\mu g/m^3$, or less than 1 percent of the 24-hour PSD increment; the maximum TSP 24-hour concentration was 1.9 $\mu g/m^3$, or about 5 percent of the TSP 24-hour increment. Annual predicted NO_2 was 6.2 $\mu g/m^3$. Estimated CO levels were insignificant. The HC concentrations calculated with a box model

(Mobil, 1983b) for worst-case conditions were 1.6 $\mu g/m^3$. No significant ozone formation is anticipated from the Mahaffey Ranch facilities.

The HC emissions from Mobil's Roan Plateau activities are expected to be small. Although no photochemical model has been approved for routine regulatory application, the Clear Creek and White River oil shale projects have reported results from photochemical modeling in their PSD applications (Chevron, 1982; Phillips Petroleum et al., 1981); in both studies, estimated ozone production would be below the NAAQS. The estimated HC emissions from the Mobil Project (569.9 pounds per hour) would be above those estimated for the White River (350 pounds per hour), but well below Chevron's estimated 1100 pounds per hour. Estimates of ozone impacts from the Mobil Project facilities were calculated using the Empirical Kinetics Modeling Approach (see Dames & Moore, 1984, for details). Results of this ozone impact analysis indicated that a wide range of values can be anticipated, depending on atmospheric conditions. Maximum 1-hour concentrations for worst-case scenarios ranged from 29 $\mu g/m^3$ to 184 $\mu g/m^3$, compared to the NAAQS of 235 $\mu g/m^3$ (Dames & Moore, 1984).

Class I impacts

Predicted SO_2 and TSP concentrations in regional Class I areas as a result of the Mobil Project are shown in Table 3.3-3. Both the Complex I and TAPAS models were employed for this evaluation and the table shows a range of values using both modeling methods. TAPAS was used primarily for the Flat Tops Wilderness Area, which is the closest Class I area to the Mobil Project, and is in the direction of the prevailing winds; TAPAS was also used to predict impacts for the Mount Zirkel Wilderness Area, which is further downwind in the direction of prevailing winds. TAPAS was used for 24-hour assessments, which generally represent the most constraining conditions.

Both models employed worst-case, site-specific data collected over an 18-month period. The worst-case meteorological scenarios identified for Complex I reflect mostly stable atmospheric stability conditions and very light wind speeds blowing in the direction of the Flat Tops. Because of the complex terrain, variations in wind directions (typical of light winds) and diurnal variations associated with the worst-case scenarios, it is not entirely certain that the plume would reach the Flat Tops under these conditions. The Complex I results must, therefore, be considered highly conservative.

The TAPAS model employs a trajectory concept and uses winds from several available regional data sources along the course of the trajectory. The worst-case meteorological scenario identified for TAPAS Flat Tops evaluations indicated persistent southwest winds, blowing from 234 degrees + 11-1/2 degrees for 23 straight hours, neutral (D) stability conditions, and moderate winds, averaging 6.6 m/s and ranging from 3.9 to 10.4 m/s. Figure 3.3-3 shows the TAPAS model plume-puff trajectory for this scenario. There were a number of closely similar scenarios and the conditions selected appear to be both realistic and typical. For winds with a slightly more southerly component, the plume passed to the west of the Flat Tops; for winds with a more westerly component, the plume passed to the south and did not show similar levels of persistence. It is noted that the TAPAS model takes into account the channeling effects of high topography. The principal impact would be along the western edge of the Flat Tops. (The Complex I worst-case conditions could not be simulated for TAPAS because of topographic channeling.)

Table 3.3-3. Maximum predicted SO_2 and particulate (TSP) concentrations as a result of the Mobil Project in Regional Class I areas ($\mu g/m^3$)

FLAT TOPS WILDERNESS AREA

		Complex I		TAPAS	
Pollutant	Averaging time	Concentration	Percent Class I increment	Concentration	Percent Class I increment
SO_2	Annual	0.43	22	--	--
	24-hour	1.99	40	1.20	24
	3-hour	10.94	44	--	--
TSP	Annual	0.19	4	--	--
	24-hour	0.74	7	0.48	5

COLORADO NATIONAL MONUMENT[a]

		Complex I	
Pollutant	Averaging time	Concentration	Percent Class I increment
SO_2	Annual	0.13	7
	24-hour	1.61	32
	3-hour	5.94	24
TSP	Annual	0.05	1
	24-hour	0.61	6

DINOSAUR NATIONAL MONUMENT[a]

		Complex I	
Pollutant	Averaging time	Concentration	Percent Class I increment
SO_2	Annual	0.07	4
	24-hour	0.74	15
	3-hour	3.74	15
TSP	Annual	0.03	1
	24-hour	0.28	3

MOUNT ZIRKEL WILDERNESS AREA

		TAPAS	
Pollutant	Averaging time	Concentration	Percent Class I increment
SO_2	24-hour	0.2	4
TSP	24-hour	0.08	1

[a]Colorado National Monument and Dinosaur National Monument are State Category I areas; SO_2 increments are identical to those for PSD Class I areas.

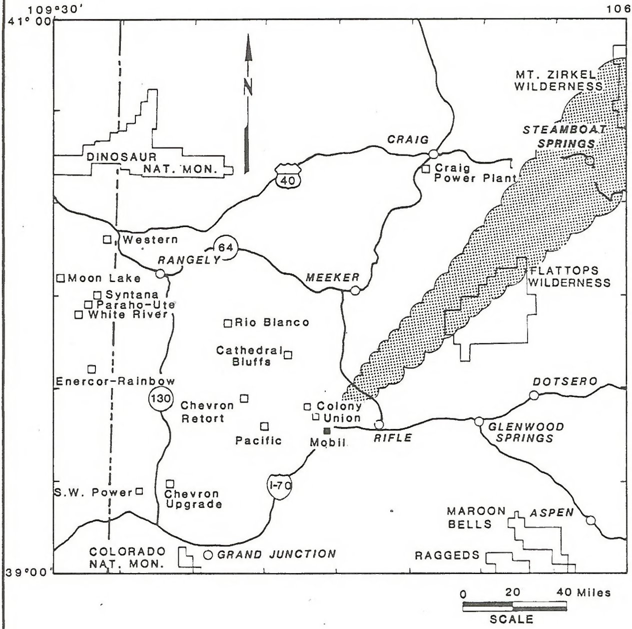


Figure 3.3-3. TAPAS model plume trajectory for worst-case condition from Mobil Project site to the Flat Tops and Mt. Zirkel wilderness areas

As shown in Table 3.3-3, Complex I model results for the Flat Tops Wilderness Area were approximately double those of TAPAS; neither model shows exceedance of Class I, PSD increments. Predicted maximum 24-hour SO_2 concentrations range from 1.99 $\mu g/m^3$ (Complex I) to 1.2 $\mu g/m^3$ (TAPAS), or from 40 to 24 percent of the Class I increment. The 3-hour SO_2 Complex I value was 10.9 $\mu g/m^3$ or 44 percent of the increment; the annual Complex I value was 0.43 or 22 percent of the increment. TSP concentrations were 7 and 5 percent of the allowable 24-hour increment for Complex I and TAPAS, respectively. The Complex I annual concentration was 4 percent of the annual increment.

Screening evaluations using site-specific data indicated impacts at other Class I areas would be minimal; these areas are not in the direction of persistent or prevailing winds (with the exception of Mount Zirkel). Complex I worst-case evaluations, as a conservative assessment, were made for the Colorado National Monument and the Dinosaur National Monument. Results for Colorado National Monument indicated a maximum 24-hour SO_2 concentration of 1.61 $\mu g/m^3$, or 32 percent of the increment, and a maximum 3-hour concentration of 5.9 $\mu g/m^3$, or 24 percent of the increment. The annual predicted concentration was 0.13 $\mu g/m^3$ or 7 percent of the annual Class I increment. TSP values were 6 percent of the 24-hour Class I increment, and 1 percent of the annual increment.

Dinosaur National Monument impacts, using Complex I, indicated both 3- and 24-hour SO_2 concentrations at 15 percent of the increments. The annual predicted SO_2 concentration was 4 percent. TSP impacts were less than 3 and 1 percent for the respective 24-hour and annual increments. The Mount Zirkel Wilderness Area assessment, using TAPAS, indicated a maximum 24-hour SO_2 concentration at 4 percent of the Class I increment; TSP was less than 1 percent of the 24-hour increment.

NO_x impacts were evaluated using TAPAS for Flat Tops and Mount Zirkel. Maximum 24-hour concentrations were 3.91 and 0.66 $\mu g/m^3$, respectively, at these Class I locations. Since the NO_2 annual NAAQS is 100 $\mu g/m^3$ and these results reflect single worst-case days for NO_x, it can be assumed that additional NO_2 impacts would be minimal.

The TAPAS model also identified maximum concentrations in Class II areas. These values showed no exceedance of standards and again are approximately 50 percent of the Complex I values beyond the immediate vicinity of the project site. At the Grand Hogback, 20 kilometers northwest of the Parachute Block, maximum 24-hour SO_2, TSP, and NO_x concentrations were 4.28, 1.72, and 13.9 $\mu g/m^3$, respectively.

Visibility

A Level I visibility screening analysis (Latimer and Ireson, 1980) was performed to determine if significant impacts would occur at nearby Class I/Category I areas. The Level I analysis is designed to identify those emission sources that have little potential of adversely affecting visibility. If a source passes a screening, it would not be likely to cause adverse visibility impairment, and further analysis of potential visibility impairment would not be necessary (Latimer and Ireson, 1980). The Level I analysis, however, indicated a potential for visibility impairment because of a visible coherent plume at the Flat Tops Wilderness Area, Colorado National Monument (Category I), and the Maroon Bells (Class I) areas. Because of these results, the EPA visibility model PLUVUE was then used to refine the analyses of plume perceptability (Dames & Moore, 1984). The model was run for average summer meteorological conditions; this is the expected season of maximum impacts. Plume discoloration is greatest in the summer as NO_2 forms faster because of higher O_3 concentrations. Also, because the average visual range is higher in the summer, any reduction is more apparent. Using wind frequency and stability distributions at the Roan Plateau, the percentage of time that a plume from the project would be perceivable from the areas studied was estimated to be 1.7 percent for the Flat Tops, 1.1 percent for Colorado National Monument, and 0.2 percent for Maroon Bells.

Atmospheric deposition

Acid deposition is considered one of the Air Quality Related Values (AQRVs) for Class I areas. Acid deposition is a regional phenomenon generally associated with emissions generated by large and major industrial sources. Acid deposition has, however, been documented in a high altitude Rocky Mountain setting where no direct connection can be made with major emission sources (Lewis and Grant, 1979; 1980). Additional studies and analysis have been done by Fox et al. (1982), and Turk and Adams (1983).

Deposition of sulfur from SO_2 emissions of the Mobil Project was calculated for Class I/Category I and other sensitive locations. This calculation used the SO_2 concentrations predicted by TAPAS and Complex I models and estimated deposition velocities to determine the total wet and dry sulfur deposition rate (Dames & Moore, 1984). Results were as follows:

Sensitive area	Total wet and dry Sulfur deposition (kg/HA-yr)
Flat Tops Wilderness Area	0.28 - 1.36[a]
Colorado National Monument	0.40
Dinosaur National Monument	0.22
Mount Zirkel Wilderness Area	0.04

[a]Range using TAPAS and Complex I, respectively.

These rates indicate no significant acid deposition impacts are likely. U.S. and Canadian scientists have agreed that wet sulfate deposition of less than 20 kg/HA-yr has not produced any recorded damage in the most vulnerable areas (Roberts, 1983). Wet sulfate deposition of 20 kg/HA-yr approximates total wet and dry sulfur deposition of 13 kg/HA-yr. At a recent conference on acidification of the environment, some participants suggested that the threshold for acidification is as low as 5 kg/HA-yr of sulfur deposition (Swedish Ministry of Agriculture, 1982). The sulfur deposition rates calculated above represent a small percentage of this postulated threshold impact value.

Secondary impacts

This section presents the estimated air quality impacts from secondary growth emission sources associated with the construction and operation of the proposed Mobil Project. Secondary growth impacts were focused on four representative locations in the Colorado River Valley: Rifle, DeBeque, Parachute, and Grand Junction. Projected air emissions were based on population growth projections presented in the socioeconomics baseline (Section 2.14), and emission inventories established in a 1982 report on air quality impacts of oil shale and related growth in western Colorado (PEDCo Environmental Inc., 1982). Projected growth emissions were modeled using a box model (Dames & Moore, 1984) to simulate the worst-case meteorological condition of a severe inversion (mixing depth 100 m) combined with very light winds (1 m/sec).

Results are provided in Table 3.3-4 and indicate modest increases of NO_x and particulate matter at Rifle above the No-Action scenario. Secondary growth pollutant increases at Parachute, DeBeque, and Grand Junction were predicted to be small to negligible. Since these concentrations are predicted from emission rates and do not include background, these results are useful only as a tool for understanding how air quality might change in a relative sense. Actual concentrations may be higher, particularly for TSP as it includes the measurement of reentrained dust as well as direct emissions.

Table 3.3-4. Secondary pollutant impacts at representative Colorado River Valley locations (24-hour average concentrations expressed in $\mu g/m^3$)

Town	1980[a]	No action[b]	With Mobil
Rifle			
SO_2	2	3	6
NO_x	14	28	52
TSP	49	62	87
DeBeque			
SO_2	2	2	2
NO_x	16	16	17
TSP	34	35	35
Parachute			
SO_2	1	2	3
NO_x	20	29	36
TSP	92	102	108
Grand Junction			
SO_2	11	14	14
NO_x	103	132	137
TSP	122	152	156

[a]Highest predicted 24-hour concentration based on 1980 emissions data.

[b]Based on population increases through 1999 for Rifle, DeBeque, and Parachute, and through 2009 for Grand Junction.

Impacts on climate

Very local wind patterns may be affected by alteration of the topography or by building construction. Land clearing could alter the reflection and evapotranspiration of the ground, resulting in temperature and humidity changes. It is also possible that hot processed shale placed in the narrow canyons may affect drainage flows, resulting in very localized eddies in these areas. These potential impacts would be very localized and temporary and would be mitigated through vegetation reclamation and the eventual decommissioning of the industrial facility. No impacts to regional climate are anticipated because of any of the proposed actions or alternatives.

Facility abandonment

Fugitive dust can be anticipated from cleared areas and processed shale disposal areas. These impacts can be mitigated significantly by reclamation.

3.3.1.2 Topography, geology, and mineral resources

Long-term topographic changes (beyond the life of the project) would result from processed shale disposal in the Wheeler Gulch drainage from terracing and earth movement for plant and support facilities on the Roan Plateau, construction of Mahaffey Ranch road, and from construction of the dam and impounding a reservoir on Main Elk Creek.

Permanent commitments of resources would result from mining and retorting raw shale from the Mahogany Zone in the Parachute Block, and from the use of other minerals (such as sand and gravel) for construction and operation of the project.

Construction

Minor topographic changes would result from construction of the various project components. A total of about 725 acres of moderately hilly terrain (100 to 200 feet of relief) would be benched to provide level sites for plant facilities. A total of about 295 acres would be disturbed by construction of contractor and access roads; an estimated 137 of these disturbed acres would be on NOSR land.

Some adverse geologic impacts could result from construction of the Cottonwood Gulch access road. The upper part of the access road would cross some talus slopes that may be activated by construction activities. Rockfall may occur at any time of the year along the access road, contractor's road, the mine bench, the lower part of the funicular railway and its base station, and the parking lot. The area is especially susceptible to rockfall in the spring because of ice wedging along the innumerable joints. Danger of rockfall may be accentuated by blasting during road construction and mine bench preparation. The Mobil Project is in seismic risk Zone 1 and may be subject to minor damage from distant earthquakes. Shocks associated with the earthquakes may increase the risk of rockfall in the project area.

Operation

Disposal of processed shale in both Upper and Lower Wheeler Gulch would result in a major change in topography in an area of 1610 acres. The narrow steep-sided valley of Lower Wheeler Gulch, with as much as 2200 feet of topographic relief, would be altered to a broad valley floor of low relief about 0.6 mile wide, with bordering steep slopes and cliffs as much as 1000 feet high. About 1 square mile of the valleys of Cabin Water and Middle Water creeks, with a present topographic relief of 300 to 400 feet, would be filled to form a flat-topped plateau with little relief.

Considerable ore would be consumed during the life of the project; nonmined materials adjacent to the mined ore would also be affected. Forty percent of the ore in the mine zone (equivalent to 435 million barrels of shale oil) would be left in the pillars providing roof support. An additional 263 million barrels of oil from lower grade oil shale in the Mahogany Zone, above and below the mine zone, would not be mined. The 1.5 billion barrels of shale oil in the Mahogany Zone on the Parachute Block are a small percentage of the 135 billion barrels of oil contained in 25-gallon per ton shale of the Mahogany Zone throughout the Piceance Basin Mahogany Zone (Keighin, 1975).

The Main Elk Dam and Reservoir would affect about 540 acres. The reservoir would have a maximum depth of about 180 feet. Water in the reservoir would cover outcrops of the Morrison Formation that may contain some uranium mineralization in the general area, and outcrops of the Entrada Sandstone, which has produced commercial quantities of uranium and vanadium a few miles to the northwest at East Rifle Creek. The reservoir may also cover some sand and gravel deposits in the valley of Main Elk Creek. Water in the reservoir would cover, and possibly lubricate and activate, a normal fault that strikes southeast across the northern third of the reservoir (Mobil, 1982a). However, this structure, known as the Graveyard Fault, is listed by the Colorado Geological Survey as "inactive." The improbability of open fissures associated with this fault in the underlying incompetent material and consideration for the original mechanism which developed the fault make future movement unlikely.

Several thousand acres, including the plant site, solid waste disposal area, the reservoir area, and the mined area, would not be available for oil and gas exploration during the life of the project. Additional oil and gas exploration, and production would be required to fuel the project. However, the project would produce about 740 million barrels of synthetic crude oil.

Abandonment

Permanent topographic change would result from the processed shale disposal, the access road, and the Main Elk Dam and Reservoir.

The 7000 acres of mined-out area, containing large areas at depth with void spaces 80 feet high, would discourage, if not prevent, future oil and gas exploration. Some time after abandonment, support pillars may fail, resulting in differential surface subsidence. The hazardous and nonhazardous solid waste disposal, utility corridor, water intake facilities, and product pipeline should have minimal impact on the geology and mineral resources of the project area.

3.3.1.3 Paleontology

Although paleontological values have been recognized in all three of the formations outcropping on the Mobil properties; the middle unit, the Green River Formation, would be most seriously affected by proposed actions, inasmuch as the underlying Wasatch Formation contains no oil shales and there are few oil-rich strata associated with the overlying Uinta Formation. Furthermore, in the upper part of the Green River Formation, the Stewart Gulch Tongue and the "Marlstone" are essentially unfossiliferous and, consequently, their disturbance would not constitute an impact on paleontological resources.

Construction

The construction phase of the proposed development would cause the lesser impacts to paleontological resources inasmuch as minimal acreage would be involved and most construction would be confined to more nearly level surfaces, which have been significantly weathered or masked with a veneer of Quaternary sediments. In either of the latter cases the value of paleontological resources has already been diminished to some extent by natural erosion. Other impacts from construction often would result from the necessary excavations as well as from unauthorized fossil collecting by construction personnel. Construction-related activities such as road building or deep excavations may also be the means of chance discovery of otherwise unknown paleontological values.

Operation

Operational impacts would be of most concern when fossiliferous formations were directly involved, as in the shale mining and processing operations, which would result in complete destruction of the paleontological resource. On the other hand, waste disposal and water impoundment facilities may tend to protect some fossil resources by making them inaccessible.

Support facilities, once installed, would have a minor impact on the fossil resource with the possible exception of access roads, which might permit exploitation of fossil resources previously protected by isolation.

Abandonment

Impacts following abandonment of the project would occur only as a result of previously isolated fossils being subject to exploitation through access to outcrops made more accessible by the project. Surfaces covered by processed shale, the water impoundments, or other vestiges of the project, although impacting the resource, may also be regarded in another sense as protecting paleontological values through isolation.

3.3.1.4 Soils and reclamation

Impacts to existing soils from this project would include soil removal, covering soils with structures, leveling, inundating soils with water, and increasing erosion of existing soils.

Inasmuch as soils are the basis of productive ecosystems, their retention and conservation would be vital to the reestablishment of existing or similar ecosystems upon abandonment. To this end, stockpiling of topsoil and suitable subsoil is planned to permit prompt revegetation of disturbed areas throughout the life of the project, but particularly upon abandonment. Although removal of soil for stockpiling would probably result in the destruction of various soil properties in the process, the soil will nonetheless serve to rectify adverse impacts once it is placed on disturbed areas.

Impacts to soils during the life of the project would be moderate to severe. Moderate impacts to soils are defined as the reduction in effective soil depth, the creation of moderately erosive conditions, the increased exposure to flooding, or an increase in stoniness of surface soils. Any single category listed would be considered as a moderate impact. A severe soil impact is defined as any one of the following conditions: the loss of effective soil depth to less than 4 inches; an increase in salinity to an electrical conductivity greater than 8 mmhos/cm; a change in permeability from moderate to slow; and increase in soil erosion losses to a high rate (>5 tons/acre/year); an increase in coarse fragments to 15 percent, or spacing between stones of less than 2.5 feet; or exposure to flooding probability of five or more times in 10 years.

Some of these impacts would be reduced because of ongoing reclamation. Upon abandonment, soil stockpiles would be used to cover disturbed areas, create productive vegetation, and minimize erosion.

Construction

Most impacts to soils would be by construction activities which cause the initial disturbance. The acres that would be disturbed by groups of associated project components are listed in Table 3.3-5; a total of 3539 acres of existing soils would be impacted.

An estimated 854 acres would be disturbed by construction of the facilities on the Roan Plateau. Impacts on soils in these areas would be severe but topsoil would be stockpiled for later use in reclamation.

Table 3.3-5. Acres of soil disturbance for the proposed action

Structures and use	Acres
Road and railroad	310
Plant facilities (plant sites, mine portal, processing facilities, upgrading facilities, staging areas, and parking areas)	854
Pipelines	194
Electrical power transmission	21
Processed shale and waste disposal	1620
Water storage reservoir and dam	540
Total	3539

The excavation of trenches for water, natural gas, and product pipelines would result in moderate, short-term impacts to soils on an estimated 194 acres. Those soils would be excavated during construction, but replaced, and should become as productive as at present. Severe impacts would occur on an estimated 310 acres of soils during road and railroad construction. The impact on soils within the utility corridor would involve about 74 acres and would be moderate.

Construction of the water storage dam and reservoir would include excavation and stockpiling, or subsequent inundation, of soils on an estimated 540 acres. This acreage includes 150 acres of prime farmland soils. The impacts would be long term and irreversible.

Operation

As portions of the processed shale disposal area are completely used, stockpiled soil would be spread on top of the waste material to a depth of 30 inches and revegetated. Since the volume of topsoil required to reclaim the processed shale disposal area would exceed that originally stockpiled from these areas, some of the topsoil would have to come from other affected areas where there are greater volumes stockpiled than needed for reclamation. Thus, the initial soils in these areas would be gradually redistributed during the operational phase.

Abandonment

At the conclusion of the project, the Main Elk Dam and Reservoir would remain. All structures on the Parachute Block and Mahaffey Ranch tracts would be removed and stockpiled soil spread over disturbed areas to recreate a soil cover similar to that which originally existed. The goal of the reclamation program would be to recreate a soil cover as productive as the original.

3.3.1.5 Ground water

Impacts on the ground-water system from the Mobil Project are expected to range from imperceptible to a total modification, or elimination locally, of the existing ground-water regime. Major ground-water impacts are expected to result if aquifers are intercepted and dewatered during construction and/or mining. This would result in changes in the recharge-discharge regime. There would also be an increase in the potential for contamination of ground and surface water from accidental spills. Disposal of processed shale and other solid and liquid wastes would also result in a potential for degradation of surface- and ground-water quality. Placement of processed shale in Wheeler, Cabin Water, and Middle Water gulches could result in local rises in ground-water levels as a result of the reduction in evapotranspiration losses. Degradation of water quality may also occur as a result of leachate generation within the processed shale piles.

Construction

Interception of aquifers and changes in the ground-water recharge-discharge regime could occur during construction of project facilities which involve the excavation and removal of talus, alluvium, and bedrock materials. These activities would include construction of access roads, site preparation for the retorting and upgrading facilities, underground utility corridors, the mine bench in Cottonwood Gulch, and the product pipeline and natural gas line corridors in Helm Gulch. Although this could cause changes in the recharge-discharge regime, the magnitudes of such impacts are expected to be small and imperceptible in a regional context.

Other impacts that could occur as a result of project facility construction include the degradation of ground-water quality by infiltration of surface runoff from the construction areas; by accidental fuel and oil spills; and disruption of natural ground-water recharge and discharge by construction of roads, parking areas, and buildings, etc. In general, the significance of such impacts will depend on the area affected, and the magnitude and duration of the spill. It is expected that the ground-water impacts will be small and of no major significance from an environmental perspective.

The local ground-water regime in the vicinity of Main Elk Reservoir and the surface-water diversion on the Colorado River would be affected by the respective construction activities. Both increases and decreases in ground-water levels and flows are anticipated because of dewatering activities to facilitate construction of the Main Elk Reservoir. Degradation of water quality as a result of disturbance and fuel and oil spills would be expected during construction. The magnitude of impacts from spills is expected to be small because of spill prevention and containment plans. After completion of the construction, the ground-water regime in both areas will return to nearly pre-development conditions. Discharge and recharge areas could also be affected by other construction activities (e.g., access roads, parking areas, rock quarries, etc.); however, the area of impact would be small compared to the overall ground-water system in the valley.

Operation

Mining. It is anticipated that dewatering/depressurization of the Mahogany Zone would be required during mining operations. Ground-water impacts from mine dewatering are expected to be minimal since the Mahogany aquifer is essentially isolated or only weakly interconnected with the overlying and underlying aquifers. There is a possibility of interaquifer communication through highly fractured or weathered zones. If interaquifer communication exists, dewatering activities may reduce the flows from springs and seeps in adjacent areas and surface-water features within the overlying areas.

Minimal, if any, ground-water effects are expected on NOSR lands. The ground-water gradient is to the west and northwest away from the NOSR. Because of the distances involved, no dewatering affects should occur within NOSR property.

The incline for the funicular railway, mine slopes, etc., constructed during the mining operations would intersect several aquifers, thereby increasing the potential for interaquifer communication. The magnitude of the potential impacts should be small, however.

Raw shale handling. No major ground-water impacts are anticipated from stockpiling or other shale handling procedures. A potential exists; however, for precipitation to infiltrate the pile.

Retorting and upgrading. No adverse impacts on the ground-water quality are expected from retorting and upgrading procedures. A potential exists, however, for localized degradation of both surface- and ground-water quality as a result of accidental spills and ancillary activities including onsite storage and disposal of liquid and solid wastes.

Waste disposal. Processed shale would be deposited initially in Middle Water and Cabin Water gulches up to an elevation of 8600 feet as illustrated in Figure 3.3-4. The bottom of these gulches would be lined with compacted processed shale, which would act as a barrier to ground-water migration. Natural ground-water discharge to those gulches and discharge from the springs in Cabin Water Gulch would be controlled by a rock drain leading to runoff ditches located down-gradient of the springs and outside the embankment. The processed shale barrier would limit evapotranspiration and both inflow and outflow from the gulch area, which could cause ground-water levels in the adjacent mesa areas to rise, allowing for ground-water discharge into the ditches surrounding the pile. The rock drain in Cabin Water Gulch would accommodate the increased ground-water discharge from the preexisting springs; however, this drain may not intersect new springs and seeps that may develop as a result of the increase in ground-water levels. This, in turn, would result in an increase in the potential for ground-water inflow to the processed shale pile, and an increase in the potential for leachate generation. The potential for leachate generation and design implications have been addressed by In-Situ Inc. (1984).

The second-stage disposal area would be down-gradient from the Cabin Water and Middle Water gulches and filled to the 7400-foot contour elevation as shown in Figure 3.3-5. This area also would be lined with a compacted layer of processed shale. Because of the reduction in evapotranspiration, the ground-water levels in the area of the pile can be expected to rise, as in Cabin Water and Middle Water gulches. The quality of ground water which comes in contact with the disposal piles would be decreased which, in turn, could degrade the quality of both ground and surface waters in areas down-gradient of the disposal site. These aspects are also addressed by In-Situ Inc. (1984). A leachate control system has been provided to minimize the magnitude of any potential impacts.

The generation, storage, and disposal of liquid and solid wastes in conjunction with the project operations could cause degradation of both surface- and ground-water quality as a result of accidental spills, leachate generation, and seepage out of the containment area. The magnitude of the potential impacts will depend on the location and nature of the spill or release, and, given the requirements for a Spill Prevention Countermeasures and Control (SPCC) plan, could range from insignificant to imperceptible.

Support facilities

Water supply and distribution. No major ground-water impacts are expected to occur from the Main Elk Reservoir or from the Colorado River diversion near the Mahaffey Ranch. Minor fluctuations in the water table would occur in the vicinity of the reservoir as a result of changes in water levels and discharge rates from the reservoir. Removal of water from the Colorado River diversion would cause an imperceptible change in the ground-water levels in the alluvial aquifer immediately surrounding the diversion site. The magnitude of this change would be masked by natural fluctuations in river levels. No other impacts on the ground-water regime are expected to occur along the water supply corridor.

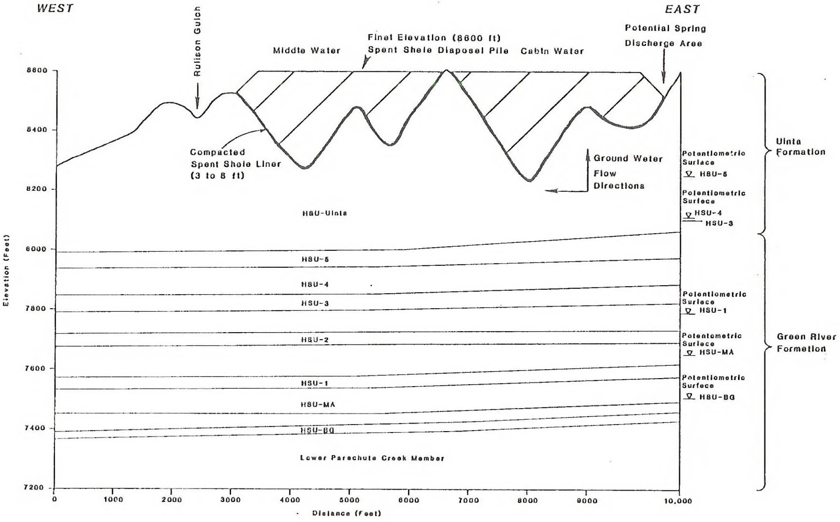


Figure 3.3-4. Schematic hydrogeological cross section of the upper Wheeler Gulch retorted shale disposal area

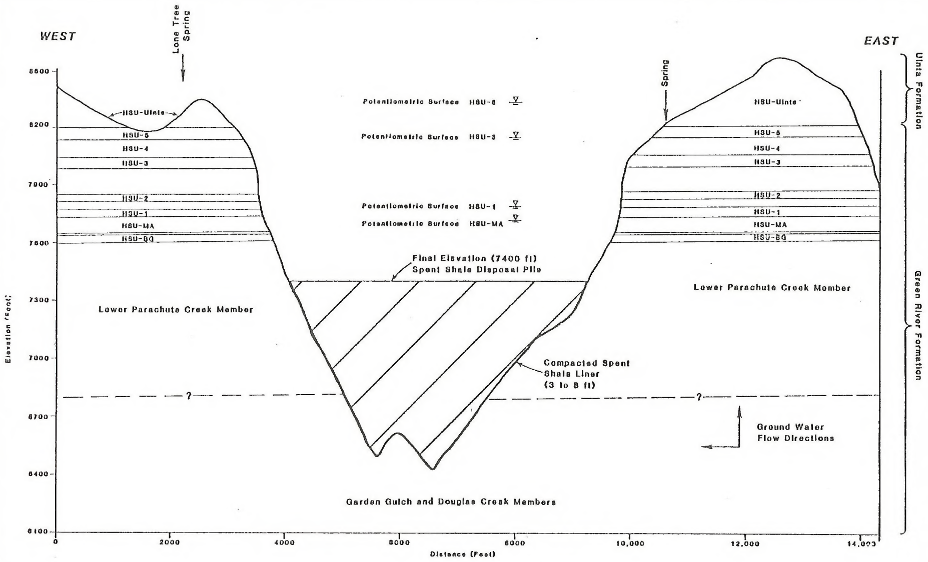


Figure 3.3-5. Schematic hydrogeological cross section of the lower Wheeler Gulch retorted shale disposal area

Utilities. Ground-water impacts from utility support operations would result only if leaks or spills of hazardous or nonhazardous materials such as fuels, oils, solvents, etc., occur. Spilled contaminants could migrate into the ground-water system causing degradation of ground-water quality. The potential impacts because of spills would be minimized and mitigated through use of SPCC plans, and compliance with applicable regulations.

Product pipeline. Leakage from product pipelines could cause degradation of ground-water quality along the pipeline corridor. The resulting impact on the ground-water regime would be minor if the leakage is short term; however, if the leakage is long term, the resulting impact to the ground-water regime could be large.

Access roads, etc. Access roads and parking areas would locally interfere with natural recharge and discharge. These impacts would occur where access roads, for instance, traverse areas of ground-water discharge or where parking areas, because of the impervious nature of their surface, reduced either natural ground-water recharge or discharge. The magnitude of these impacts, however, is expected to be small. Additional ground-water impacts would occur if fuels, oils, and other materials were spilled within these areas.

Abandonment

The main potential ground-water impact that may occur during abandonment procedures would be continued degradation of the ground-water quality. Surface runoff from any contaminated area may infiltrate into the ground and affect the ground-water quality. Closure of the mine itself should not impact the ground-water system. However, potential subsidence within the mine workings and in the overlying strata may establish intercommunication between the surface and the mine workings. This may impact surface springs and seeps in the areas overlying the mine workings. The mine waters may be poorer in quality than the original aquifer waters because of increased dissolution of soluble minerals exposed in the mine. Closure of the mine may eventually result in new springs and seeps in the area along the Mahogany Zone outcrop and near the mine portal and ventilation shafts.

3.3.1.6 Surface water

Overall, impacts on surface-water quantity would be minimal. Duly appropriated water rights would supply water for the project by storing Main Elk Creek water during the high runoff season. Steady releases to serve project needs would cause beneficial impacts on both quantity and quality of downstream surface waters during low-flow periods.

Generally, existing water quality conditions would not be impacted by the project. However, product and by-product storage, waste handling and disposal facilities, and especially processed shale disposal, could have long-term adverse effects on surface-water quality if proper impact mitigation techniques are not implemented.

Construction

The processed shale and waste disposal operation would occupy an area of about 1620 acres. The hydrology of a small portion of this area would be disturbed during the construction phase, but the major impacts to surface water in this area would occur during the operations phase of the project; thus, they are discussed under that heading.

Approximately 1919 acres would be disturbed during the construction phase of the project. About 1379 acres of this area are situated in the Parachute Creek Basin, which represents about 1 percent of the watershed. The remaining 540 acres would be in the Elk Creek Basin which is about 0.5 percent of that watershed. For a temporary period of about 2 years, the erosion potential of these disturbed areas is expected to be 3 to 4 times higher than at present. However, the net increase in the sediment loads of Parachute and Elk creeks would be less than 3 and 1.5 percent, respectively. The Cottonwood, Allenwater, Hayes, Wheeler, Cabin Water, and Middle Water gulches, where most of the disturbance would occur, are low-flow, intermittent, and spring-fed streams. Therefore, temporary increases in their sediment loads would be experienced only when there is runoff because of intense storms or snowmelt during the period of construction. The resulting impact on the sediment load of the Colorado River would be insignificant. Construction of the 8-foot-high overflow weir, intake, and associated structures would temporarily increase the maximum sediment load of the Colorado River by less than 0.5 percent. The construction of the water treatment facilities and water supply line would temporarily increase the sediment load in Cottonwood Gulch. However, the total disturbed area would be only about 50 acres. So, the increase in the sediment load of this gulch would have insignificant impact on the Colorado River.

The hydrologic regimes of the above-mentioned gulches would be altered by diverting them through man-made channels. The drainage course of the Main Elk Creek would be altered by constructing a diversion tunnel and coffer dam, and that of the Colorado River would be altered by constructing coffer dams. Water withdrawal during construction would be about 300 acre-feet per year (0.4 cubic feet per second) which would have negligible impact on the Colorado River.

Salinity (TDS) increases because of disturbed area runoff would be most important where stream channels are disturbed (road and pipe crossings, and dams), although sheet flows from all disturbed areas would contribute to a general TDS increase during construction. Areas requiring disturbance only during construction, such as utility corridors and construction staging areas, would contribute higher TDS loads than similar undisturbed terrain, even after revegetation, and may require a long time to return to pre-disturbance conditions in terms of salinity contribution to runoff. The canyon areas below the Roan Cliffs can be expected to contribute more heavily to TDS increases than the Roan Plateau areas of disturbance, since the weathered Wasatch Formation materials in the canyons are higher in soluble minerals (Section 3.2.6).

Operation

The total disturbed area of about 6 square miles is less than 0.1 percent of the drainage area of the Colorado River, and the area disturbed in the Parachute Creek Basin is less than 3 percent of its drainage area. With the proposed runoff collection, diversion, and zero discharge plan for the Cabin Water Creek, Middle Water Creek, and Wheeler Gulch watersheds, the impacts of project operation on the sediment loads of Parachute Creek and the Colorado River are estimated to be insignificant. The sediment load of Elk Creek is estimated to be reduced by 40 percent because of sediment trapped on the Main Elk Creek Dam.

The courses of the Cabin Water, Middle Water, and Upper and Middle Wheeler drainages would be permanently altered. The hydrologic regime of Main Elk Creek would be altered by the storage dam and controlled releases. The peak flows of Elk Creek would be reduced by about 40 percent and the low flows would be increased up to about 70 cubic feet per second, which is the anticipated downstream release requirements from the proposed reservoir, in addition to the natural flows of the East and West Elk Creeks. With the construction of retention dams on Cabin Water, Middle Water, and Wheeler gulches, the streamflows of Parachute Creek would be reduced by about 4 percent. The overflow weir on the Colorado River would create a backwater that would be situated within the natural high-water channel of the Colorado River and is not expected to extend beyond a distance of 0.6 mile from the weir. During normal conditions, sediment concentrations downstream of the weir would be lower than those at present. However, small slugs of sediment would be released downstream through the sluiceway in front of the intake. Because of the construction of the Main Elk Creek Reservoir and other onsite retention dams, the peak flows of the Colorado River would be reduced by about 1 percent. The proposed withdrawal from the Colorado River would be less than 5 percent of the minimum recorded low flow at Glenwood Springs. Users of junior water rights may not have water available which is currently being used.

<u>Potential impacts of a dam failure</u>

The onsite retention dams and the Main Elk Reservoir dam would be designed with appropriate factors of safety. Therefore, the probability of a partial or complete failure of these dams is extremely low. In the unlikely event of the failure of an onsite retention dam, the streamflows of Parachute Creek may be temporarily increased for a day or so. A breach in the Main Elk Creek Dam might release up to 4000 cubic feet per second per foot of breach and cause flooding conditions in the area downstream of the dam.

The results of three alternative approximate methods of dam-break analysis indicate that the maximum water surface elevation at New Castle resulting from an accidental breach of the Main Elk Creek Dam would be in the range of 5582 to 5613 ft. Thus, the expected flood elevation would be about 5600 ft. The contour interval of the topographic map used for these analyses is 40 ft and the methods of analyses are based on a number of simplifying assumptions. Therefore, the accuracy of the results is judged to be approximately ±20 ft.

The inhabited portion of the town of New Castle extends approximately from elevation 5560 to elevation 5640. Therefore, a sudden and complete breach of the Main Elk Creek Dam could likely result in substantial damage to the town of New Castle.

Assuming a breach width of 50 ft, which would be nearly equal to the channel width at the dam site, the attenuated peak discharge and water surface elevation at New Castle are estimated to be 192,000 cfs and 5560 ft, respectively. This would not result in any significant damage to the town of New Castle.

Salinity

The major impacts of project operation on salinity would be two-fold:

1. Depletions in Colorado River flow and reduced salt loading because of diversions for supply; and

2. Reductions in flow and salt loading because of retention of contaminated area runoff.

Analysis of the changes in TDS at Imperial Dam as a result of the project flow depletions and salt load decreases yields a net increase of TDS at Imperial Dam of 0.932 mg/l, mainly because of the Colorado River diversions of 22.6 cubic feet per second at Mahaffey Ranch. This salinity increase has been calculated using the model equation provided by the U.S. Department of the Interior (1983). This increase would be 0.17 percent of the salinity standard for Imperial Dam (CRBSCF, 1981).

Waste handling and disposal

Nonhazardous, municipal-type solid wastes and raw-water sludge not disposed with the processed shale are planned to be disposed in the onsite sanitary landfill in the headwaters of the Forked Gulch. The proposed landfill site includes the ephemeral stream channel and steeply sloping areas of a headwaters stream valley. Landfilling in the stream channel would heighten the possibility of migration of landfill leachates downstream through the relatively high permeability alluvium-colluvium of the stream channel area. However, the relatively small quantity of wastes to be landfilled (5500 TPY), the small scale of the disposal site (10 acres) and the use of acceptable waste containment, runoff diversion facilities, and operations procedures, should preclude the possibility of major water-quality impacts because of leachate seepage. The potential for leachate generation and design implications have been addressed by In Situ Inc. (1984).

During the operational period of the processed shale embankment, continuous surface-water quality impacts associated with leachate migration could occur by the mechanism described in Section 3.3.1.5 (see Operation, Waste Disposal). Water-quality impacts associated with an extreme, high-intensity precipitation or snowmelt runoff event in the Wheeler Gulch area could feasibly occur in the Wheeler Gulch area. This could involve breaching of the watershed runoff control system, erosion of the toes and lateral edges of the processed shale embankments, and discharge of processed shale solids to the natural drainage below the retention dams. The water-quality impacts of contaminants leaching out of processed shale in such an excessive runoff event are difficult to quantify. In a single massive runoff pulse, the concentrations of contaminants could be expected to be relatively low because of dilution.

Main Elk Creek water quality

As described above, Main Elk Creek Reservoir would modify the flow of Main Elk Creek below the reservoir outlet. Discharges of this relatively high quality water would have beneficial impacts on the quality of Elk Creek and the Colorado River during the low-flow winter months and periods of flow depletion during the irrigation season. High TDS concentrations would be reduced significantly and stream temperature would be moderated in Main Elk Creek.

Spill risks

Operation of the project facilities would require handling of fluids and solids which would cause surface- and ground-water quality impacts if spills or other uncontrolled releases occurred. Materials which pose this risk would include raw and upgraded shale oil, vehicle lubricating oil and transmission fluid, gasoline and diesel fuels, ammonium nitrate blasting material, and ammonia and sulfur by-products. Risks of spills or other uncontrolled releases would occur whenever and wherever these materials are stored, transported by truck or pipeline, or transferred from one storage or transport facility to another.

Risks of surface-water quality degradation would exist in situations where materials are transported to or away from the project facilities. Surface-water quality impacts associated with spills because of truck accidents would be most severe over a short term on aquatic habitat and water users downstream of the spill site.

Another spill risk would exist for the shale oil pipeline, which transports upgraded shale oil to the LaSal pipeline terminal at Davis Point. Ruptures of this pipeline could occur because of pipeline corrosion, damage by a vehicle or excavator, natural causes such as a landslide, or a malfunction of the pumping or valving in the pipeline. Despite sophisticated remote sensing and inspection of pipeline conditions, a spill of oil could enter surface waters adjacent to the pipeline, depending on the rupture site, causing significant short-term surface-water impacts. Statistics from 1970 indicate that in the U.S. an average of 2.8 barrels of oil are spilled annually per mile of oil pipeline (BLM, undated). This translates to an average annual loss of 28 barrels of oil along the 10-mile route to the LaSal pipeline terminal.

A third type of uncontrolled release would involve small storage tank leaks which go undetected for a long period of time. Nearly all the fuels, by-products, and oils discussed above would be stored in project area tankage at some point in handling and use. However, there are effective and routine design and operation alternatives to minimize and detect leaks quickly. Thus, with proper controls and clean-up procedures, long-term impacts on surface waters down-gradient of the storage areas should not be significant.

Abandonment

During reclamation, the disturbed areas would be recontoured and revegetated. Inasmuch as major portions of the Cabin Water, Middle Water, and Upper and Middle Wheeler gulches would have been partially filled up with wastes and sediment, the overall relief, slopes, and erosion potential of these areas would be reduced. Consequently, the sediment load of Parachute Creek would be reduced, since the slopes of these watersheds would be reduced, resulting in somewhat lower flood peaks. The impacts on the peak flows of Parachute Creek and the Colorado River would be insignificant. The flood flows of Elk Creek would be attenuated throughout the life of the Main Elk Creek Reservoir.

The hydrologic regimes of Cabin Water Creek, Middle Water Creek, Wheeler Gulch, and Main Elk Creek would have been altered, but this would only provide negligible impacts on Hayes Gulch, Cottonwood Gulch, Parachute Creek, and Elk Creek. Long-term impacts associated with shale embankment faces are discussed below.

As no retention dam would be left in place, there would be no chance of flooding because of breaches in such structures. Any breach in the Main Elk Creek Dam, a very unlikely event, could create flooding conditions in the area. Since water use for the Parachute Shale Oil Project would cease, the appropriated water stored in the Main Elk Creek Reservoir would be available for other beneficial uses.

The minor impact on salinity during abandonment would be associated with the lagging return of reclaimed disturbed areas to their pre-disturbance condition. Runoff which had been retained would flow across disturbed areas, picking up slightly higher TDS levels than under natural, undisturbed conditions, and enter surface waters.

The average annual runoff contribution after abandonment from previously retained areas would be only about 0.97 percent of the baseline annual discharge of Parachute Creek near Parachute; moreover, salt loading from these areas only constitutes about 1.44 percent of Parachute Creek salt loading near Parachute. Thus, slight TDS increases in the runoff would have no noticeable effect on Parachute Creek or the Colorado River.

Processed shale disposal - After abandonment, water-quality impacts associated with the processed shale embankments would be caused by slow-rate erosional and geologic processes. The most direct effect would be erosion of the 30-inch cover of topsoil, exposing the processed shale to contact with surface runoff, dissolution of minerals, and erosion and sediment transport into downstream surface water. This effect would be most pronounced on the benched, 16-degree (3.5 horizontal:1 vertical) faces of the embankments. Despite the placement of 25-foot-wide benches in the embankment faces, a relatively high rate of erosion would still occur on the roughly 182-foot-long slopes, especially after periods of drought when vegetation is most sparse. Another long-term problem may be earth movements and general deterioration of the Cabin Water springs rock drain under the upper Wheeler Gulch embankment, causing contact of spring water with processed shale. The severity of these slow-rate effects cannot be readily determined.

3.3.1.7 Aquatic ecology

Aquatic ecosystems in the area of the Parachute Shale Oil Project would potentially be impacted by the construction, operation, and abandonment phases of the proposed major project facilities and support facilities.

Construction

Major project facilities. Potential impacts associated with the construction of the main plant systems would include increased total suspended solids (TSS) in receiving streams and increased harvest of the fishery resource.

During construction of the major project facilities (process facilities, upgrading facilities, staging areas, and material handling areas), a total of approximately 860 acres of local soils would be disturbed (see Table 3.3-5); accelerated soil erosion on these areas would increase sediment loading of local streams. The increased sediment loading in receiving streams is projected to be less than 1 percent (Section 3.3.1.6). This projected increase in TSP would not have an impact on the aquatic resources.

The construction work force for the Parachute Shale Oil Project would peak at 3900 workers in the 7th year (Section 3.3.1.14). The associated population growth of the area is predicted to create an additional 66,820 fishing trips annually during the peak construction year (Section 3.3.1.13). The goal of the Colorado Division of Wildlife (CDW) is to provide a harvest of 2.3 fish per fishing trip (Sealing, 1983). The fishery resource of the region is presently being harvested at or above its production capacity (Sealing, 1983). Therefore, under present conditions, the fishery is not capable of supplying the 153,700 fish that would be required to meet the CDW goal. Because of a 42.5 percent mortality of stocked fish, about 267,280 trout would need to be stocked annually in the region to prevent the fishery resource from being overharvested. Another concern is the Colorado River cutthroat trout (*Salmo clarki pleurificus*), residing in such streams as Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch. This species can be easily overharvested (Binns, 1977); thus, overharvest impacts could be expected.

Support facilities. Potential impacts of support facility construction include increased TSS levels in receiving streams and destruction of aquatic habitat. Approximately 2660 acres would be disturbed during the construction of the support facilities (see Table 3.3-5); accelerated erosion of disturbed soils is projected to increase TSP levels in receiving streams by less than 1 percent (Section 3.3.1.6). This increase would not affect the aquatic resources.

Cofferdams would be constructed in the Colorado River to allow "dry" construction of the concrete overflow weir and intake structure. The concrete overflow weir would extend 4 feet below and 8 feet above the streambed across the entire river. The intake structure would impact approximately 150 feet of shoreline. Disturbance of the river substrate and associated benthic inhabitants, resulting from cofferdam installation would be temporary with rapid recolonization of benthic inhabitants following cofferdam removal. The area occupied by the concrete overflow weir and intake structure would be impacted for the duration of the project. Presently, the river channel near the intake structure site provides only fair habitat for aquatic organisms. In relation to the total habitat in this reach of the Colorado River, these disturbances should not have a detectable impact on the aquatic ecosystem of the Colorado River.

Construction of the dam for Main Elk Reservoir would destroy approximately 1500 feet of stream habitat within Main Elk Creek, which is classified as a major fishing stream containing a high-value fishery resource (USF&WS, 1979). Construction impacts would be associated with the area occupied by the dam and associated disturbance areas and occur prior to inundation of stream habitat by the operation of the dam. At the dam site, the stream contains good brown trout (*Salmo trutta*) habitat. The dam would permanently eliminate the stream habitat, an irreversible impact.

Operation

Major project facilities. Potential effects of the operational phase which were studied include reduction of aquatic habitat, increased harvest of the resource, and acidification of regional lakes.

Both water supply alternatives would annually divert approximately 16,400 acre-feet of water from the Colorado River system for project use. Based on the Colorado River flows for the period of record (1962-1981), the proposed average daily depletion of the river at the town of Parachute would be as indicated in Table 3.3-6. With these flow reductions, there would be a reduction in downstream aquatic habitat. Through the reduction in aquatic habitat and possible induced changes in temperature, the Mobil Project is one of a number of projects that may affect the Federally listed endangered Colorado squawfish (Ptchocheilus lucius) and humpback chub (Gila cypha), and the razorback sucker (Xyrauchen texanus) which is a candidate for Federal listing and a state-listed species (USF&WS, 1982; Bio/West, Inc., 1983). However, releases from Main Elk Reservoir would augment normal flows in the Colorado River during low-flow periods. Therefore, important habitat for threatened and endangered species should not be adversely impacted during low flow periods (Bio/West, Inc., 1983). A more detailed discussion of potential effects on endangered fishes is contained in Bio/West, Inc. (1983).

Under worst-case conditions, annual acid deposition is projected to be between 0.25 and 1.21 pounds per acre of sulfur (Section 3.3.1.1). At this deposition rate, even the most sensitive aquatic ecosystems would not be adversely impacted (Environment Reporter, 1983).

Table 3.3-6. Proposed average daily depletion (cfs) for the Mobil Project on the Colorado River at Parachute, Colorado based on the period of record 1962-1981

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1962	1	36	55	30	62	44	42	30	27	31	24	1
1963	1	19	51	45	44	37	1	58	24	1	1	1
1964	1	8	16	1	1	1	1	229	77	24	1	1
1965	1	22	49	56	56	43	1	57	27	31	24	24
1966	1	39	53	27	27	27	1	57	28	1	1	1
1967	1	10	35	33	24	50	1	151	27	31	1	1
1968	1	1	34	48	53	43	1	95	28	31	24	1
1969	1	64	51	27	27	27	29	30	27	31	1	1
1970	1	65	75	27	27	27	1	56	28	31	1	24
1971	1	24	33	38	24	24	54	55	28	31	24	24
1972	1	41	51	27	27	27	24	35	29	31	1	24
1973	1	24	26	34	48	55	1	66	28	31	24	1
1974	1	24	25	43	46	28	24	64	28	24	1	1
1975	1	1	35	35	32	26	1	150	27	31	24	1
1976	1	32	53	33	34	44	24	35	28	24	24	1
1977	1	23	65	60	27	27	1	1	24	1	1	1
1978	1	31	53	44	45	37	1	156	27	31	1	1
1979	1	17	15	10	47	39	1	149	27	31	1	1
1980	1	36	44	30	62	44	33	30	27	31	24	1
1981	1	19	51	45	44	37	1	58	24	1	1	1

Source: Bio/West, Inc., 1983.

The operational work force of the Mobil Project would peak in the 16th year at 3410 workers (Section 3.3.1.14). The resulting population growth of the region would create an additional 87,910 fishing trips annually (Section 3.3.1.13). If stocking is to be used to prevent the fishery resource from being overharvested, an additional 351,600 trout would need to be stocked annually in the region. Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch, which contain Colorado River cutthroat trout, could be expected to be overexploited.

Operation of other major project facilities should not impact the aquatic resources of the area.

Support facilities. Operation of the support facilities could impact aquatic resources by entrainment and impingement of aquatic organisms, blockage of fish migration, inundation of stream habitat, or accidental spills.

The proposed water intake structure on the Colorado River would be designed according to best available control technology (BACT), and would have traveling screens and intake velocities less than 0.5 foot per second. The maximum withdrawal rate would be approximately 40 cfs, and would average 23 cfs. The maximum withdrawal rate represents 1.5 and 4.5 percent of the average and minimum flows, respectively, of the Colorado River at DeBeque (USGS, 1982). No Federally listed threatened or endangered fish species (USF&WS, 1982) are known to occur in this reach of the Colorado River. In 1982, razorback suckers (*Xyraucher texanus*), a state-listed species under review for Federal listing (USF&WS, 1982), were collected by USF&WS in this reach of the river (Valdez et al., 1982). What was possibly a larval razorback sucker was collected at Parachute in 1983 (Union Oil Company, 1983). Young razorback suckers could be entrained by the intake, but it is doubtful that significant numbers would be affected. Mountain whitefish (*Prosopium williamsoni*), brown trout, and rainbow trout (*Salmo gairdneri*), the only game fish that occur in this reach of the river (Mobil, 1983), are not expected to spawn in the vicinity of the intake. Therefore, suckers and minnows are the predominant species that could be impacted by entrainment and impingement.

Highest entrainment rates could be expected in July and August when larval fish densities would be highest. In comparison, impingement rates are normally highest in late fall and winter when young-of-the-year (YOY) fish are moving from rearing to wintering areas. Based on flows during the period of peak larval drift in recent years, water withdrawal during the peak entrainment period would normally not exceed 1.5 percent, and under worst-case conditions, would not exceed 2.5 percent of the flow of the river.

Studies on other rivers have shown that larval fish densities can be two to four times higher along the shoreline than in mid-channel (Merriman and Thorpe, 1976; Hergenrader, et al., 1982). If a similar distributional pattern exists in the Colorado River, then 3 to 10 percent of the larvae in the drift may encounter the intake.

Fish that are too large to be entrained would be subject to impingement by the intake structure. With intake velocities of less than 0.5 foot per second, most YOY and larger fish would be able to avoid the intake, but may inadvertently enter it. Because the intake is designed according to BACT, it would have at least 3/8-inch screens that would prevent most fish from being impinged. Based on the expected entrainment and impingement rates and species likely to be impacted, the aquatic biota of the Colorado River should not be altered.

The diversion dam across the Colorado River would create a barrier to upstream fish movement. This would not be a major impact unless it prevents substantial numbers of adult fish from reaching their required spawning habitat. Based on available information, the blockage of fish should not affect the overall spawning success of any species.

The filling of Main Elk Reservoir would inundate 2.2 miles of Main Elk Creek, a major fishing stream containing a high-value fishery resource. In the area that would be inundated, Main Elk Creek provides good habitat for brown, rainbow, and brook trout (Salvelinus fontinalis) (Mobil, 1982a). The reservoir would permanently replace the stream fishery and cause an irreversible impact on the stream fishery. The reservoir would experience large annual fluctuations in water level. Regardless, a fishery would develop in the reservoir and could be expected to be of fair quality.

Accidental spills could occur during the transport of chemicals by truck, rail, or pipeline; transported chemicals are discussed in Section 3.3.1.6. The severity of an impact would depend on the quantity entering a waterbody, toxicity of the chemical, and the dilution rate within the waterbody. In the unlikely event of a major spill, impacts on aquatic organisms could be severe.

Abandonment

Impacts to aquatic resources would be minimal with an orderly abandonment of the project. Cessation of air emissions and water withdrawals would reduce potential impacts from the construction and operation phases of the project on aquatic ecosystems.

3.3.1.8 Vegetation

Construction, operation, and abandonment of the Mobil Project could result in elimination of 3539 acres of existing vegetation and loss of individual plants of some special-status species. The Mobil Project may affect Barneby's columbine (Aquilegia barnebyi), the dragon milkvetch (Astragalus lutosus), and the Utah fescue (Festuca dasyclada) during construction, operation, and abandonment phases. No effect on the Uinta Basin hookless cactus (Sclerocactus glaucus), the Grand Junction milkvetch (Astragalus linifolius), or the DeBeque phacelia (Phacelia submutica) is anticipated by project activities. Effects on endangered plant species are discussed in more detail in Bio/West, Inc. (1983). These impacts would be only moderately important from a local and regional perspective. The loss of the important riparian plant community type would be the most serious impact to vegetation from the project. Adverse effects on sensitive species resulting from air pollution impacts are expected to be minimal.

Construction

Loss of existing vegetation. The most widespread impacts on vegetation would occur during the construction phase of the project. During this period extensive land areas would be cleared, roads built, and pipelines and powerlines constructed. Most of the construction activity would occur on the Roan Plateau and Mahaffey Ranch and would impact the vegetation types characteristic of the valley bottoms, side slopes, and upland areas.

During construction, approximately 1453 acres of limited-importance plant communities would be disturbed. This acreage represents 83 percent of the total construction disturbance. The limited-importance communities include those which are abundant on the project site, are of limited importance to wildlife, have limited productivity, are relatively easy to reclaim, and are widespread and abundant on a regional basis. On the Mobil properties, these communities include: mixed brush, sagebrush grassland, pinyon-juniper woodland, grassland, mixed brush/rocky slopes, saltbush grassland, bottomland/greasewood-sagebrush, pinyon-juniper/mixed brush, sagebrush, saltbush, disturbed lands, and agricultural pasture.

Construction would disturb approximately 252 acres of important plant communities (14 percent of the disturbed area). Important plant communities include those which are important to wildlife, have high levels of productivity, are of limited regional extent, or are difficult to reclaim. These communities include the following types: aspen, conifer forest, moist meadow, riparian, and hardwoods.

The loss of the limited-importance plant communities would be moderately important when viewed on a local and regional basis. The types which would experience the greatest percentage loss on the site are the agricultural pasture, moist meadow, riparian, hardwoods, and saltbush grassland types.

The moist meadow, riparian, and hardwoods types are important to wildlife and are restricted in distribution within the region. The greatest impact associated with the important plant communities would be the loss of 60 percent of the riparian habitat within the project site. This type provides important wildlife habitat and is also one of the most productive types within the area. The impact would be greatest along Main Elk Creek where the proposed reservoir would inundate approximately 88 acres of cottonwood forest.

Impacts on special status species. During the construction phase, impacts on special status species would be limited. The only population of Barneby's columbine found on the site would be destroyed during the construction phase of the project. Barneby's columbine is widespread throughout the southern portion of the Piceance Basin and the loss of one population would not be an important impact. It is possible that with careful construction the existing population may be avoided. During construction approximately 37 acres of potential habitat for special status species would be disturbed.

Air pollution impacts. Impacts on vegetation resulting from air pollution during the construction phase are expected to be negligible. The primary pollutant would be fugitive dust, which would not likely be harmful to the vegetation bordering areas of construction.

Operation

Loss of existing vegetation. The largest disturbance associated with operation of the facility would be the disposal of processed shale. Over the life of the project, the total disposal site disturbance would be 1610 acres. Of this total, 1242 acres (77 percent) would be in limited-importance plant communities, and 183 acres (11 percent) in important plant communities. Of the important plant communities, the loss of the riparian type would be the most important since it is limited on both a local and regional basis.

Impacts on special-status species. During the operation phase, approximately 184 acres of potential habitat for special-status species would be destroyed. During both construction and operation only 6 percent of the available habitat for special-status species would be adversely impacted by the project.

Air pollution impacts. During operation, a variety of air pollutants would be produced from the retorting and upgrading processes. Emissions from these sources would be controlled in order to meet established air quality standards. As long as these standards are met, there would not likely be significant impacts on the vegetation resulting from sulfur dioxide, nitrogen oxides, or particulates.

Abandonment

The greatest impacts from abandonment would be the changes in vegetation associated with the reclaimed processed shale disposal areas. The reclaimed areas would support different vegetation types than those which currently characterize the disposal areas.

3.3.1.9 Wildlife

The major impacts on wildlife resulting from development and operation of the Mobil Project would be caused by 1) loss of wildlife habitat, and 2) disturbances related to increased human activities in the region. Populations of mule deer, elk, and mountain lion would likely be reduced. Golden eagles would likely be displaced from existing nest sites near mining operations. Populations of other wildlife, both nongame and game species, would be diminished mainly by reduction in acreage of important habitats, particularly agricultural meadows, pinyon-juniper, and mountain shrub habitats in lower valley areas, riparian habitats in both lower valleys and on the plateau, and moist meadows and aspen woodlands on the plateau. The Mobil Project may affect the endangered bald eagle (*Haliaeetus leucocephalus*) but would have no effect on the endangered peregrine falcon (*Falco peregrinus*) or black-footed ferret (*Mustela nigripes*) (Bio/West, Inc., 1983).

Because the Mobil Project would encompass a wide area, site-specific impacts to wildlife are discussed under four headings; impacts related to 1) plant site location (the synfuels plant, mine portal, shale preparation facilities, mine bench, etc.); 2) processed shale and other waste disposal locations; 3) linear disturbances such as roads, pipelines, powerlines, and other corridors; and 4) water supply and conveyance.

Construction

For each of the aggregates of the proposed action's components (plant site location, processed shale and other waste disposal locations, linear disturbances, and water supply and conveyance) construction impacts would largely be the forerunners of the operational impacts discussed below. However, certain impacts would be unique to the construction phase. These would be related to the timing, intensity, and control of construction activities. The more rapid the initiation of construction, the greater the impacts to wildlife. If construction activities coincide with critical periods for wildlife (e.g., late winter for big game or spring for raptors), then impacts could be substantial. High levels of traffic and human activity during construction could cause greater impacts (e.g., road kills, wildlife displacement) during construction than during operation.

Operation

Plant site location. The proposed location for upgrading facilities is the Roan Plateau where impacts to wildlife would be substantial. Habitats of particular importance on the proposed plateau site are aspen, moist meadow, conifer forest, and mountain shrub. Approximately 276 acres of aspen would be lost. Aspen habitat is important fawning habitat for deer, brood habitat for blue grouse, and nesting habitat for raptors. Also, because of generally moist conditions and dense herbaceous understory, nongame bird diversity tends to be high. Approximately 3 acres of moist meadow would be lost. Moist meadow habitat is limited in extent but supports comparatively large numbers of important small mammal prey species. Approximately 26 acres of conifer forest would be lost. Conifer forest (spruce, fir, Douglas-fir) tends to occur as small, isolated stands near the proposed plant site location, which results in interspersion or edge that is important to wildlife, particularly to mule deer, elk, and black bear. Also, some of the least common wildlife species occur here. Approximately 549 acres of mountain shrub habitat would be lost. Mountain shrub, notably serviceberry, chokecherry, and bitterbrush, is an important fall and winter dietary component to deer.

Processed shale and other waste disposal locations. The proposed location for processed shale disposal is in upper as well as lower Wheeler Gulch. Wildlife habitat in Wheeler Gulch would be impacted severely. Deer winter range would be lost. The exact acreage cannot be calculated because the disturbances to deer would extend beyond boundaries of physically disturbed areas. Activities near headwall cliffs would appreciably reduce the potential of the cliff habitat to support nesting raptors. Chukar brood habitat on the valley floor of Wheeler Gulch, especially the mixed riparian habitat at the extreme upper end of the gulch, would probably be totally lost, although much of the fall and winter chukar habitat on the adjacent side slopes would remain.

The disposal of nonhazardous solid waste in a sanitary landfill plus on the processed shale pile is proposed. Offsite disposal of hazardous wastes is also proposed. Disposal in the processed shale pile would cause no additional impacts. The degree of impact from the sanitary landfill would depend on the type and area of habitat disturbed. Offsite disposal cannot be evaluated without knowledge of the offsite location.

Linear disturbances (roads, pipelines, powerlines, other corridors). In general, the more corridor routes there are, the greater the impacts to wildlife. Placing roads, pipelines, and powerlines along the same corridor would result in less habitat lost and restrict the total area over which behavioral disturbances to wildlife would occur. The proposed access road and utility corridor to the plateau site is up Cottonwood Gulch. The proposed Mahaffey Ranch route for the contractor's road is in important deer winter range, and the alignment would cut across deer migrational routes. Shale transportation would be important to wildlife only if the alignment crossed major big game movement routes; no such big game routes are known in this area. In any case, the proposed conveyors would likely have less impact on wildlife than trucks. The impact of the proposed product shipment tie into the LaSal Pipeline would reflect the extent of habitat disturbance it causes. The proposed product feeder pipeline through Helm Gulch would result in additional wildlife habitat disturbance because it would be a new route. The electric powerline alternative proposed for Hayes Gulch represents a corridor alignment completely separate from any other. As such, it expands the area of habitat disturbance appreciably. The funicular railway personnel transportation alternative would minimize the deer road kill hazard by minimizing vehicular transportation in Cottonwood Gulch.

Water supply and conveyance. The proposed source of water is Main Elk Reservoir. Construction of this reservoir would represent a major impact to wildlife populations, both to nongame and game species alike. Approximately 88 acres of quality riparian habitat would be lost. As well, 126 acres of the adjacent pinyon-juniper and mountain shrub habitats, both excellent deer and elk winter range, would be lost. The CDW has classified the entire area as critical winter range for elk. The project may affect the bald eagle in the Main Elk Creek area, but more studies are needed to establish this. The reservoir could result in some beneficial impacts on bald eagles (Bio/West, Inc., 1983). The proposed use of natural streamflow for water conveyance would minimize habitat loss and could improve conditions for winter foraging by eagles in Elk Creek below the dam and along the Colorado River between New Castle and Parachute.

Abandonment

The impacts of the abandonment phase of the Mobil Project would all be improvements over the impacts of the operations phase. The degree of improvement would depend on the success of reclamation.

3.3.1.10 Cultural resources

Even though a total of 38 cultural resource sites have been recorded in the project areas, when considered on a regional level this is a low site density. Thus, the impacts of the Mobil Project should be minimal to cultural resources.

The proposed construction and operation activities for the access road, mine portal location, and processed shale disposal areas, would directly alter, damage, or destroy 13 known cultural resources in Wheeler and Cottonwood gulches, including five considered to be potentially eligible for the National Register of Historic Places (5GF894, 899, 906, 907, 910). Damage or destruction of these resources could result in loss of scientific and cultural information and artifacts, and loss of physical expression of the cultural resources.

In addition to direct impacts, significant indirect adverse impacts could occur as a result of the construction and maintenance of the proposed project. These indirect effects would include: increased exposure of cultural resource sites as a result of construction and maintenance activities, such as additional access routes throughout the project area; increased uncontrolled collection of cultural resources (for example, artifacts) by nonprofessional hobbyists, as recreational activity.

3.3.1.11 Visual resources

A streamlined version of the BLM Contrast Rating process was used as the basis to evaluate visual resource impacts. Very simply, this process identifies the degree of modification that would take place to the existing site, considering the form, line, color, and texture conditions of the landform, vegetation, and structures, as seen from sensitive viewpoints.

In order to ensure consistency in rating the large number of viewer-project interactions, and to document the process in clear steps, the contrast rating procedure used for the Mobil Project was organized into three distinct efforts:

- Evaluation of landscape conditions - to understand the physical makeup of various landscape types in order to predict the physical effect that project facilities would have on them;

- Evaluation of visual conditions - to understand the conditions of the viewers/viewpoints in order to determine the nature and degree to which the physical modifications would be seen as visual contrast; and

- Determination of impacts - by comparison of the level of predicted visual contrast with the visual resource management guidelines for that area (as determined through the inventory process). Visual resource contrasts that exceed VRM Class guidelines are defined as "significant impacts" by the BLM.

Components of the proposed action that have been addressed in other environmental assessments, which are existing or approved, or which were determined not to be visible from any sensitive viewpoint, were not assessed further.

Construction

The Roan Cliffs are the most visually dominant landscape type within the study area. They are extremely steep (slopes average 75 percent) and prominent (2700-foot vertical rise). As such, they are sensitive to disturbance, once disturbed, would be slow to recover, and are highly visible from a number of adjacent viewpoints including: Interstate 70; the towns of Parachute, Morrisania, and Battlement Mesa; Parachute Creek Road; and the River Road (south of the Colorado River between Parachute and Rifle). Virtually all facilities that are proposed on (or would cross) the Roan Cliffs would create a significant adverse visual impact because the visual contrast would exceed the Visual Resource Management (VRM) Class II guidelines. These include the following: Cottonwood Creek access road, upper and lower Wheeler Gulch processed shale disposal, Cottonwood Gulch water conveyance, a portion (3500 feet) of the funicular railroad, the Cottonwood Gulch utility corridor route, and the Hayes Gulch transmission line.

In addition, certain facilities proposed for the top of the Roan Plateau would be visible from sensitive viewpoints below. Because the plateau itself is not visible, these facilities would be seen as extending above the Roan Cliffs and were evaluated in that context (VRM Class II). The following facilities would result in a significant visual impact: retorting facilities, upgrading facilities, and power supply. Other facilities proposed for the Roan Plateau would exceed the contrast rating for VRM Class II but will not be seen from sensitive viewpoints; therefore, they would result in less significant impacts.

Below the Roan Cliffs is the Colorado River valley, which is relatively flat, generally well vegetated, and unrevealing of physical disturbance. In addition, it presently contains a scattered variety of structures. Visual modifications would, therefore, have to be relatively extensive in order to result in a significant visual impact, despite its high visibility from a number of viewpoints and VRM Class II and III designations. Of the various project components proposed in this area, only the railroad facilities have the potential to result in a significant adverse impact.

Between the Roan Cliffs and the Colorado River valley is a relatively narrow band of steep foothills. Portions of this area are quite prominent to a variety of viewpoints, but other areas are hidden and offer good project siting opportunities. This area is relatively free of existing structures and disturbance, and is designated VRM Class II. The Hayes Gulch transmission line would result in a significant visual impact.

The steep hills enclosing the Main Elk Creek valley contain scattered juniper trees. This valley contains a clear flowing stream bounded by cottonwoods and small agricultural fields. The valley itself has been designated VRM Class II while the surrounding hills have been designated VRM Class III. The proposed dam and lake would change the character of this area altogether and result in a significant visual impact to the existing setting.

Operation

The only changes in impact levels during operation from those listed for construction concern the buried pipelines. Through the operational life of the project, portions of the Cottonwood Gulch utility corridor would return to a similar vegetated condition as the adjacent land and, thus, would become an insignificant visual impact.

Abandonment

At the time of abandonment, all structures (except the Main Elk Creek Dam) would be removed, and the site would be recontoured and reclaimed using natural vegetation. Those facilities that would have been considered as significant visual impacts during operation, largely because of their strongly contrasting structures, would be reduced to insignificant levels of visual impact as soon as vegetation reestablishment takes place. This would be particularly true of the facilities on the Roan Plateau, the Helm Gulch transmission line, and the railroad facilities. With reclamation and reasonable time, all visual modifications would return to an insignificant level except for the access road, which would remain and be an evident and significant long-term adverse visual impact.

3.3.1.12 Noise

Most of the severe noise problems encountered by society are in the occupational context. Work-place noise standards are enforced under the Occupational Safety and Health Act (OSHA) of 1971, which sets forth the duration of permissible noise exposure limits by time interval and provides for a maximum sound level for impact of impulsive noise (e.g., blasting) of 140 dBA (decibels on the A scale).

The Colorado Civil Revised Statute 25-12-101 sets noise limits at 25 feet from the boundaries of the property on which the noise-producing activity occurs. Any noise above the limits shown in Table 3.3-7 constitutes a public nuisance under this statute.

Table 3.3-7. Colorado noise limits

Zone	7:00 a.m. to next 7:00 p.m. dBA	7:00 p.m. to next 7:00 a.m. dBA
Residential	55	50
Commercial	60	55
Light industrial	70	65
Industrial	80	75[a]

[a]Because the noise-production activities on the property would be operating both day and night, it is the 75-dBA standard at the property line that must be met during construction and operation of the facility.

The Mobil properties are, at present, unzoned. When development of the oil shale commences, it is expected that the area would be zoned industrial. Since the noise-producing activities would occur both day and night, it is the 75-dBA standard which is of significance in predicting the noise impacts.

Three areas were analyzed in detail to define the probable extent of the noise impact resulting from construction and operation of the oil shale facility. These areas were: (1) the Mahaffey Ranch and proposed railroad spur in the Colorado River valley, (2) Cottonwood Gulch including the proposed roadway to the mesa top and the mine exhaust vents in the canyon wall, and (3) the mesa top including the proposed retort facilities, mine activities, flares, etc. A cursory screening analyses of the alternate Wheeler Gulch access road route was also done. The affected area is unpopulated except for the Mahaffey Ranch which is owned by the Company and which would be used as part of the proposed facilities.

Four basic types of activities were considered in the noise assessment: roadway traffic, railroads, construction, and process equipment. Since sound pressure levels are additive logarithmically, e.g., two sounds of equal magnitude will increase the overall sound level by 3 decibels, only major sources need be considered since lesser sources would be masked and would not contribute to the overall noise level. The Mobil Project is designed to meet good engineering practice standards and all construction and operations were assumed to be in compliance with the Federal Occupational Safety and Health Administration and Mine Safety and Health Administration regulations for noise exposure. Very short-term noise sources (blasting) were not included in the assessment. Operations of many noise sources at one location such as a retort or power plant were included as one 90 dBA source. A modified version of the Federal Highway Department's STAMINA I computer model was used to estimate noise levels at grid receptors located for the three areas during both the construction and operations phases.

The noise analysis indicates that noise levels would generally be within industrial standards during both construction and operation of the Mobil Project. Short-term noise exposure would have a minimal impact on persons traveling through the region on I-70.

Construction

Mahaffey Ranch and railroad spur. The major noise emissions during the construction period would be from the earth-moving equipment and heavy trucks used in building the railyard and the access road from the junction with I-70 to the mouth of Cottonwood Gulch. In order to estimate noise production, it was assumed that three earth movers, two heavy-duty trucks, and two light-duty trucks would be active in the railyard and the same number of each would be working on each mile of the access road on the busiest day during the construction (plans actually call for two or four headings, rather than one every mile). Even with the assumption that equipment would be operating simultaneously on each mile of the access road, no noise levels exceeding 75 dBA would be expected beyond the property boundary (see Figure 3.3-6).

Cottonwood Gulch. For noise estimating purposes, it was again assumed that three earth movers, two heavy-duty trucks, and two light-duty trucks would be in operation on each mile of the road. The 75-dBA isoline would be close to the road and only in the upper portion of the gulch (Figure 3.3-7). It would extend beyond the property boundary in several areas as would the roadway. A small area at the switchback may experience noise levels exceeding 80 dBA during construction if the assumed numbers and kinds of equipment actually operated simultaneously.

The mesa top. During the construction phase, it was estimated that five heavy-duty earth moving machines (each at 90 dBA), four heavy-duty trucks, and three light-duty vehicles would be in operation at one time in the construction of the retorts, conveyors, mine portals, etc. Figure 3.3-8 shows the estimated noise isolines from construction of the mesa-top facilities. Under these conditions, the 75-dBA isoline would extend beyond the north property boundary in the area of East Fork Gulch. The 80-dBA noise isoline may also extend beyond the property boundary a short distance during the construction of some of the mesa-top facilities. The 75-dBA isoline would extend beyond the property boundary in the Allen Point/Hayes Gulch area, but since this is well above the Colorado River valley, little or no impact at the surface would be expected.

Operation

Mahaffey Ranch and railroad spur. During the busiest hour of the operational period, it was assumed that 1 train and 4 trucks would be moving in the

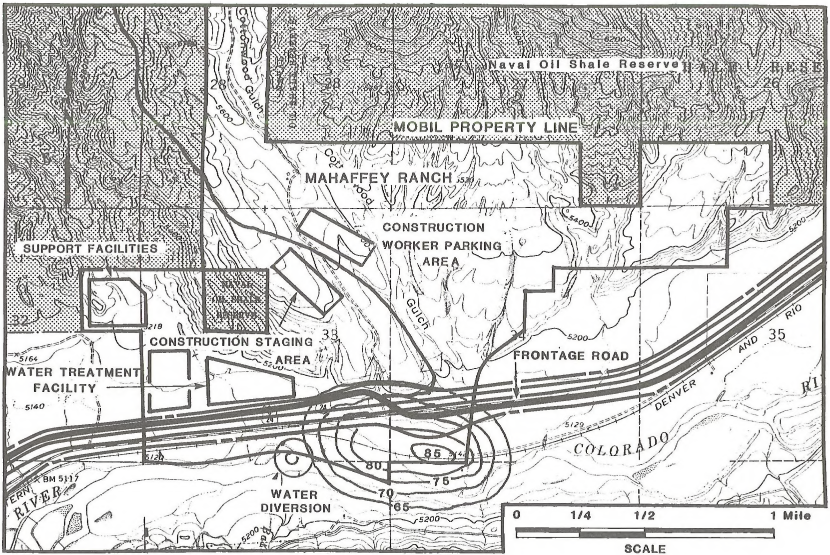


Figure 3.3-6. Isolines of ambient noise levels during construction phase, Mahaffey Ranch and railroad spur area

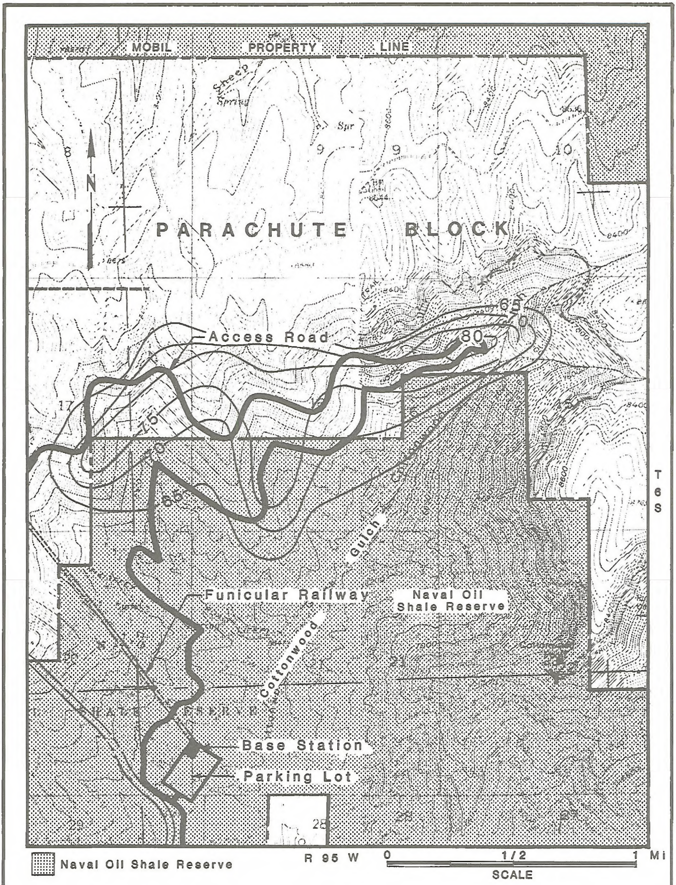


Figure 3.3-7. Isolines of ambient noise levels during access road construction from Mahaffey Ranch to Mesa Top

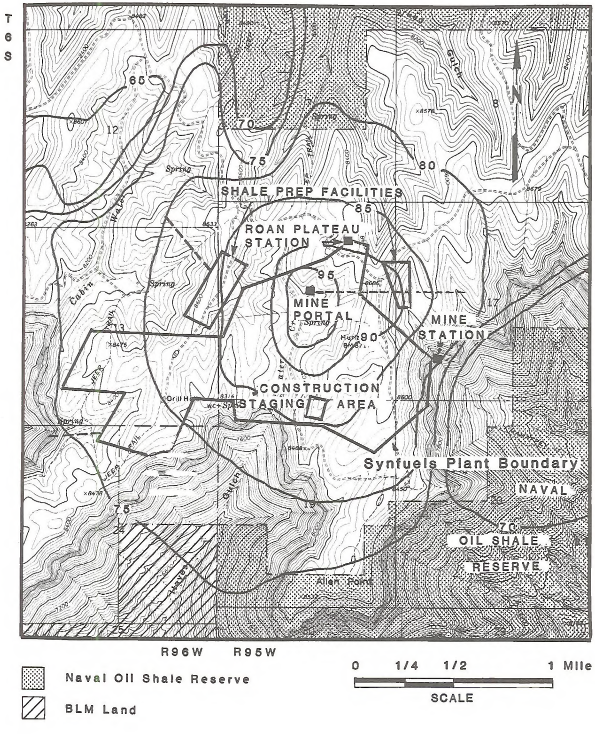


Figure 3.3-8. Isolines of ambient noise levels during construction phase of the Mobil Project, Roan Plateau

railyard and 400 cars plus 3 buses would be moving toward the Mahaffey Ranch parking lot from the I-70 frontage road. Under these worst-case conditions, it might be expected that the 75- and 80-dBA isolines would extend beyond the property boundary a short distance bewteen I-70 and the Colorado River (Figure 3.3-9).

Cottonwood Gulch. It was assumed that 10 heavy-duty trucks per hour would be the probable maximum activity in Cottonwood Gulch. During the operations phase of the project, L_{eq}* noise levels beyond a few feet from the roadway would rarely exceed 50-60 dBA.

The mesa top. For the operations analysis, it was assumed that each retort would produce a 90-dBA noise, the flare located at the top of a 200-foot stack near the mine portal would produce a 130-dBA noise and two mine exhaust vents, each producing a 110-dBA noise, would be located 200 feet below the cliff top northeast of Allen Point. Figure 3.3-10 shows the estimated noise isolines from the mesa-top facilities under full operation. The 75-dBA noise isolines would only be in the area of the mine vents, where the noise levels may exceed 80 to 85 dBA. This is particularly likely in Cottonwood Gulch where the sounds would tend to reverberate between the canyon walls.

Offsite noise impacts

Secondary noise impacts, e.g., community noise, tend to be a function of the population density and are not generally quantifiable. Additional traffic, railroad, and construction noises would occur as the communities develop to accommodate the population growth. Most of these impacts should be of short duration and would be of low adverse impact. As the population density increases from a few hundred to several thousand people per square mile, the ambient noise level might be expected to increase by 5 to 10 dBA.

3.3.1.13 Land use and recreation

Land use

Project site. Impacts from site-specific project components would convert to industrial uses approximately 2274 acres of rangeland and 716 acres of cultivated land. Assuming that grazing continues on lands not needed for industrial uses, this would result in the loss of approximately 455 AUMs and between 716 and 2148 tons of hay production per year. Although conversion of this amount of rangeland might be significant to the individual leaseholders involved, it would not be a significant loss when viewed from a regional perspective. Cultivated land, however, is considered a high-value resource in the region, and its conversion would be a significant impact.

The following project components would involve conversion of cultivated lands and, therefore, would result in significant impacts:

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*L_{eq} is defined as the continuous noise level that would be equivalent, on an energy basis, with the fluctuating noise signal under consideration.

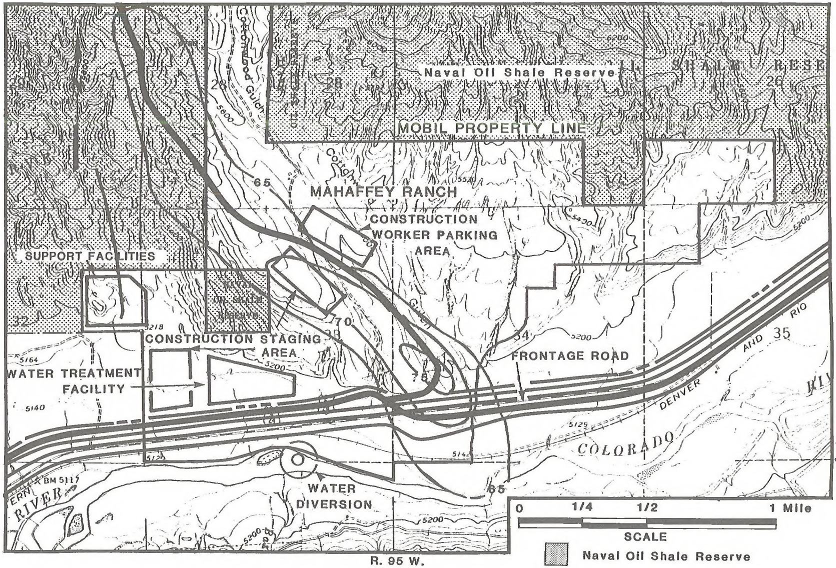


Figure 3.3-9. Isolines of ambient noise levels during operation phase, Mahaffey Ranch and railroad spur area

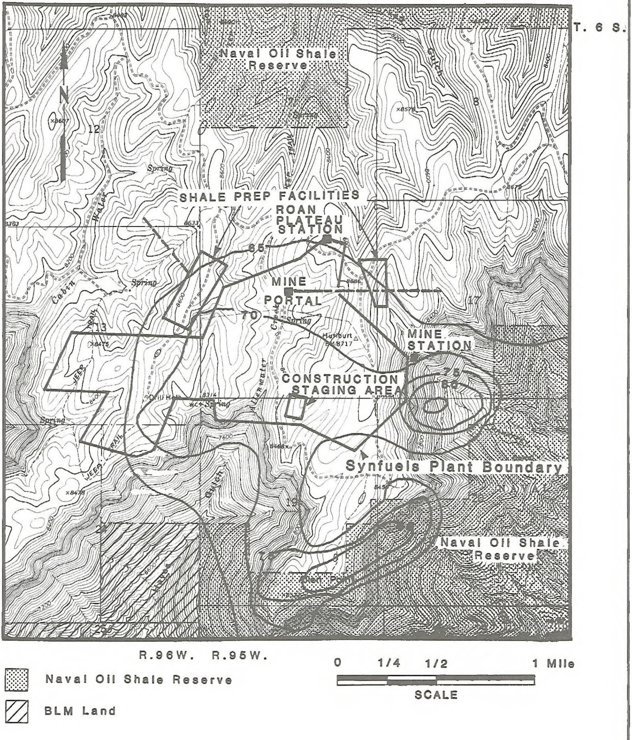


Figure 3.3-10. Isolines of ambient noise levels during operations phase of the Mobil Project, Roan Plateau

- Water supply. The proposed Main Elk Dam and Reservoir site would affect approximately 540 acres, of which 437 acres are presently cultivated hay lands. Four occupied residences would also be displaced.

- Mahaffey Ranch facilities. The use of Mahaffey Ranch for the raw water treatment facility, the support facilities, and the construction staging areas would convert approximately 220 acres of hay meadow to industrial uses. The construction staging area would directly convert 25 acres of agricultural land. While the remainder of the agricultural land on Mahaffey Ranch may not be directly disturbed by project facilities, it is unlikely that the cultivation would continue after the project is constructed.

- Wheeler Gulch facilities. The construction staging area and the retention dam in Wheeler Gulch would convert 59 acres of agricultural land to industrial use.

Impacts on land use during operation would be essentially the same as those of the construction phase.

Abandonment of the project would allow other land uses to be established; however, it is not possible at this time to forecast the nature of these future uses.

Project region. Increased population associated with project construction and operation would induce secondary land use changes in the region. These changes are shown in Table 3.3-8. By the year 2009, project-related population would result in the conversion of approximately 1401 acres from existing uses. Most of these land use conversions would occur in Garfield County; 906 acres compared to 495 acres in Mesa County. Although a sufficient amount of developable land is estimated to be available in the year 2009, much of the area identified for future urban development is currently cultivated land (see Figure 2.13-1). Preservation of highly productive agricultural land is an important priority (SCS, 1980) in both the Mesa and Garfield County land use plans. A significant impact would, therefore, result if the projected land use requirements were met through conversion of cultivated lands.

Recreation

Project site. Project facilities in the Parachute Block and portions of the Mahaffey Ranch would change the area from the roaded natural ROS class to the semiurban class; i.e., the generally natural setting would become substantially modified and evidence of man would be readily apparent. This change would result in a reduction in the amount of area suitable for recreational activities desiring a more natural environment, e.g., back-country camping and hiking.

The Main Elk Reservoir area would not be changed from its roaded natural ROS class; however, the setting opportunity would change from a stream fishing environment to a large reservoir environment. The BLM will require an evaluation of need for reservoir-oriented recreation prior to dam construction. Mobil will be required to offset impacts with recreational opportunities in accordance with an approved BLM recreation management plan. However, recreational use of the reservoir could be affected during heavy drawdown since nonrecreational uses of the water are the first priority.

Table 3.3-8. New land use requirements associated with increased project-related population (in acres)

	Garfield County	Mesa County	Total (Mesa and Garfield)
Residential[a]	542	341	883
Commercial[b]	11	6	17
Industrial[c]	82	41	123
Public facilities[d]	271	107	378
Total	906	495	1401

[a]Assumes housing type mix as follows: 55 percent single family, 30 percent multifamily, and 15 percent mobil home. Standard used for land requirements were: single family (3.5 units per acre), multifamily (20 units per acre), mobile homes (6 units per acre).

[b]Based on a standard of 1.5 acres per 1000 population.

[c]Based on a standard of 11 acres per 1000 population.

[d]Based on a standard of 12 acres per 1000 population for community facilities and a standard of 25 percent of total developed area for streets.

Abandonment of the project would potentially allow project lands to revert to a more natural condition and, thus, again support activities which require this setting.

Project region. Population increases associated with project construction and operation (see Section 2.14) would increase use levels at recreational areas within the project region. Most of the increased use in dispersed activities, hunting, back-country camping, etc., would occur on Federal lands, which account for the great majority (98.5 percent) of the accessible recreational acreage within the two-county project region. Use levels would also increase in non-dispersed recreational activities such as softball, tennis, etc., which require facilities provided by local governments. These impacts are described in the socioeconomic section.

Table 3.3-9 presents estimates for increased use levels associated with project-related population. Project-related population increases and associated increases in recreational use are an element of an overall pattern of projected growth which would substantially influence the oil shale region (see Section 5.2.13).

It is difficult to allocate the projected increased use on Federal lands to specific locations. Visitation to BLM RMAs would increase. Increased visitation would have the most significant impact on areas which are currently near or above carrying capacity, such as Grand Valley and Ruby Canyon/Black Ridge. Overall, with the possible exception of fishing and a few developed areas which are already heavily used, it is expected that increased use on Grand Mesa, White River, and Uncompahgre National Forests would not exceed carrying capacities because of

Table 3.3-9. Estimated increased activity days in selected activities resulting from project-related population, Mesa and Garfield counties

	Camping (developed)	Camping (back-country)	Fishing	Hunting	Downhill skiing	Snow-mobiling	Four-wheeling
1980[a]	423,300	526,300	904,900	551,300	316,200	157,100	1,015,200
Year 7 1994 (peak construction employment)	14,687	38,850	66,820	40,690	23,330	10,110	56,210
Year 13 1999 (overall peak employment, i.e., construction and operation combined)	28,256	74,730	128,550	78,267	44,880	19,436	108,124
Year 16 2002 (operation employment only)	19,326	51,110	87,910	53,530	30,700	13,294	73,950

[a]1980 use levels taken from Mobil, 1982a.

Note: Increased activity days are estimated by applying participation percentage and participation rate factors from 1981 Colorado SCORP to estimated project-related population increases. (See socioeconomic section for population projections.)

project-related increased use levels. This conclusion is based on the fact that developed sites on the national forests currently have a surplus capacity of approximately 166,000 activity days. Given a projected peak increased use of 28,256 activity days (Table 3.3-9), it is apparent that adequate capacity would exist even if all the projected increased use occurred on the national forests.

Back-country camping use levels, which occur to a large degree in wilderness areas, would also increase and decrease the quality of wilderness experience. It is significant to note, however, that projected project-related increases would be small relative to the existing level of use. The peak project-related increase in back-country camping would be 74,730 activity days; this compares to an estimated 1980 use level of 526,300 in the two-county project region. It is likely that the majority of this increased visitation would occur in the Flat Tops Wilderness Area, and to a lesser extent, in other regional wilderness areas and WSAs.

Because the "carrying capacity" of back-country areas is dependent upon several variables such as individual tolerances of crowding, it is difficult to describe the effect project-related increased use would have on the quality of back-country experiences in the region and the amount of available carrying capacity that would be used. USFS officials estimate that current carrying capacities would be reached in the region's wilderness areas by the year 2000 (see Section 5.2.13).

Fishing activity days are projected to increase by 128,550 during the peak period of employment and decline to 87,910 during operation. As described in Section 3.3.1.7, the fishery resource in the project region is already used at or above carrying capacity. The projected increase could be partially mitigated by potential fishing opportunities at the Main Elk Creek reservoir.

Hunting activity days are projected to increase by 78,267 during the period of peak employment and decline to 53,530 thereafter. These increases would be relatively minor when compared to existing use levels, and it can be assumed that the CDW would manage the future allowable number of hunters to be compatible with wildlife production and available habitat. These increased activity levels may, therefore, force changes in management policies, such as restricting the number of licenses or the length of seasons within management units in the two-county region.

Effects on other uses, such as downhill skiing, snowmobiling, four-wheeling, and motorcycling, are expected to be minor because of the large amount of available and proposed areas and facilities for these activities.

3.3.1.14 Socioeconomics

This section describes the social and economic impacts associated with the construction and operation of the 100,000 BPD Mobil Project. The process for determining the impacts was as follows: first, social and economic projections were made for the study area "Without" the Mobil Project. This set of projections is referred to as the "No-Action" alternative. Then, projections were made for the same area "With" the Mobil Project. The differences between the With and Without project cases were defined as the project impacts. Projections were made for employment, demographic, economic, housing, education, public facilities, services, fiscal, and social impacts. The quantified projections were based on the Planning and Assessment System (PAS) that was developed by Mountain West Research - Southwest Inc., and was updated by them for this EIS (MWR, 1982; CITF, 1982). Assumptions were based on information derived through the Cumulative Impacts Task Force (CITF). Projections of the fiscal balances and capital expenditure needs were made by FISPLAN using PAS data inputs. The critical assumptions are identified in the text at the points where the analyses are undertaken.

The period covered is from the present to the year 2009. For purposes of this EIS, the estimated start of construction is 1987. The dam and reservoir project at Main Elk is scheduled for construction from 1987 through 1991. Estimates of employment and local purchases have been provided by Mobil.

Direct project employment, wages, and local purchases

Table 3.3-10 shows the estimated employment, wages, and local purchases. Dollars are held constant at their 1982 value unless specifically stated otherwise. Construction employment would rise sharply to peak in 1993 at 3900 workers. This approximate level of employment would be maintained through 1999 and then drop off in a 3-year period as construction activities are concluded. Construction wages, figured at $34,000 per worker per year, would follow the same pattern of increase and decline. Construction purchases would follow a different pattern altogether and depend upon the type of construction being done at any one time. The peak period for purchases from the region would be 1999 to 2000 when purchases would be in excess of $145 million for each year.

Operation employment would begin in 1990 and would rise annually to 3410 at full operation in 2002. This level would then be maintained for the remainder of the projection period. Wages would follow the same pattern of increase. Average wages for operation workers are estimated to be $32,612 per year, and at full operation, this would produce almost $111 million of basic income annually for the study area. Annual local operations purchases during operation would rise with the increase in production until they reach $104 million in 2003, maintaining that level thereafter.

The peak year for total employment and wages paid would be 1999, when 5860 workers would be employed onsite. This work force would be made up of 3840 construction and 2020 operation workers. Total wages paid in 1999 would be about $198 million in 1982 dollars. The same year is also projected to produce the peak in local purchases, more than $195 million.

Residential allocation of work force

The allocation of direct-basic (onsite) employees to the local communities is based on information provided by Mobil and reviewed with local planning officials. This allocation for both the construction and operation period is shown in Table 3.3-11. The allocation is necessarily speculative and would depend importantly on Mobil having a single-status camp and encouraging its workers to live in areas (e.g., Battlement Mesa) best able to accommodate them. The construction work force is divided to identify both local and nonlocal workers. These estimates show that Garfield County would be the place of residence of 54.0 percent of the local and 84.8 percent of the nonlocal construction

Table 3.3-10. Mobil Project construction and operation employment and income - 1987-2009

Year	Construction	Operation	Total	Total wages[a] Construction	Total wages[a] Operation	Local purchases[a] Construction	Local purchases[a] Operation
1987	60[b]	--	60	2,064	--	2,754	--
1988	150[b]	--	150	5,160	--	12,586	--
1989	760[b]	--	760	26,144	--	9,266	--
1990	760[b]	10	770	26,144	326	4,475	--
1991	1,720[b]	30	1,750	59,168	978	13,711	--
1992	2,960	130	3,090	101,824	4,240	37,646	--
1993	3,900	260	4,160	134,160	8,479	26,895	--
1994	3,840	680	4,520	132,096	22,176	55,156	75
1995	3,840	980	4,820	132,096	31,960	122,659	11,450
1996	3,840	980	4,820	132,096	31,960	120,378	11,450
1997	3,840	1,470	5,310	132,096	47,940	46,262	13,983
1998	3,840	1,740	5,580	132,096	56,745	33,948	43,809
1999	3,840	2,020	5,860	132,096	65,876	148,883	46,201
2000	2,560	2,420	4,980	88,064	78,921	145,472	43,428
2001	1,120	3,190	4,310	38,528	104,032	91,923	42,422
2002	--	3,410	3,410	--	111,207	31,242	81,033
2003	--	3,410	3,410	--	111,207	--	104,295
2004	--	3,410	3,410	--	111,207	--	104,295
2005	--	3,410	3,410	--	111,207	--	104,295
2006	--	3,410	3,410	--	111,207	--	104,295
2007	--	3,410	3,410	--	111,207	--	104,295
2008	--	3,410	3,410	--	111,207	--	104,295
2009	--	3,410	3,410	--	111,207	--	104,295

[a]Thousands of 1982 dollars.
[b]Includes Main Elk Reservoir construction.

Source: Mobil, 1982a.

Table 3.3-11. Residential allocation of Mobil Project work force

Place	Construction[a]		Operation
	Local	Nonlocal	Local
Garfield County	0.540	0.848	0.768
Carbondale area	0.005	--	--
Glenwood Springs area	0.020	0.010	0.010
New Castle area	0.035	0.005	0.024
Silt area	0.050	0.025	0.062
Rifle area	0.270	0.200	0.267
Parachute area	0.080	0.127	0.134
Battlement Mesa	0.080	0.250	0.271
Mobil single status camp	--	0.231	--
Mesa County	0.380	0.145	0.205
DeBeque	0.020	0.005	0.017
Palisade	0.035	0.020	0.030
Clifton CCD	0.075	0.020	0.041
Grand Junction area	0.250	0.100	0.117
Out of the area	0.080	0.007	0.027
Main Elk Reservoir			
Glenwood Springs area	0.329		
REI - Garfield	0.107		
New Castle area	0.049		
Silt area	0.077		
RE 2 - New Castle	0.164		
Rifle area	0.190		
RE 2 - Rifle	0.084		

[a]The local are 35 percent and the nonlocal 65 percent of the total construction employment.

Source: MWR, 1982; Mobil, 1982a; Bureau of Economic Analysis, 1983.

work force. Rifle is projected to supply housing for about half of the local construction workers from Garfield County. The Mobil single-status camp is expected to provide housing for almost a quarter of the nonlocal construction workers, with another quarter going to Battlement Mesa, and 20 percent to Rifle. Construction of the Main Elk Reservoir would employ local workers as shown; Glenwood Springs would supply about a third of the demand.

Mesa County would be allocated 38 percent of the local construction work force, with the Grand Junction area providing the greatest number, 25 percent of the total for both counties. For the nonlocal construction workers, Mesa County would house only 14.5 percent and most of these (10 percent of the total) would live in the Grand Junction area. Almost 8 percent of the local, but less than 1 percent of the nonlocal workers would be assigned to communities outside of the study area.

Over 75 percent of the operation work force is assigned to Garfield County, with Battlement Mesa and Rifle each providing housing for over a quarter of the total. Mesa County would be expected to have over 20 percent of these workers, with almost 12 percent of the total in the Grand Junction area. Less than 3 percent of the operation workers would be expected to live outside the study area.

Study area employment, income, and population impacts

The Mobil Project is projected to produce employment and income both from its onsite construction and operation activities and from its purchases in the local area. This would be basic employment and income, since the demand for it would come from outside the area. When the basic income is spent and respent in the local area, it creates additional jobs and income which are called non-basic. The number of nonbasic jobs and the amount of nonbasic income that would be produced depends upon several factors. The total amount of money spent in the area and the ability of the local area to capture spending are important. The proportion of basic income actually spent in the local area would depend upon who the workers are and their obligations outside the area. For local workers, the spending patterns are included in the PAS model. It is different for nonlocal workers, however. For example, construction workers with families living in other communities would be expected to spend less of their income in the area than would workers with their families present or workers who are single.

The assumptions on family characteristics of nonlocal workers are those adopted by the CITF, namely that 55 percent would be married with family present, 10 percent married with family absent, and 35 percent single. Income weights have been assigned to reflect the different spending patterns of these nonlocal workers. The weights estimate the effect of income paid to nonlocal workers as compared to local workers. The weights used are: 0.8 for the workers with family present, 0.35 for married workers with family absent, and 0.6 for single workers. This means that 80, 35, and 60 percent of the income of these respective categories of nonlocal workers are used to calculate the effects of their basic income on nonbasic employment and income in the study area.

In the economic hierarchy and market area definitions used by CITF, Garfield County is a second-order county and Mesa County is a fifth-order county. This means that Mesa County serves as a trade and service center providing a level of goods and services that are not available in Garfield County. Therefore, in the established market patterns, a certain proportion of the income to Garfield County residents will be spent in Mesa County, an activity that produces nonbasic employment and income in Mesa County. The amount and distribution of this economic activity to each sector of the county economy is accomplished by determining "gammas" -- the ratio between total basic income and the nonbasic share assigned to each sector. The calculations and reiterations necessary to complete a presentation of the total county economy with the numerous variables involved, including gammas, are a key function of the PAS model.

One idea about the relationship between basic and nonbasic employment and income is that there would be a time lag between the production of basic income and the response by nonbasic elements of the economy. Although there has been much speculation about the timing of nonbasic response to the basic stimulus, no empirically based theory has been developed. Through consultation with local leaders, a ratio of 75 percent/25 percent lag has been developed, where 75 percent of the nonbasic response would occur in the same period as the change in basic response, with the remaining 25 percent occurring in the next period. This lag structure has been incorporated into PAS model assumptions.

For this analysis, the nonbasic response to basic activity is assumed to remain constant over time. This means that the gammas (sector-specific multipliers for employment and income that are applied to effective basic income) do not change as the county economy expands.

The level of purchases of materials and supplies from local businesses was provided by Mobil, as was the distribution of these purchases by economic sector. CITF assumptions on the spatial distribution of these purchases were incorporated in the PAS projections.

The projections of employment and income for the No-Action alternative, without the Mobil Project, include the addition of a number of important assumptions about future basic employment and income in the study area. These assumptions are contained in the Basic Activity System (BAS) file for the PAS model. The version of the BAS file used for this baseline projection was the CITF BAS file as of May 1, 1983. This list includes basic employment for Garfield and Mesa counties that is likely to occur over the next 20 years. It assigns future levels of growth to agriculture, manufacturing, and the basic components of trade, services, transportation, and communications. The BAS file also includes project-specific projections that were made for conventional oil and gas, coal, uranium, electric power generation, water projects, and other energy-related facilities such as transmission lines, pipelines, and railroads. In general, these estimates are conservative in that they deal only with existing projects, or projects for which firm commitments have been made, useable project data are available, and development appears highly probable. The BAS file for the Mobil baseline projections included changes in basic employment by sector made for the Union I Oil Shale Project and reviewed by CITF. The Union I (10,000 bpd) Project was the only shale project included in the No-Action projections.

Employment

Employment impacts are calculated as the difference in total employment between the No-Action and the With Mobil alternatives. These figures are shown in Table 3.3-12 for the study area as a whole, and separately for Garfield and Mesa counties.

The year of maximum impacts would be 1999, when area employment is projected to be 57,316 for the No-Action alternative, but 69,036 for the With Mobil case, a difference of 11,720 jobs. This means that employment would be about 20 percent higher in the two-county area with the Mobil Project than without it. It also means that unemployment would be about 4.5 percent less with the Mobil Project. Following the peak employment in 1999, there would be a decline in the employment impacts to about 7300 in 2003 when all construction work would be completed and full operation underway. This level of employment impact, which is about a 12 percent increase over the No-Action alternative, would continue for the remainder of the projection period.

Garfield County would receive the majority of the employment impacts, about 60 percent at peak employment and over 65 percent during operation. In 1999, the

Table 3.3-12. Summary of employment impacts by jurisdiction for Mobil

Year	GARFIELD COUNTY With Project	No Action	Impact Number	%	TOTAL GARFIELD & MESA With Project	No Action	Impact Number	%	MESA COUNTY With Project	No Action	Impact Number	%
1980	11305	11305	0	0	47907	47907	0	0	36602	36602	0	0
1981	13400	13400	0	0	52276	52276	0	0	38876	38876	0	0
1982	14808	14080	0	0	54679	54679	0	0	39791	39791	0	0
1983	14013	14013	0	0	53221	53221	0	0	39209	39209	0	0
1984	12659	12659	0	0	51046	51046	0	0	38387	38387	0	0
1985	12626	12626	0	0	51289	51289	0	0	38663	38663	0	0
1986	12464	12464	0	0	51718	51718	0	0	39254	39254	0	0
1987	12602	12512	90	0	52682	52559	122	0	40080	40047	32	0
1988	12791	12594	196	1	53713	53364	349	0	40922	40770	152	0
1989	13611	12682	928	7	55317	54023	1294	2	41707	41341	365	0
1990	13796	12773	1023	8	55380	54018	1362	2	41584	41245	338	0
1991	14821	12846	1975	15	57004	53883	3121	5	42183	41037	1146	2
1992	16302	12918	3384	26	59678	54439	5238	9	43376	41522	1854	4
1993	17610	12993	4617	35	61918	54926	6991	12	44307	41933	2374	5
1994	18251	13069	5181	39	63241	55230	8011	14	44990	42160	2829	6
1995	18792	13148	5643	42	64872	55614	9258	16	46080	42466	3614	8
1996	18926	13230	5695	43	65399	56026	9372	16	46473	42796	3677	8
1997	19507	13313	6193	46	66026	56447	9578	17	46519	43133	3385	7
1998	19976	13403	6573	49	67098	56874	10224	18	47122	43471	3651	8
1999	20515	13490	7025	52	69036	57316	11720	20	48521	43826	4694	10
2000	19810	13581	6228	45	68222	57733	10488	18	48412	44152	4260	9
2001	19186	13671	5515	40	67068	57970	9097	15	47882	44299	3582	8
2002	18315	13762	4552	33	65700	58194	7505	12	47385	44432	2953	6
2003	18307	13857	4450	32	65708	58425	7284	12	47402	44568	2833	6
2004	18401	13955	4445	31	65942	58664	7277	12	47541	44709	2831	6
2005	18507	14058	4449	31	66201	58916	7284	12	47694	44858	2835	6
2006	18619	14165	4453	31	66473	59179	7293	12	47854	45015	2839	6
2007	18735	14277	4458	31	66757	59455	7302	12	48022	45178	2844	6
2008	18856	14394	4462	31	67055	59744	7310	12	48199	45351	2848	6
2009	18982	14515	4467	30	67365	60045	7319	12	48383	45530	2852	6

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

impacts would increase the Garfield County employment from 13,490 for the No-Action alternative to 20,515 for the With Mobil alternative, an increase of 7025 jobs or 52 percent more employment. During operation, the With Mobil impacts would add over 4400 jobs to the county, increasing employment by more than 30 percent over the No-Action case. These jobs would mostly affect the area of south-central Garfield County, where Rifle, Parachute, and Battlement Mesa are the major communities.

Mesa County's share of the total employment impacts at peak construction are projected to be 4694 jobs, about 40 percent of the 11,720 total for the area. Since Mesa County has a considerably larger work force to begin with, this employment impact would not be nearly as large a proportion of total employment for the With Mobil alternative as is the case for Garfield County. These 4964 jobs would be an increase of just over 10.5 percent from the No-Action alternative in 1999. During operation, the With Mobil alternative would add about 6 percent to the county employment. These jobs would be mainly located in the Grand Junction area, which serves as the market and trade center for the entire Western Slope.

Income

Labor income impacts are calculated as the difference in total labor income between the No-Action and the With Mobil alternatives. Labor income figures are shown in Table 3.3-13.

As would be expected, the income impacts generally would follow the pattern of the employment impacts. At the same time, there are some noteworthy differences that can be attributed to differential pay rates in the various economic sectors. For example, wage rates in the construction and mining sectors tend to be higher than rates in the trade and service sector, and higher than the study area average for all sectors. This is reflected in the income impact figures.

The area impacts would peak in 1999 at more than $257 million, then decline as construction work is completed. During the operation period, labor income impacts would be over $175 million per year. While the study area employment impacts show an increase of 20 percent over the No-Action alternative at peak construction, the labor income impacts would record an increase of over 27 percent higher. During operation, the impacts for the With Mobil alternative would be about 12.5 percent in employment and 18.5 percent in income. Not only would the income impact be higher because of higher wage rates for the project workers, but the distribution of income impacts would be slightly different from employment impacts. The employment impact split between Garfield and Mesa counties at peak construction was 60/40 for employment, but it is 64/36 for income impacts. This is because the higher wage rates of the basic as compared to the nonbasic workers.

For Garfield County, the income impact would be $165 million, an increase of 73.7 percent over the No-Action alternative in 1999 at peak employment. During operation, the figure would be almost $114 million, a 49 percent increase With Mobil. Both these rates of increase are substantially higher than employment; the rate of increase during the operation period is almost twice as high for income as for employment.

Table 3.3-13. Summary of labor income impacts by jurisdiction for Mobil (1000s 1982 $$)

	GARFIELD COUNTY				TOTAL GARFIELD & MESA				MESA COUNTY			
	With	No	Impact		With	No	Impact		With	No	Impact	
Year	Project	Action	Number	%	Project	Action	Number	%	Project	Action	Number	%
1980	167159	167159	0	0	746167	746167	0	0	579008	579008	0	0
1981	230079	230079	0	0	864974	864974	0	0	634895	634895	0	0
1982	256608	256608	0	0	902187	902187	0	0	645579	645579	0	0
1983	238043	238043	0	0	871335	871335	0	0	633292	633292	0	0
1984	210734	210734	0	0	829426	829426	0	0	618692	618692	0	0
1985	210532	210532	0	0	834947	834947	0	0	624415	624415	0	0
1986	206156	206156	0	0	841496	841496	0	0	635341	635341	0	0
1987	209293	206781	2512	1	860217	857239	2978	0	650924	650458	466	0
1988	212793	208045	4748	2	879495	872179	7315	0	666701	664134	2567	0
1989	232821	209399	23422	11	914078	883393	30684	3	681256	673994	7262	1
1990	235823	210801	25022	11	915351	883507	31844	3	679528	672706	6822	1
1991	258025	211825	46200	21	950181	881189	68992	7	692156	669364	22792	3
1992	290060	212830	77230	36	1005766	889871	115895	13	715705	677041	38664	5
1993	319261	213882	105378	49	1053368	897496	155871	17	734107	683614	50493	7
1994	334069	214946	119123	55	1079846	902404	177441	19	745777	687459	58318	8
1995	346202	216037	130165	60	1110022	908531	201491	22	763820	692495	71325	10
1996	348127	217179	130947	60	1118237	915069	203167	22	770111	697890	72220	10
1997	363483	218338	145145	66	1137131	921751	215379	23	773648	703413	70234	10
1998	374097	219585	154511	70	1159287	928522	230764	24	785190	708937	76253	10
1999	385878	220785	165092	74	1193038	935539	257498	27	807160	714754	92406	12
2000	370140	222057	148083	66	1173028	942197	230831	24	802888	720139	82748	11
2001	359197	223284	135913	60	1152257	943446	208810	22	793060	720162	72898	10
2002	339656	224535	115120	51	1123747	944703	179044	19	784091	720168	63923	8
2003	339409	225825	113583	50	1124482	945988	178493	18	785074	720163	64910	9
2004	340592	227166	113426	49	1125763	947324	178439	18	785171	720158	65013	9
2005	342078	228567	113530	49	1127260	948720	178540	18	785162	720153	65009	9
2006	343634	230035	113599	49	1128791	950183	178608	18	785157	720148	65009	9
2007	345233	231567	113666	49	1130386	951710	178675	18	785153	720144	65009	9
2008	346907	233172	113734	48	1132055	953312	178743	18	785148	720139	65009	9
2009	348645	234839	113806	48	1133790	954975	178814	18	785145	720137	65008	9

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

In Mesa County, the income impacts would be significant, although they because Mesa County would receive much of the lower paid nonbasic employment, it has a smaller proportion of the project-related jobs allocated to it, and, its much larger employment and income base, records smaller percentage increases in response to the income impacts. Still, the income impact of almost $92 million or a 12 percent increase over the No-Action alternative in 1999 would be a large difference for the area. The annual income impact of over $64 million during operation would be a 9 percent increase for the county. As in the case of employment, the Grand Junction area would be most affected by the income impacts because it is the area's market center.

Population

Population change is the result of births, deaths, and migration. Births and deaths produce natural increase (plus or minus), while migration produces positive or negative population change because of in- or out-migration. The rates of change in these demographic components were developed in conjunction with the CITF and local officials. Migration was divided into employment-related and nonemployment-related with the former being by far the most important. For the With Mobil alternative, employment-related population change would be directly linked to the jobs generated by the project, both basic and nonbasic. The assumptions about the characteristics of the households associated with the workers are important in calculating the population impacts. The assumptions for the nonlocal basic employees are stated in the section on residential allocation of work force, above.

The distribution of population to communities was accomplished by considering the residential characteristics of three categories of workers: direct basic, indirect basic, and nonbasic. Direct-basic workers were allocated as shown in Table 3.3-11, above, taking into account the location of the work site, transportation, community capabilities, and past experience as shown in survey data. Indirect-basic employment would be created by project purchases, so the place of work for these people was based on where the purchases would be made. In the same manner, nonbasic jobs would exist in market centers where the goods and services were purchased. The distribution of population effects for indirect-basic and nonbasic workers was based on a commuter matrix that identifies their residential locations. Thus, population additions by county and community were based on increases in basic and nonbasic employment, a decline in unemployment, and a subsequent increase in labor force, which required inmigration. The population projections for the No-Action and With Mobil alternatives are shown in Table 3.3-14. Included are figures for the entire area, the counties, and the significant communities.

The population projections for the No-Action alternative anticipate little overall growth, about a quarter of 1 percent annually for the study area as a whole for the period 1983 to 2009. Garfield County shows a slight decline for the period (-0.1 percent average annual rate of change), most of it in the period 1983 to 1986 (a -2.1 percent average annual rate of change) following the shutdown of recent oil shale activities. Battlement Mesa, Parachute, Rifle, and New Castle all show declines for the period 1983 to 2009, while Carbondale, Glenwood Springs, and Silt would expect slight increases. In Mesa County, the No-Action projections show a slight growth rate (0.4 percent average annual rate of change), with every community increasing except Collbran, where the population decline is projected to be from 348 to 334 over the 26-year period.

Table 3.3-14. Summary of population impacts by jurisdiction with Mobil

Year	GARFIELD COUNTY With Project	GARFIELD COUNTY No Action	GARFIELD COUNTY Impact Number	GARFIELD COUNTY Impact %	CARBONDALE With Project	CARBONDALE No Action	CARBONDALE Impact Number	CARBONDALE Impact %
1980	22514	22514	0	0	1997	1997	0	0
1981	27052	27052	0	0	2103	2103	0	0
1982	29166	29166	0	0	2135	2135	0	0
1983	27535	27535	0	0	2164	2164	0	0
1984	26578	26578	0	0	2195	2195	0	0
1985	25919	25919	0	0	2203	2203	0	0
1986	25806	25806	0	0	2230	2230	0	0
1987	25992	25865	127	0	2255	2249	6	0
1988	26290	26014	275	1	2278	2270	8	0
1989	26933	26160	773	3	2299	2291	8	0
1990	27065	26284	780	3	2318	2309	8	0
1991	28587	26353	2234	8	2335	2322	12	0
1992	30548	26415	4132	15	2349	2334	15	0
1993	32854	26482	6372	24	2369	2345	24	1
1994	33817	26476	7340	27	2391	2349	41	1
1995	34587	26493	8094	30	2414	2356	57	2
1996	34687	26483	8204	31	2426	2361	64	2
1997	35542	26491	9051	34	2445	2368	77	3
1998	36167	26499	9668	36	2464	2375	89	3
1999	36995	26527	10468	39	2490	2382	107	4
2000	35651	26554	9096	34	2505	2389	115	4
2001	34633	26581	8052	30	2524	2396	127	5
2002	33278	26608	6669	25	2551	2403	147	6
2003	33377	26637	6740	25	2562	2409	152	6
2004	33470	26665	6805	25	2572	2415	156	6
2005	33559	26694	6865	25	2582	2421	160	6
2006	33642	26722	6920	25	2592	2427	164	6
2007	33719	26748	6971	26	2601	2433	168	6
2008	33968	26770	7197	26	2628	2438	189	7
2009	34259	26787	7472	27	2660	2443	217	8

Year	GLENWOOD SPRINGS With Project	GLENWOOD SPRINGS No Action	GLENWOOD SPRINGS Impact Number	GLENWOOD SPRINGS Impact %	NEW CASTLE With Project	NEW CASTLE No Action	NEW CASTLE Impact Number	NEW CASTLE Impact %
1980	4637	4637	0	0	563	563	0	0
1981	4858	4858	0	0	623	623	0	0
1982	4901	4901	0	0	671	671	0	0
1983	4923	4923	0	0	644	644	0	0
1984	4939	4939	0	0	634	634	0	0
1985	4946	4946	0	0	636	636	0	0
1986	4974	4974	0	0	638	638	0	0
1987	5002	4987	14	0	643	586	57	9
1988	5027	5011	16	0	648	589	59	10
1989	5052	5032	20	0	655	591	63	10
1990	5068	5048	19	0	657	594	63	10
1991	5094	5062	31	0	668	595	73	12
1992	5119	5074	44	0	682	597	85	14
1993	5164	5084	80	1	721	598	123	20
1994	5196	5090	106	2	746	599	146	24
1995	5229	5095	134	2	764	599	164	27
1996	5235	5098	137	2	766	600	166	27
1997	5265	5099	165	3	788	600	187	31
1998	5296	5099	196	3	804	600	204	34
1999	5335	5099	235	4	823	600	223	37
2000	5337	5098	239	4	822	600	222	37
2001	5354	5097	257	5	835	600	235	39
2002	5382	5097	285	5	834	600	234	39
2003	5390	5096	293	5	837	600	236	39
2004	5398	5096	301	5	840	601	239	39
2005	5405	5096	309	6	843	601	241	40
2006	5412	5096	316	6	845	601	244	40
2007	5418	5095	322	6	847	601	246	40
2008	5474	5094	379	7	861	601	260	43
2009	5542	5092	450	8	878	601	276	46

Year	PARACHUTE With Project	PARACHUTE No Action	PARACHUTE Impact Number	PARACHUTE Impact %	RIFLE With Project	RIFLE No Action	RIFLE Impact Number	RIFLE Impact %
1980	331	331	0	0	3215	3215	0	0
1981	902	902	0	0	5115	5115	0	0
1982	1189	1189	0	0	5552	5552	0	0
1983	926	926	0	0	5225	5225	0	0
1984	678	678	0	0	4827	4827	0	0
1985	680	680	0	0	4840	4840	0	0
1986	671	671	0	0	4850	4850	0	0
1987	676	676	0	0	4890	4875	14	0
1988	698	681	17	2	4962	4910	52	1
1989	767	685	81	11	5136	4941	194	3
1990	772	690	82	12	5165	4970	195	3
1991	959	693	265	38	5574	4995	599	12
1992	1204	697	507	72	6156	5017	1139	22
1993	1451	700	751	107	6986	5038	1948	38
1994	1536	703	833	118	7352	5055	2297	45
1995	1608	705	902	127	7639	5071	2568	50
1996	1612	708	903	127	7662	5084	2577	50
1997	1689	710	979	137	7961	5096	2864	56
1998	1739	712	1026	144	8188	5107	3080	60
1999	1822	715	1106	154	8503	5118	3385	66
2000	1633	717	916	127	8122	5128	2994	58
2001	1482	720	762	105	7863	5137	2725	53
2002	1306	722	583	80	7524	5148	2376	46
2003	1311	725	585	80	7555	5158	2397	46
2004	1315	728	587	80	7585	5169	2416	46
2005	1320	730	589	80	7615	5180	2434	47
2006	1324	733	590	80	7642	5190	2451	47
2007	1328	736	592	80	7658	5201	2467	47
2008	1336	739	597	80	7731	5210	2521	48
2009	1345	741	603	81	7805	5219	2586	49

Year	SILT With Project	SILT No Action	SILT Impact Number	SILT Impact %	BATTLEMENT MESA AA With Project	BATTLEMENT MESA AA No Action	BATTLEMENT MESA AA Impact Number	BATTLEMENT MESA AA Impact %
1980	923	923	0	0	416	416	0	0
1981	1118	1118	0	0	1071	1071	0	0
1982	1178	1178	0	0	1877	1877	0	0
1983	1130	1130	0	0	937	937	0	0
1984	1105	1105	0	0	930	930	0	0
1985	1106	1106	0	0	937	937	0	0
1986	1107	1107	0	0	705	705	0	0
1987	1113	1111	1	0	707	705	2	0
1988	1124	1118	6	0	756	705	51	7
1989	1145	1123	22	2	936	707	229	32
1990	1151	1129	22	2	940	708	232	32
1991	1201	1133	67	5	1447	702	745	106
1992	1265	1137	127	11	2116	697	1418	203
1993	1365	1141	224	19	2810	695	2115	304
1994	1426	1145	281	24	3076	683	2393	350
1995	1470	1148	321	28	3260	676	2583	381
1996	1474	1151	323	28	3261	666	2595	389
1997	1529	1153	376	32	3506	659	2847	431
1998	1567	1155	412	35	3661	653	3007	459
1999	1613	1157	455	39	3845	653	3192	488
2000	1580	1159	420	36	3316	653	2663	407
2001	1579	1161	418	36	2892	654	2238	342
2002	1547	1162	384	33	2391	653	1738	265
2003	1554	1164	389	33	2399	654	1745	266
2004	1560	1166	393	33	2405	655	1750	267
2005	1565	1168	397	34	2410	656	1754	267
2006	1571	1170	400	34	2415	657	1758	267
2007	1576	1172	404	34	2420	658	1762	267
2008	1594	1174	420	35	2426	659	1767	268
2009	1616	1175	440	37	2431	660	1771	268

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 3.3-14 (continued)

	MESA COUNTY				GRAND JUNCTION				PALISADE				FRUITA			
Year	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	81530	81530	0	0	28143	28143	0	0	1551	1551	0	0	2810	2810	0	0
1981	86101	86101	0	0	30045	30045	0	0	1781	1701	0	0	2991	2991	0	0
1982	87483	87483	0	0	30484	30484	0	0	1856	1856	0	0	3061	3061	0	0
1983	87944	87944	0	0	30693	30693	0	0	1808	1808	0	0	3079	3079	0	0
1984	88506	88506	0	0	30922	30922	0	0	1766	1766	0	0	3074	3074	0	0
1985	89173	89173	0	0	31228	31228	0	0	1779	1779	0	0	3085	3085	0	0
1986	90262	90262	0	0	31693	31693	0	0	1799	1799	0	0	3103	3103	0	0
1987	91309	91309	0	0	32114	32114	0	0	1817	1817	0	0	3141	3141	0	0
1988	92206	92179	27	0	32461	32450	11	0	1835	1832	3	0	3172	3172	0	0
1989	93118	92988	129	0	32819	32764	54	0	1864	1846	18	1	3201	3201	0	0
1990	93405	93276	129	0	32882	32827	54	0	1862	1844	18	1	3206	3206	0	0
1991	93813	93147	665	0	32985	32686	299	0	1896	1835	61	3	3204	3201	3	0
1992	94721	93672	1048	1	33335	32874	461	1	1956	1841	114	6	3223	3220	3	0
1993	95459	94152	1307	1	33613	33042	570	1	1998	1847	151	8	3242	3239	2	0
1994	95882	94587	1294	1	33760	33194	566	1	2003	1852	150	8	3259	3256	2	0
1995	96918	94862	2056	2	34180	33300	880	2	2031	1853	178	9	3284	3269	14	0
1996	97411	95215	2196	2	34351	33419	932	2	2043	1857	186	10	3303	3285	18	0
1997	97744	95527	2216	2	34467	33526	941	2	2048	1860	188	10	3318	3299	18	0
1998	98042	95806	2236	2	34570	33620	950	2	2053	1862	190	10	3331	3313	18	0
1999	100358	96054	4303	4	35581	33702	1878	5	2116	1865	251	13	3373	3326	46	1
2000	100292	96277	4015	4	35534	33776	1757	5	2073	1867	206	11	3385	3338	47	1
2001	100169	96488	3681	3	35463	33845	1617	4	2023	1868	155	8	3398	3350	48	1
2002	100126	96693	3432	3	35426	33913	1513	4	1985	1870	115	6	3411	3361	49	1
2003	100382	96898	3484	3	35514	33980	1534	4	1988	1871	116	6	3423	3373	50	1
2004	100637	97105	3532	3	35602	34048	1554	4	1991	1873	117	6	3437	3385	51	1
2005	100892	97316	3576	3	35691	34117	1573	4	1994	1875	119	6	3450	3397	52	1
2006	101146	97528	3617	3	35779	34187	1591	4	1997	1877	120	6	3463	3410	52	1
2007	101395	97741	3654	3	35866	34258	1607	4	2000	1879	121	6	3476	3422	53	1
2008	101637	97950	3687	3	35950	34328	1622	4	2003	1881	122	6	3488	3434	53	1
2009	101867	98149	3718	3	36030	34394	1636	4	2006	1883	123	6	3501	3447	54	1

	DE BEQUE				COLLBRAN				TOTAL GARFIELD & MESA							
Year	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	279	279	0	0	342	342	0	0	104044	104044	0	0				
1981	344	344	0	0	348	348	0	0	113153	113153	0	0				
1982	380	380	0	0	348	348	0	0	116649	116649	0	0				
1983	350	350	0	0	348	348	0	0	115479	115479	0	0				
1984	353	353	0	0	348	348	0	0	115084	115084	0	0				
1985	356	356	0	0	348	348	0	0	115092	115092	0	0				
1986	359	359	0	0	348	348	0	0	116067	116067	0	0				
1987	361	361	0	0	348	348	0	0	117301	117173	127	0				
1988	364	364	0	0	348	348	0	0	118496	118193	302	0				
1989	370	366	4	1	348	348	0	0	120051	119148	903	0				
1990	372	368	4	1	348	348	0	0	120470	119560	910	0				
1991	384	369	14	4	347	347	0	0	122400	119500	2900	2				
1992	399	371	27	7	347	347	0	0	125268	120087	5181	4				
1993	410	373	37	9	347	347	0	0	128313	120634	7679	6				
1994	411	374	36	9	346	346	0	0	129699	121064	8635	7				
1995	420	375	45	12	346	345	0	0	131505	121355	10150	8				
1996	423	376	46	12	346	345	1	0	132098	121698	10400	8				
1997	424	377	47	12	345	344	1	0	133286	122018	11267	9				
1998	425	378	47	12	344	343	1	0	134209	122305	11904	9				
1999	444	378	65	17	345	343	2	0	137353	122582	14771	12				
2000	433	379	54	14	344	342	2	0	135943	122831	13111	10				
2001	421	379	41	11	343	341	2	0	134803	123068	11734	9				
2002	412	380	31	8	342	340	2	0	133404	123302	10102	8				
2003	412	380	32	8	342	339	2	0	133759	123535	10224	8				
2004	413	381	32	8	341	338	2	0	134108	123771	10337	8				
2005	414	381	32	8	340	338	2	0	134451	124010	10441	8				
2006	415	382	33	8	340	337	2	0	134788	124250	10537	8				
2007	416	382	33	8	339	336	2	0	135115	124489	10625	8				
2008	417	383	33	8	338	336	2	0	135605	124720	10885	8				
2009	418	384	34	8	337	335	2	0	136126	124936	11190	9				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

The population growth rate for the entire study area with the Mobil Project is projected to be twice that which would be experienced without the project. The maximum population impacts, an increase of 14,771 (12 percent), would occur in 1999 at peak employment, then drop slightly before leveling off to about 11,000 (9 percent) during the operation period.

The distribution of the new project-related population is expected to be concentrated in the Battlement Mesa, Parachute, and Rifle communities. Of the 14,771 people who would be added to the study area in 1999, over 70 percent or 10,468 would be in Garfield County. Rifle would get almost a third of the county total, 3385, followed by Battlement Mesa's 3192, and Parachute's 1106. These three communities would account for over 70 percent of the county total and about half that for the entire study area. The population of Battlement Mesa would be over 400 percent greater with the Mobil Project than with the No-Action alternative. The figures are 154 percent for Parachute, 66 percent for Rifle, and almost 40 percent greater for Garfield County in 1999.

During operation, the population impact would be around 11,000 for the study area, with about 7000 people (65 percent) in Garfield County. The Rifle-Parachute-Battlement Mesa area would get about 4700 (43 percent) of the population impacts for the total study area. This is two-thirds of the Garfield County total. Of the remaining 2000, about 600 would go to Silt and New Castle, and the others to the communities in the eastern part of the county and to the unincorporated areas.

Mesa County is projected to realize population impacts of about 4303 at peak employment, 1999, and around 3600 during operation. This is almost 30 percent of the total study area impacts for 1999 and 35 percent during operation. Since Mesa County has a much larger population base, these impacts would be a relatively modest proportion, 4.5 percent in 1999, and 3.7 percent during operation. Grand Junction would receive 1878 people at peak employment, a figure that is surpassed only by Battlement Mesa and Rifle in Garfield County. However, the size of the city means that the population impacts would be a small proportion of the total population, 5.6 percent in 1999, and 4.8 percent during operation. While these are important increases for any community, they are not near the rate of increase that would occur in Battlement Mesa and Rifle where the population bases are much smaller.

DeBeque shows the largest proportional increase in Mesa County, 17.2 percent in 1999 and over 8.5 percent during operation. The increase in the number of people would be 65 at peak employment, 1999, and 33 during operation. Palisade would increase by 251 for 1999, a 13.5 percent increase over the No-Action alternative, and 6 percent during operation. In Fruita and Collbran, the population impacts would be less than 1.5 percent at any time during the forecast period.

<u>Housing</u>

Existing housing characteristics were described in Section 2.14. During the late 1970s and early 1980s, there was a rapid increase in demand and an equally rapid expansion of the housing stock. Battlement Mesa was established as a major residential area to house population growth related to oil shale development. The shutdown of the Colony Project in mid-1982 dramatically slowed expansion of the housing stock. Prices in Garfield County declined between 10 and 30 percent and vacancy rates climbed. In the fall of 1982, only a third of 280 new apartment units in Battlement Mesa were rented. In Mesa County, building activity was down by 30 to 40 percent below 1981 levels (DRI, 1983). Given this background, any new project would make a positive contribution to the housing sector of the study area economy.

Mobil proposes to house almost 25 percent of the nonlocal project employees (15 percent of the total construction work force) in a single-status camp. This facility would provide housing for up to 575 workers. No decision on its location has been made. The workers assigned to the single-status camp are not distributed to the communities in the allocation process.

The future demand for housing units (total number of units required at any time) is based upon forecasts of households. The number of households is determined by the total number of people, the age structure, and the household size. The housing mix (single-family, multifamily, and mobile homes) is estimated based on past experience and the type and location of demand. Table 3.3-15 shows housing demand for the period 1983 to 2009.

The No-Action growth for the study area, Garfield and Mesa counties, forecasts that the housing demand would increase from 41,633 units in 1980 to 60,591 in 2009, a 1.3 percent annual rate of change. This rate is higher than that projected for population because of changing household sizes. Single family units would decline from 67.4 to 61.1 percent; multifamily would increase from 19.4 to 24.8 percent, while mobile homes would increase from 13.2 to 14.2 percent. The forecasts for the With Mobil alternative anticipate growth of the housing demand to 65,915 units in 2009, 8 percent greater than with the No-Action alternative. The configuration of the housing stock would be 60.5 percent single family, 24.6 percent multifamily, and 14.9 percent mobile homes. There would be an increase in the proportion of mobile homes. Single family homes and multifamily units would be a slightly smaller proportion of the stock.

Garfield County housing demand for the period 1980 to 2009 would be expected to record an annual growth rate of 1.3 percent for the No-Action alternative and 2.1 percent for the With Mobil alternative. Housing demand was 9360 in 1980 and is projected to increase by 2009 to 13,741 and 17,329 with the No-Action and With Mobil alternatives, respectively. In 1980, the housing mix was 58.9 percent single family, 22.4 percent multifamily, and 18.7 percent mobile homes. For the No-Action alternative in 2009, these percentages are 52.0 percent single family, 27.5 percent multifamily, and 20.5 percent mobile homes. The With Mobil alternative forecasts are 51.6 percent single family, 26.3 percent multifamily, and 22.1 percent mobile homes. The annual demand of additional housing units with the Mobil alternative for Garfield County is shown in Table 3.3-14.

The most dramatic increase would take place at Battlement Mesa, where the With Mobil demand would be more than triple the No-Action case, 990 units With Mobil and 295 with No Action. The housing demand in Rifle would be about 1244 more units in 2009 with the project, a 46 percent impact. In Parachute, the increased demand for 289 units in 2009 would be a 75 percent impact With Mobil. The housing impact in New Castle and Silt in 2009 projects demands of 45 and 37 percent more units with the project as compared to without it.

Mesa County is a more urban area with a much larger housing stock. The PAS estimate for 1983 is that the county has 35,759 units. The No-Action alternative

Table 3.3-15. Summary of changes in housing demand with Mobil

Year	GARFIELD COUNTY				CARBONDALE				GLENWOOD SPRINGS				NEW CASTLE			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	9360	9360	0	0	787	787	0	0	2046	2046	0	0	249	249	0	0
1981	11565	11565	0	0	845	845	0	0	2146	2146	0	0	276	276	0	0
1982	12668	12668	0	0	872	872	0	0	2178	2178	0	0	295	295	0	0
1983	12181	12181	0	0	898	898	0	0	2203	2203	0	0	289	289	0	0
1984	11475	11475	0	0	926	926	0	0	2228	2228	0	0	288	288	0	0
1985	11376	11376	0	0	943	943	0	0	2246	2246	0	0	291	291	0	0
1986	11486	11486	0	0	967	967	0	0	2273	2273	0	0	295	295	0	0
1987	11677	11625	52	0	990	988	2	0	2298	2293	5	0	300	275	24	8
1988	11913	11795	118	1	1012	1009	3	0	2322	2315	6	0	305	279	25	9
1989	12308	11969	338	2	1033	1030	3	0	2345	2338	7	0	310	283	27	9
1990	12474	12133	341	2	1053	1050	3	0	2367	2360	7	0	314	286	27	9
1991	13261	12279	981	8	1073	1067	5	0	2391	2381	10	0	320	290	30	10
1992	14234	12419	1815	14	1091	1084	7	0	2414	2400	13	0	328	293	34	11
1993	15324	12551	2772	22	1111	1100	11	1	2445	2417	27	1	347	297	50	16
1994	15821	12652	3169	25	1131	1112	19	1	2471	2433	38	1	361	300	61	20
1995	16244	12756	3488	27	1151	1125	26	2	2497	2447	50	2	373	303	70	23
1996	16406	12865	3541	27	1168	1139	29	2	2515	2464	50	2	378	306	71	23
1997	16869	12967	3902	30	1186	1152	34	3	2541	2478	63	2	392	309	82	26
1998	17235	13059	4176	32	1204	1163	40	3	2566	2489	76	3	403	312	91	29
1999	17693	13159	4533	34	1225	1175	49	4	2595	2500	94	3	415	314	101	32
2000	17192	13247	3944	29	1241	1186	54	4	2611	2510	100	4	421	317	104	32
2001	16818	13330	3488	26	1258	1196	61	5	2633	2518	114	4	433	319	114	35
2002	16409	13409	3000	22	1272	1206	85	7	2686	2526	159	6	443	321	121	37
2003	16541	13473	3068	22	1304	1214	90	7	2699	2532	167	6	448	323	124	38
2004	16666	13533	3133	23	1315	1221	93	7	2710	2537	173	6	452	325	127	39
2005	16794	13599	3194	23	1326	1229	96	7	2722	2542	179	7	457	327	130	39
2006	16907	13655	3252	23	1336	1236	99	8	2731	2547	184	7	461	328	132	40
2007	17007	13699	3308	24	1344	1242	102	8	2738	2549	189	7	464	330	134	40
2008	17165	13728	3437	25	1359	1246	112	9	2764	2549	214	8	473	331	142	43
2009	17329	13741	3588	26	1374	1249	125	10	2792	2546	246	9	482	331	151	45

Year	PARACHUTE				RIFLE				SILT				BATTLEMENT MESA AA			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	142	142	0	0	1270	1290	0	0	355	355	0	0	154	154	0	0
1981	388	388	0	0	2057	2057	0	0	435	435	0	0	368	368	0	0
1982	514	514	0	0	2247	2247	0	0	463	463	0	0	626	626	0	0
1983	404	404	0	0	2152	2152	0	0	451	451	0	0	329	329	0	0
1984	297	297	0	0	2026	2026	0	0	447	447	0	0	326	326	0	0
1985	301	301	0	0	2054	2054	0	0	453	453	0	0	328	328	0	0
1986	300	300	0	0	2085	2085	0	0	458	458	0	0	263	263	0	0
1987	305	305	0	0	2124	2119	5	0	465	465	0	0	265	265	0	0
1988	314	309	4	1	2170	2155	15	0	473	471	1	0	278	266	12	4
1989	335	313	21	6	2241	2191	49	2	484	478	5	1	321	269	51	19
1990	339	318	21	6	2276	2227	49	2	490	484	5	1	323	272	51	18
1991	391	322	69	21	2408	2262	146	6	507	490	16	3	438	272	165	60
1992	458	326	131	40	2573	2296	277	12	527	496	31	6	588	273	315	115
1993	540	330	210	63	2878	2327	551	23	565	501	64	12	779	275	504	183
1994	582	334	247	74	3058	2357	700	29	594	506	87	17	881	273	608	222
1995	616	337	278	82	3201	2385	815	34	615	511	104	20	951	273	677	247
1996	619	341	277	81	3238	2416	821	34	621	516	105	20	953	272	680	249
1997	657	345	311	90	3389	2444	945	38	648	520	127	24	1046	272	773	283
1998	681	349	332	95	3511	2470	1041	42	668	524	143	27	1106	273	833	305
1999	722	352	369	104	3671	2495	1176	47	690	528	162	30	1178	275	903	327
2000	679	356	323	90	3621	2518	1103	43	690	532	158	29	1072	278	794	285
2001	659	359	300	83	3634	2540	1093	43	703	535	168	31	1016	280	736	262
2002	624	362	262	72	3633	2562	1071	41	709	538	171	31	922	282	640	226
2003	630	365	265	72	3673	2580	1092	42	716	541	175	32	931	284	647	227
2004	636	368	268	72	3711	2598	1113	42	723	544	179	32	940	286	654	228
2005	643	371	271	72	3750	2617	1133	43	729	546	182	33	950	288	661	229
2006	649	374	274	73	3786	2633	1152	43	735	549	186	33	960	290	669	230
2007	655	377	278	73	3819	2648	1171	44	741	551	189	34	970	292	677	231
2008	662	379	283	74	3864	2659	1205	45	751	553	197	35	980	294	686	233
2009	670	381	289	75	3911	2667	1244	46	762	554	207	37	990	295	695	235

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 3.3-15 (continued)

Year	MESA COUNTY				GRAND JUNCTION				PALISADE				FRUITA			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	32273	32273	0	0	11720	11720	0	0	658	658	0	0	1026	1026	0	0
1981	34378	34378	0	0	12593	12593	0	0	752	752	0	0	1104	1104	0	0
1982	35246	35246	0	0	12885	12885	0	0	785	785	0	0	1142	1142	0	0
1983	35759	35759	0	0	13090	13090	0	0	773	773	0	0	1159	1159	0	0
1984	36305	36305	0	0	13294	13294	0	0	763	763	0	0	1170	1170	0	0
1985	36897	36897	0	0	13528	13528	0	0	773	773	0	0	1185	1185	0	0
1986	37608	37608	0	0	13808	13808	0	0	786	786	0	0	1204	1204	0	0
1987	38320	38320	0	0	14078	14078	0	0	798	798	0	0	1229	1229	0	0
1988	38965	38959	6	0	14318	14315	2	0	810	810	0	0	1252	1252	0	0
1989	39605	39574	31	0	14556	14543	13	0	825	821	4	0	1275	1275	0	0
1990	40059	40028	31	0	14706	14693	12	0	831	827	4	0	1290	1290	0	0
1991	40493	40289	204	0	14846	14751	94	0	845	830	15	1	1301	1300	1	0
1992	41112	40813	298	0	15075	14941	134	0	867	839	27	3	1321	1319	1	0
1993	41675	41313	362	0	15281	15120	161	1	884	848	35	4	1340	1338	1	0
1994	42135	41774	361	0	15447	15287	160	1	891	856	34	4	1358	1356	1	0
1995	42876	42208	668	1	15739	15448	291	1	909	863	45	5	1380	1373	6	0
1996	43412	42678	733	1	15934	15618	316	2	920	872	48	5	1401	1392	8	0
1997	43861	43112	749	1	16098	15775	322	2	929	880	48	5	1418	1409	9	0
1998	44278	43515	763	1	16249	15920	328	2	936	887	48	5	1435	1426	9	0
1999	45505	43893	1611	3	16776	16057	719	4	969	894	74	8	1463	1441	21	1
2000	45847	44268	1579	3	16898	16192	706	4	966	901	64	7	1479	1457	22	1
2001	46138	44609	1528	3	17001	16314	686	4	960	908	52	5	1495	1472	23	1
2002	46451	44955	1496	3	17113	16439	673	4	958	914	43	4	1510	1487	23	1
2003	46806	45271	1535	3	17243	16552	691	4	965	920	45	4	1525	1501	24	1
2004	47139	45564	1575	3	17366	16657	708	4	972	926	46	5	1539	1514	25	1
2005	47484	45868	1615	3	17492	16766	725	4	979	931	47	5	1553	1527	25	1
2006	47815	46169	1646	3	17613	16873	740	4	986	937	48	5	1567	1541	26	1
2007	48110	46434	1676	3	17721	16967	753	4	992	942	50	5	1580	1553	26	1
2008	48370	46664	1705	3	17815	17048	767	4	998	946	51	5	1591	1564	26	1
2009	48587	46850	1736	3	17894	17113	781	4	1002	950	52	5	1601	1574	27	1

Year	DE BEQUE				COLLBRAN				TOTAL GARFIELD & MESA							
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	134	134	0	0	159	159	0	0	41633	41633	0	0				
1981	163	163	0	0	162	162	0	0	45943	45943	0	0				
1982	183	183	0	0	164	164	0	0	47914	47914	0	0				
1983	168	168	0	0	165	165	0	0	47940	47940	0	0				
1984	171	171	0	0	166	166	0	0	47780	47780	0	0				
1985	173	173	0	0	167	167	0	0	48273	48273	0	0				
1986	175	175	0	0	169	169	0	0	49095	49095	0	0				
1987	178	178	0	0	170	170	0	0	49998	49945	52	0				
1988	180	180	0	0	171	171	0	0	50878	50753	124	0				
1989	183	182	1	0	173	173	0	0	51912	51542	369	0				
1990	185	184	1	0	174	174	0	0	52533	52160	372	0				
1991	190	186	4	2	175	175	0	0	53754	52568	1185	2				
1992	196	187	8	4	176	176	0	0	55345	53232	2113	4				
1993	200	189	10	5	177	177	0	0	56998	53864	3134	5				
1994	201	191	10	5	178	178	0	0	57956	54426	3530	6				
1995	206	192	14	7	179	179	0	0	59120	54963	4157	7				
1996	209	194	14	7	180	180	0	0	59818	55543	4275	7				
1997	210	196	14	7	181	180	0	0	60731	56080	4650	8				
1998	212	197	14	7	182	181	0	0	61513	56574	4939	8				
1999	221	198	22	11	183	182	1	0	63197	57053	6144	10				
2000	219	200	19	9	184	182	1	0	63039	57515	5523	9				
2001	217	201	15	7	184	183	1	0	62955	57938	5016	8				
2002	215	202	13	6	185	184	1	0	62860	58364	4496	7				
2003	217	203	13	6	185	184	1	0	63347	58744	4603	7				
2004	218	204	13	6	186	184	1	0	63805	59097	4708	8				
2005	220	205	14	7	186	185	1	0	64277	59467	4810	8				
2006	221	206	14	7	187	185	1	0	64722	59823	4898	8				
2007	222	207	15	7	187	185	1	0	65118	60133	4984	8				
2008	224	208	15	7	187	186	1	0	65535	60392	5143	8				
2009	225	209	15	7	187	186	1	0	65915	60591	5324	8				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

projections estimate 46,850 units by 2009, a 1.0 percent average annual rate of change. For the With Mobil alternative, the total housing demand in 2009 is estimated to be 48,587, a 1.2 percent average annual rate of growth. The impact of 1736 additional units is a 3 percent increase over the No-Action alternative. There would be no important change in the housing mix. The annual impacts for Mesa County and its local jurisdiction are shown in Table 3.3-15.

Within Mesa County, Grand Junction would receive the largest increase in housing units. In the year 2009, the Grand Junction housing demand would increase by 781 units or 4 percent With Mobil, as compared to the No-Action alternative. For Palisade, these figures are 52 units and 5 percent. DeBeque's additional demand of 15 units would be a 7 percent increase with the project.

Thus, the housing demand generated by the Mobil Project would be significant, adding 5324 units or 8 percent to the study area by the year 2009. Experience in the recent past shows that the local housing industry is capable of meeting the level of demand forecast in this case. However, a critical element in the analysis is the fact that Battlement Mesa has a well-developed capability to meet future oil shale project demand. Necessary improvements, such as streets, water, community facilities, and planning for housing needs have already been accomplished. Other communities have also upgraded their ability to provide housing in anticipation of impacts from oil shale development.

Education

Projections for the school-age population have been made for five school districts in the study area: These districts are: RE-2 and RE-16 in Garfield County, Joint District No. 49 (which includes DeBeque and part of eastern Garfield County), and District Nos. 50 and 51 in Mesa County. The background and current conditions in each district are discussed in Section 2.14.

Table 3.3-16 shows the projections for each school district over the forecast period, 1983 to 2009. For the No-Action alternative, the total population is expected to remain generally stable for the forecast period, while the school-age population is expected to decline. This is due mostly to changes in the fertility rates and the age structure of the population. The trend toward smaller average family size means that in a stable population, there will be fewer school-age children. The average annual rate of change for all 5 school districts over the 26-year period is -0.7 percent. Every district shows a negative average annual rate of change with District No. 51 the smallest at -0.5 percent, followed by RE-2 with -1.5 percent, Joint District No. 49 with -1.6 percent, District No. 50 with -1.7 percent, and with RE-16, the largest proportional decline, -2.7 percent per year. While these five systems had 21,497 school-aged children in their districts in 1983, they are projected to have only 18,030 in 2009.

The With Mobil alternative would result in significant additional school-age children in the area. However, even With Mobil, the total number of school-age children would only be 20,535 in 2009, less than the 21,497 recorded for 1983. Only during the years of peak employment and impact would there be more school-age children than during 1983. The maximum impact would be reached in 1999, when all five districts would contain 25,700 school-age children, 3269 more

Table 3.3-16. Summary of school-age population with Mobil

	DE BEQUE NO 49J				GARFIELD CTY SCHOOL 2				GRAND VALLEY SCHOOL NO 16				PLATEAU VALLEY SCHOOL 50J			
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	124	124	0	0	2117	2117	0	0	321	321	0	0	500	500	0	0
1981	141	141	0	0	2551	2551	0	0	643	643	0	0	447	447	0	0
1982	144	144	0	0	2691	2691	0	0	917	917	0	0	430	430	0	0
1983	129	129	0	0	2590	2590	0	0	547	547	0	0	403	403	0	0
1984	127	127	0	0	2501	2501	0	0	470	470	0	0	386	386	0	0
1985	122	122	0	0	2383	2383	0	0	494	494	0	0	375	375	0	0
1986	121	121	0	0	2402	2402	0	0	441	441	0	0	367	367	0	0
1987	121	121	0	0	2430	2411	19	0	460	459	0	0	361	361	0	0
1988	122	122	0	0	2467	2434	32	1	492	471	20	4	356	356	0	0
1989	123	121	1	1	2531	2453	78	3	574	481	92	19	352	352	0	0
1990	122	121	1	1	2542	2462	80	3	570	485	85	17	347	347	0	0
1991	125	120	4	3	2671	2459	212	8	775	482	293	60	343	342	0	0
1992	128	120	8	6	2838	2450	388	15	1026	476	550	115	339	338	0	0
1993	130	119	10	9	3081	2448	632	25	1259	470	789	167	337	336	0	0
1994	130	118	11	9	3187	2440	746	30	1307	461	846	183	334	334	0	0
1995	131	116	14	12	3247	2412	835	34	1351	449	901	200	333	328	5	1
1996	130	115	15	13	3227	2373	854	36	1345	434	911	210	331	325	5	1
1997	130	114	15	13	3283	2333	949	40	1430	419	1011	241	328	322	5	1
1998	128	112	16	14	3307	2283	1023	44	1490	402	1087	270	324	318	5	1
1999	129	110	19	17	3320	2208	1112	50	1562	382	1180	308	323	313	9	3
2000	124	107	17	16	3135	2140	994	46	1355	364	991	272	316	306	10	3
2001	118	104	13	13	2977	2070	907	43	1197	348	849	243	309	299	10	3
2002	112	101	11	11	2783	2004	778	38	1036	331	705	212	302	292	10	3
2003	110	98	11	12	2720	1943	777	40	1089	316	773	244	295	285	10	3
2004	106	95	11	11	2664	1888	776	41	1120	303	817	269	289	278	11	3
2005	104	92	11	12	2614	1838	775	42	1131	292	839	287	283	272	11	4
2006	102	90	11	12	2569	1797	772	42	1131	283	847	299	278	267	11	4
2007	100	88	11	13	2532	1766	766	43	1122	276	846	306	274	262	11	4
2008	97	86	10	12	2516	1744	772	44	1107	269	837	310	271	259	12	4
2009	96	85	10	12	2510	1729	780	45	1085	266	819	307	269	257	12	4

	MESA COUNTY VALLEY SCHOOL															
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	17659	17659	0	0												
1981	18158	18158	0	0												
1982	18066	18066	0	0												
1983	17828	17828	0	0												
1984	17782	17782	0	0												
1985	17988	17988	0	0												
1986	18328	18328	0	0												
1987	18729	18729	0	0												
1988	19107	19100	7	0												
1989	19466	19431	34	0												
1990	19615	19580	34	0												
1991	19745	19579	166	0												
1992	19957	19688	269	1												
1993	20204	19866	338	1												
1994	20290	19954	336	1												
1995	20456	19971	485	2												
1996	20481	19965	516	2												
1997	20392	19867	525	2												
1998	20220	19686	534	2												
1999	20366	19417	949	4												
2000	19895	19014	880	4												
2001	19373	18569	803	4												
2002	18860	18110	750	4												
2003	18429	17652	776	4												
2004	18015	17214	800	4												
2005	17631	16805	825	4												
2006	17289	16442	847	5												
2007	16999	16135	864	5												
2008	16761	15885	876	5												
2009	16575	15693	882	5												

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

With Mobil than with the No-Action alternative. This is a 14.5 percent increase. During the operation period, the impact would be about 2500, about 14 percent over the No-Action alternative.

Garfield County District No. RE-2 serves the communities of Rifle, New Castle, and Silt, and in 1983, contained about 2590 school-age children. The current maximum capacity is estimated at 3475. During peak employment in 1999, the total number of school-age children in the district with the Mobil Project would be 3320 with about 1112 of these being project-related effects. Because of the capacity built in anticipation of the Colony and Union projects, the district could accommodate this level of increased demand during the projection period.

Garfield County District No. RE-16 includes Parachute, the unincorporated community of Battlement Mesa, and the surrounding areas. The enrollment in 1983 was 547, down from the 917 students of the previous year. Construction of two new schools at Battlement Mesa raised the capacity of the district to 1105. The district has no outstanding debt since the recent construction has been built with funds from the Oil Shale Trust Fund and assistance from the oil shale developers. Maximum school-age population for the district is forecast at 1562 for 1999, with 1180 of these because of the Mobil Project. During operation, school-age children impacts with the Mobil Project would be about 850, with the total for the district over 1000. During the period 1993 to 2001, the number of school-age children would be more than current capacity of the school district; in 1999, the capacity would fall short by over 400.

Mesa County Joint District No. 49 serves DeBeque and parts of rural Mesa and Garfield counties. In 1983, there were 129 school-age children in the district and a maximum enrollment capacity of about 180 to 190. Current forecasts show generally declining numbers of school-age population and relatively small impacts. At peak employment, the impact is expected to be 19 and the total number of school-age children in the district for the With Mobil alternative would be 129, well below the enrollment capacity.

Plateau Valley School District No. 50 serves the communities of Collbran, Mesa, Plateau City, and Molina. The district had 403 school-age children in 1983, and was operating at capacity. The projections show a continual decline in the number of school-age children for both the No-Action and With Mobil alternative. In addition, impacts from the Mobil Project would be quite small, 9 additional children at peak employment, and a gradual increase to 12 during the operation period.

Mesa County Valley School District No. 51 serves Grand Junction, Fruita, Palisade, and surrounding portions of Mesa County. It is the largest district in the study area and contained 17,828 school-age children in 1983. The No-Action alternative projects gradual increases in children until 1997 when annual decreases would begin to take effect. The total number forecast for 2009 is 15,693, a decline of 12 percent from the 1983 figure. The Mobil impacts would produce two peaks, one of 949 additional children at peak employment in 1999, and a smaller one of over 800 during the operation period. These additions would increase the maximum number of school-age children in the district to 20,481 in 1996. The school district has an ability to accommodate additional students now, perhaps 600 to 900 overall, although shifting housing patterns can produce mismatches between the locations of demand of school facilities. For the No-Action alternative, the greatest number of additional school-age children would be 2000 more than the 1983 figures, for the With Mobil alternative, the number would be more than 2500 higher. Both these peaks would exceed current capacity, while in the long term, both the No-Action and the With Mobil alternatives project that the number of school-age children would be less than current capacity.

The school districts within the region should be able to accommodate the projected impacts which would result from the Mobil Project. Operating costs are subsidized by the state equalization process which provides adequate resources for instruction, even during periods of rapid growth. The ability of districts to meet requirements for capital expenditures depends upon their bonding capacity and outside funding sources. For example, both RE-2 and RE-16 have received substantial funds for new facilities from the Oil Shale Trust Fund and from oil shale developers. These sources of capital funding could be considered precedents for future needs because of major resource development. Because of the size of the increases and the demands made upon school districts to provide education, the impact of increased school-age children must be considered to be important for RE-2 and RE-16 in Garfield County and Mesa County School District No. 51.

Public facilities, services, and fiscal impacts

The presentation of fiscal information on local facilities, services, and financial conditions quickly can become very involved and difficult to follow. This is because local jurisdictions operate under restraints imposed by a number of other public authorities, including state and Federal agencies, legislatures, constitutions, statutes, and the legal decisions pertaining to all these areas. Through the years, numerous revenue sources and expenditure obligations have developed for local jurisdictions. The purpose of this section is to take into account potential revenues, expenditures, and capital spending needs for both the No-Action and the With Mobil alternatives. These findings are summarized for presentation in the EIS. Revenues and expenditures are based on current conditions for the appropriate jurisdictions and both categories are projected separately for the two alternative cases. All the revenue sources currently in effect are calculated based on present rates. All expenditures are forecast based on current levels of service. The differences between revenues and expenditures using this approach are designated as the fiscal impacts.

Projections made in this way will show either positive or negative balances, both annually and cumulatively. Local jurisdictions occasionally have a surplus of funds at year-end which is carried over into the next fiscal year. They are not allowed to accumulate deficits except through issuing debt. Generally, budgets are balanced by increasing revenues or decreasing expenditures, as needed. Such adjustments are a normal part of the annual budgeting process.

It is not the purpose of the EIS to speculate about how future budgets might be balanced, a process that involves complex changes to numerous variables. Rather, the purpose is to isolate one variable which will represent the magnitude, duration, and direction (positive or negative) of fiscal impacts. By holding current tax rates, procedures, expenditure patterns, and levels of service constant, an exogenous variable (the difference between revenues and expenditures) is created. This variable is projected for both the No-Action and the With Mobil alternatives. The important information is the difference between alternatives. Based on the same assumptions about how the tax base is determined, tax rates, levels of service, etc., will the project product a net fiscal loss or gain? The difference between the projection for the two alternatives addresses this question.

The projections are the output of FISPLAN, a computer model which estimates revenues, expenditures, and facility capacity requirements by jurisdiction. FISPLAN uses inputs from PAS; therefore, the projections are compatible with figures used in the sections above (i.e., employment, population, housing, etc.). Direct project additions to local revenues are specified (i.e., assessed valuation of the project for property taxes and severence taxes), but other tax base increases and decreases for jurisdictions are estimated by FISPLAN based on PAS inputs.

Table 3.3-17 shows the cumulative fiscal balances by jurisdiction for the years 1982 to 2009. Each column presents a running total of the net difference between revenues and expenditures for each jurisdiction or significant fund. If revenues exceed expenditures according to the FISPLAN projections, the difference is shown as positive; if expenditures exceed revenues, it is shown as negative. It is possible for the No-Action and the With Mobil columns to both show a negative cumulative balance, but a positive impact. This happens when the negative balance is smaller with the project (a positive difference) than without it.

For Mesa and Garfield counties, as shown in Table 3.3-17, the projections estimate fiscal balance of almost $360 million at the year 2009. Impacts are shown for the period beginning in 1983, because the model allocates capital expenditures in anticipation of actual demand. This means that these local jurisdictions together would realize a net balance (revenues in excess of expenditures) of $360 million more for the With Mobil as compared to the No-Action alternative. These balances would not be equally distributed, and the greatest advantages would accrue to those jurisdictions that have access to the tax bases most positively effected by the Mobil Project. Garfield County would realize a significant increase in its property tax base as the Mobil facilities are added to the county's assessed valuation. As the regional market center, Mesa County would realize significant increases in sales tax revenues because of the project-induced spending. This source of revenue is even more important to Mesa County because of the restructuring of the sales tax shares, so that the county now collects a 2 percent levy on sales.

The cumulative balance for Garfield County shows a net positive balance of $336 million, about 93 percent of the total gain for the study area. This increase would be produced by dramatic increases in property taxes and severance taxes. Garfield County's assessed valuation for property tax increases from $124 million in 1982 to $2.6 billion in the first decade of the 21st century (an increase of almost 20 times), and local property taxes rise from $2.4 million to over $50 million per year. Severance taxes, which are less than $25,000 in 1983, would increase to over $800,000 per year when the Mobil Project would be in full operation.

With its share of the net gain in income from the Mobil Project, it is clear that Garfield County's financial position would be greatly strengthened. In fact, the net positive balance would be almost double with the Mobil Project. It should be noted that one of the areas most affected in other categories, Battlement Mesa, is not included in the fiscal balance table. This is because

Table 3.3-17. Cumulative net fiscal impact with Mobil (1000s 1982 $$)

	GRAND JUNCTION ALL FUNDS				GRAND JUNCTION GEN FUND				GRAND JUNCTION WATER				GRAND JUNTION SANITATION			
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-16512	-16411	-101	-0	-9207	-9172	-35	-0	-1576	-1511	-65	-4	-5728	-5727	-0	-0
1984	-41066	-40953	-113	-0	-27409	-27369	-40	-0	-4470	-4398	-72	-1	-9186	-9185	-0	-0
1985	-59908	-59783	-125	-0	-36285	-36239	-45	-0	-11914	-11835	-78	-0	-11709	-11708	-1	-0
1986	-74874	-74734	-139	-0	-43953	-43899	-53	-0	-18770	-18684	-85	-0	-12150	-12149	-1	-0
1987	-83735	-83582	-153	-0	-49416	-49357	-59	-0	-21713	-21621	-92	-0	-12605	-12604	-1	-0
1988	-97841	-98157	315	0	-56286	-56394	108	0	-28653	-28859	205	0	-12901	-12903	2	0
1989	-106204	-105430	-774	-0	-60927	-60687	-240	-0	-32074	-31546	-527	-1	-13202	-13195	-6	-0
1990	-113953	-113118	-834	-0	-65865	-65616	-248	-0	-34604	-34026	-578	-1	-13483	-13476	-7	-0
1991	-120722	-119918	-804	-0	-69753	-69580	-173	-0	-37132	-36508	-623	-1	-13837	-13829	-7	-0
1992	-126935	-126297	-638	-0	-73141	-73176	34	0	-39597	-38932	-665	-1	-14197	-14189	-7	-0
1993	-132966	-132629	-336	-0	-76376	-76753	376	0	-42055	-41350	-704	-1	-14534	-14526	-8	-0
1994	-138897	-138922	25	0	-79513	-80290	777	1	-44509	-43766	-743	-1	-14873	-14865	-8	-0
1995	-144497	-144817	320	0	-83259	-84057	797	0	-46946	-46474	-472	-1	-14290	-14285	-4	-0
1996	-149894	-149735	-158	-0	-86749	-87684	934	1	-49430	-48348	-1081	-2	-13714	-13702	-11	-0
1997	-154309	-154519	210	0	-89899	-91265	1365	1	-51278	-50135	-1142	-2	-13131	-13119	-11	-0
1998	-158626	-159260	633	0	-92954	-94803	1849	2	-53124	-51920	-1204	-2	-12548	-12535	-12	-0
1999	-162728	-163955	1226	0	-95816	-98299	2482	2	-54947	-53703	-1244	-2	-11964	-11952	-11	-0
2000	-166887	-168605	1718	1	-98734	-101751	3016	3	-56772	-55485	-1287	-2	-11380	-11369	-11	-0
2001	-171116	-173273	2157	1	-101721	-105223	3501	3	-58598	-57265	-1333	-2	-10796	-10785	-11	-0
2002	-175879	-178621	2741	1	-105241	-109238	3997	3	-60425	-59179	-1245	-2	-10213	-10203	-9	-0
2003	-180116	-183312	3195	1	-108138	-112722	4584	4	-62347	-60969	-1378	-2	-9630	-9620	-10	-0
2004	-184222	-187969	3746	2	-110995	-116174	5178	4	-64180	-62758	-1421	-2	-9046	-9036	-10	-0
2005	-188324	-192589	4265	2	-113850	-119591	5740	4	-66010	-64545	-1465	-2	-8463	-8453	-10	-0
2006	-192351	-197175	4823	2	-116632	-122974	6341	5	-67839	-66331	-1507	-2	-7879	-7869	-9	-0
2007	-196341	-201729	5387	2	-119380	-126328	6948	5	-69666	-68115	-1550	-2	-7295	-7285	-9	-0
2008	-200288	-206419	6130	3	-122086	-129819	7732	6	-71491	-69898	-1592	-2	-6711	-6701	-9	-0
2009	-204194	-210946	6751	3	-124753	-133148	8395	6	-73314	-71679	-1634	-2	-6127	-6118	-9	-0

	FRUITA ALL FUNDS				FRUITA GEN FUND				FRUITA WATER				FRUITA SANITATION			
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-3471	-3471	-0	-0	-4058	-4058	-0	-0	604	604	-0	-0	-17	-17	0	0
1984	-4758	-4758	-0	-0	-4820	-4820	-0	-0	101	101	-0	-0	-39	-39	0	0
1985	-6419	-6423	4	0	-5428	-5432	4	0	-288	-288	-0	-0	-703	-703	0	0
1986	-7485	-7497	11	0	-6017	-6029	11	0	-680	-680	-0	-0	-787	-787	0	0
1987	-9178	-9197	19	0	-6599	-6619	19	0	-1333	-1333	-0	-0	-1245	-1245	0	0
1988	-10283	-10338	55	0	-7162	-7214	51	0	-1755	-1759	4	0	-1365	-1365	0	0
1989	-11437	-11497	61	0	-7735	-7798	63	0	-2179	-2177	-1	-0	-1523	-1523	0	0
1990	-12559	-12652	92	0	-8275	-8369	94	1	-2608	-2606	-1	-0	-1676	-1676	0	0
1991	-13674	-13809	134	1	-8818	-8954	136	1	-3032	-3030	-2	-0	-1823	-1823	0	0
1992	-14770	-14947	177	1	-9347	-9527	180	1	-3461	-3459	-2	-0	-1961	-1961	0	0
1993	-15865	-16085	219	1	-9884	-10105	221	2	-3888	-3886	-2	-0	-2093	-2093	0	0
1994	-16965	-17212	247	1	-10426	-10676	249	2	-4317	-4315	-2	-0	-2220	-2220	0	0
1995	-18047	-18343	295	1	-10958	-11252	294	2	-4747.	-4748	0	0	-2342	-2342	0	0
1996	-19096	-19410	313	1	-11506	-11823	316	2	-5181	-5178	-2	-0	-2408	-2408	0	0
1997	-20150	-20481	331	1	-12060	-12393	333	2	-5615	-5612	-2	-0	-2474	-2474	0	0
1998	-21202	-21553	351	1	-12609	-12962	353	2	-6051	-6049	-2	-0	-2541	-2541	0	0
1999	-22235	-22628	393	1	-13135	-13530	394	2	-6492	-6490	-2	-0	-2607	-2607	0	0
2000	-23284	-23710	426	1	-13679	-14107	427	3	-6931	-6929	-1	-0	-2673	-2673	0	0
2001	-24347	-24799	452	1	-14231	-14684	452	3	-7376	-7375	-1	-0	-2739	-2739	0	0
2002	-24762	-25239	477	1	-14337	-14814	477	3	-7620	-7619	-0	-0	-2805	-2806	0	0
2003	-25143	-25646	503	2	-14416	-14919	502	3	-7855	-7854	-0	-0	-2871	-2872	0	0
2004	-25519	-26049	529	2	-14492	-15020	528	3	-8089	-8090	0	0	-2937	-2938	0	0
2005	-25891	-26447	556	2	-14563	-15118	554	3	-8324	-8325	1	0	-3003	-3004	1	0
2006	-26258	-26842	584	2	-14630	-15212	581	3	-8558	-8560	1	0	-3069	-3070	1	0
2007	-26622	-27234	612	2	-14694	-15302	608	4	-8792	-8794	2	0	-3135	-3136	1	0
2008	-26982	-27637	655	2	-14754	-15402	647	4	-9026	-9033	6	0	-3201	-3202	1	0
2009	-27339	-28024	685	2	-14812	-15488	675	4	-9260	-9268	7	0	-3267	-3268	1	0

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 3.3-17 (continued)

Year	PALISADE ALL FUNDS				PALISADE GEN FUND				PALISADE UTILITY				DEBEQUE ALL FUNDS			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-158	-158	0	0	-35	-35	0	0	-123	-123	0	0	66	66	0	0
1984	-259	-259	0	0	-61	-61	0	0	-197	-197	0	0	-80	-80	0	0
1985	-2792	-2792	-0	-0	-86	-86	0	0	-2706	-2706	-0	-0	-33	-33	-0	-0
1986	-3094	-3093	-0	-0	-110	-110	0	0	-2983	-2983	-0	-0	16	16	-0	-1
1987	-3411	-3408	-2	-0	-134	-134	0	0	-3277	-3274	-2	-0	66	68	-1	-1
1988	-3703	-3701	-2	-0	-156	-156	-0	-0	-3547	-3545	-2	-0	119	120	-1	-1
1989	-3979	-3979	0	0	-175	-174	-0	-0	-3804	-3804	0	0	164	175	-10	-6
1990	-4334	-4265	-69	-1	-261	-190	-70	-37	-4072	-4074	1	0	-143	-89	-54	-60
1991	-4609	-4550	-58	-1	-274	-204	-70	-34	-4334	-4346	12	0	-124	-63	-61	-95
1992	-4865	-4838	-27	-0	-276	-214	-61	-28	-4589	-4624	34	0	-106	-33	-72	-216
1993	-5092	-5110	17	0	-268	-222	-46	-20	-4824	-4888	63	1	-83	0	-84	-1020
1994	-5332	-5396	63	1	-253	-227	-26	-11	-5079	-5169	90	1	-59	39	-98	-248
1995	-5498	-5625	127	2	-226	-229	2	1	-5271	-5396	124	2	-28	80	-108	-135
1996	-5659	-5852	193	3	-196	-229	32	14	-5462	-5623	161	2	2	124	-122	-98
1997	-5622	-5882	260	4	-163	-226	62	27	-5458	-5656	198	3	34	168	-134	-79
1998	-5581	-5934	353	6	-103	-220	116	53	-5477	-5714	236	4	78	212	-134	-63
1999	-5528	-6000	471	7	-36	-212	175	82	-5492	-5788	296	5	127	256	-128	-50
2000	-5496	-6074	578	9	29	-201	231	114	-5526	-5872	346	5	175	300	-124	-41
2001	-5472	-6150	677	11	101	-189	290	153	-5573	-5961	387	6	186	302	-116	-38
2002	-4969	-5771	801	13	206	-174	381	218	-5176	-5596	420	7	214	304	-89	-29
2003	-4447	-5390	942	17	329	-159	488	306	-4776	-5231	454	8	251	307	-56	-18
2004	-3922	-5004	1082	21	453	-140	593	423	-4375	-4864	488	10	288	311	-22	-7
2005	-3393	-4615	1221	26	579	-118	698	587	-3972	-4496	523	11	327	316	10	3
2006	-2859	-4222	1362	32	708	-95	803	842	-3568	-4126	558	13	366	322	43	13
2007	-2322	-3825	1503	39	838	-69	908	1302	-3161	-3755	594	15	406	329	77	23
2008	-1780	-3425	1644	48	972	-42	1014	2406	-2752	-3383	630	18	447	336	110	32
2009	-1235	-3021	1786	59	1107	-12	1120	8860	-2342	-3009	666	22	488	344	144	41

Year	DEBEQUE GEN FUND				DEBEQUE UTILTY				MESA COUNTY				GARFIELD COUNTY			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	70	70	0	0	-4	-4	0	0	9065	9102	-36	-0	115	115	0	0
1984	-72	-72	0	0	-7	-7	0	0	-2445	-2405	-40	-1	1885	1884	0	0
1985	-21	-21	-0	-0	-11	-11	0	0	-4586	-4641	55	1	4072	4051	20	0
1986	31	31	-0	-0	-15	-15	0	0	-3356	-3846	489	12	6278	6234	43	0
1987	87	88	-1	-1	-20	-20	0	0	-1266	-2527	1260	49	8473	8406	67	0
1988	144	146	-1	-1	-25	-25	0	0	1479	-786	2266	288	11612	11498	113	1
1989	202	205	-2	-1	-38	-30	-8	-26	4356	1482	2873	193	17187	16830	356	2
1990	27	53	-25	-47	-171	-142	-28	-20	4982	2660	2322	87	25059	24241	818	3
1991	64	94	-30	-32	-188	-158	-30	-19	8451	4431	4020	90	34833	33798	1035	3
1992	103	141	-38	-27	-209	-174	-34	-20	13003	7320	5683	77	47404	45452	1952	4
1993	144	191	-47	-24	-228	-190	-37	-19	17724	10378	7345	70	63620	59718	3901	6
1994	189	247	-57	-23	-248	-207	-40	-19	21485	13900	7585	54	82172	75728	6444	8
1995	239	306	-66	-21	-268	-225	-42	-18	25657	16673	8984	53	103062	92657	10405	11
1996	290	366	-76	-20	-288	-242	-46	-19	28527	19745	8781	44	128515	110737	17777	16
1997	343	428	-84	-19	-309	-259	-50	-19	31154	23012	8142	35	155819	128660	27159	21
1998	409	489	-80	-16	-331	-277	-54	-19	34139	26237	7902	30	184782	146439	38343	26
1999	478	551	-73	-13	-350	-294	-55	-19	42692	29665	13027	43	218408	164052	54355	33
2000	548	613	-64	-10	-372	-312	-59	-19	45539	33216	12322	37	254909	181526	73383	40
2001	577	630	-52	-8	-391	-327	-63	-19	48838	37196	11642	31	293770	198959	94811	47
2002	624	647	-22	-3	-410	-343	-66	-19	52350	41316	11033	26	334919	216413	118506	54
2003	679	665	14	2	-428	-358	-70	-19	57305	46217	11088	24	381453	233887	147566	63
2004	735	684	50	7	-446	-373	-73	-19	62365	51221	11144	21	430297	251382	178915	71
2005	792	704	87	12	-465	-388	-77	-19	67543	56290	11253	20	479220	268900	210320	78
2006	850	725	124	17	-483	-403	-80	-20	72802	61451	11351	18	528231	286438	241793	84
2007	908	747	161	21	-502	-418	-84	-20	78128	66672	11455	17	577269	303995	273274	89
2008	968	769	198	25	-521	-433	-87	-20	83500	71940	11560	16	626339	321567	304771	94
2009	1028	792	235	29	-539	-448	-91	-20	88902	77234	11667	15	675430	339154	336276	99

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 3.3-17 (continued)

Year	RIFLE ALL FUNDS				RIFLE GEN FUND				RIFLE WATER				RIFLE SANITATION			
	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-39	-39	0	0	-38	-38	0	0	-99	-99	0	0	98	98	-0	-0
1984	-37	-37	0	1	-89	-89	0	0	-138	-138	0	0	190	190	-0	-0
1985	-25	-23	-1	-8	-128	-126	-2	-1	-181	-180	-0	-0	283	283	0	0
1986	114	119	-4	-3	-61	-56	-5	-9	-221	-221	-0	-0	397	396	0	0
1987	405	412	-8	-1	157	166	-9	-5	-264	-264	-0	-0	512	510	1	0
1988	617	634	-16	-2	275	314	-18	-5	-304	-304	-0	-0	627	624	2	0
1989	795	837	-42	-5	398	445	-47	-10	-348	-347	-0	-0	745	739	5	0
1990	474	974	-500	-51	185	508	-323	-63	-514	-388	-126	-32	803	854	-51	-6
1991	219	1224	-1004	-82	202	630	-427	-67	-903	-375	-528	-140	920	969	-48	-5
1992	42	1509	-1466	-97	-59	787	-846	-107	-944	-363	-581	-160	1046	1085	-38	-3
1993	77	1838	-1761	-95	-118	987	-1105	-112	-987	-350	-636	-181	1182	1201	-18	-1
1994	108	2187	-2079	-95	-174	1208	-1382	-114	-1029	-338	-691	-204	1312	1317	-4	-0
1995	194	2588	-2394	-92	-188	1481	-1669	-112	-1073	-325	-747	-229	1455	1433	21	1
1996	288	2992	-2704	-90	-193	1755	-1949	-111	-1116	-313	-802	-256	1598	1550	48	3
1997	390	3394	-3004	-88	-195	2028	-2224	-109	-1160	-301	-859	-285	1745	1667	78	4
1998	673	3794	-3121	-82	-18	2299	-2318	-100	-1204	-288	-915	-316	1895	1783	111	6
1999	949	4193	-3244	-77	148	2569	-2420	-94	-1248	-276	-972	-351	2049	1900	148	7
2000	1258	4589	-3331	-72	354	2836	-2482	-87	-1292	-264	-1028	-389	2197	2018	179	8
2001	1697	5025	-3328	-66	692	3142	-2450	-78	-1336	-252	-1084	-430	2341	2135	206	9
2002	2436	5463	-3026	-55	1334	3450	-2115	-61	-1378	-239	-1139	-475	2480	2252	227	10
2003	3292	5901	-2609	-44	2094	3758	-1664	-44	-1421	-227	-1194	-524	2619	2370	249	10
2004	4148	6340	-2191	-34	2853	4067	-1214	-29	-1464	-215	-1249	-580	2759	2488	271	10
2005	4928	6780	-1851	-27	3536	4377	-841	-19	-1507	-203	-1304	-642	2899	2605	293	11
2006	5778	7221	-1442	-20	4288	4688	-399	-8	-1550	-190	-1359	-712	3040	2723	316	11
2007	6628	7662	-1033	-13	5040	4998	41	0	-1593	-178	-1414	-791	3181	2842	339	11
2008	7476	8103	-627	-7	5789	5309	479	9	-1636	-166	-1469	-882	3322	2960	362	12
2009	8319	8544	-225	-2	6533	5620	913	16	-1679	-154	-1524	-987	3465	3078	386	12

Year	PARACHUTE ALL FUNDS				PARACHUTE GEN FUND				PARACHUTE WATER				PARACHUTE SANITATION			
	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-1194	-1102	-92	-8	-1081	-1029	-51	-5	-118	-77	-41	-53	5	5	-0	-0
1984	-1538	-1436	-101	-7	-1433	-1376	-56	-4	-111	-66	-45	-68	6	6	-0	-0
1985	-1876	-1768	-108	-6	-1782	-1721	-60	-3	-103	-54	-48	-89	8	8	0	8
1986	-2219	-2101	-117	-5	-2132	-2066	-65	-3	-96	-43	-52	-120	9	8	0	7
1987	-2554	-2428	-126	-5	-2479	-2408	-70	-2	-88	-31	-56	-179	12	11	0	7
1988	-2871	-2755	-116	-4	-2818	-2750	-67	-2	-74	-19	-55	-291	21	14	7	48
1989	-3134	-3082	-51	-1	-3136	-3093	-42	-1	-45	-6	-39	-613	47	17	30	175
1990	-4362	-3426	-936	-27	-3986	-3442	-543	-15	-428	-3	-425	-1194	52	20	32	158
1991	-4702	-3734	-967	-25	-4424	-3765	-658	-17	-400	8	-408	-4984	122	22	99	436
1992	-4941	-4010	-931	-23	-4700	-4055	-644	-15	-457	20	-477	-2386	215	25	190	752
1993	-5078	-4258	-819	-19	-4983	-4318	-665	-15	-404	31	-436	-1366	310	27	282	1013
1994	-5391	-4478	-912	-20	-5352	-4553	-799	-17	-389	43	-432	-986	350	30	320	1058
1995	-5690	-4666	-1024	-22	-5704	-4754	-949	-20	-373	55	-429	-768	387	32	355	1085
1996	-6065	-4856	-1208	-24	-6095	-4959	-1135	-22	-374	68	-442	-649	404	35	369	1051
1997	-6347	-5052	-1294	-25	-6439	-5169	-1269	-24	-353	79	-432	-546	445	37	407	1086
1998	-6567	-5249	-1317	-25	-6706	-5380	-1325	-24	-338	91	-429	-470	477	40	437	1094
1999	-6749	-5449	-1300	-23	-6958	-5595	-1363	-24	-311	103	-415	-400	520	42	478	1126
2000	-7020	-5652	-1367	-24	-7244	-5813	-1430	-24	-312	116	-428	-369	536	45	491	1091
2001	-7536	-6033	-1502	-24	-7621	-6109	-1511	-24	-463	28	-492	-1738	548	47	501	1051
2002	-7658	-6244	-1413	-22	-7730	-6335	-1395	-22	-486	40	-526	-1294	558	50	508	1009
2003	-7714	-6455	-1259	-19	-7777	-6561	-1215	-18	-507	53	-560	-1052	569	53	516	973
2004	-7771	-6665	-1105	-16	-7824	-6787	-1036	-15	-528	65	-593	-900	580	55	524	940
2005	-7829	-6876	-952	-13	-7872	-7013	-858	-12	-548	78	-627	-796	591	58	533	908
2006	-7886	-7086	-800	-11	-7920	-7240	-680	-9	-569	91	-661	-720	603	61	541	878
2007	-7943	-7297	-646	-8	-7967	-7466	-501	-6	-590	104	-694	-662	614	64	549	851
2008	-7992	-7507	-484	-6	-8011	-7693	-318	-4	-608	118	-726	-615	627	67	560	829
2009	-8040	-7718	-322	-4	-8054	-7919	-135	-1	-626	131	-757	-577	641	70	570	809

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 3.3-17 (continued)

	NEW CASTLE ALL FUNDS				NEW CASTLE GEN FUND				NEW CASTLE WATER				NEW CASTLE SANITATION			
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	-147	-144	-2	-1	-90	-88	-2	-2	-19	-19	0	0	-36	-36	0	0
1983	-1030	-1028	-2	-0	-594	-592	-2	-0	-280	-280	0	0	-156	-156	0	0
1984	-1464	-1462	-2	-0	-1018	-1016	-2	-0	-271	-271	0	0	-174	-174	0	0
1985	-1497	-1495	-2	-0	-1041	-1039	-2	-0	-262	-262	0	0	-193	-193	0	0
1986	-1531	-1529	-2	-0	-1064	-1062	-2	-0	-253	-253	0	0	-212	-212	0	0
1987	-1564	-1558	-6	-0	-1088	-1083	-5	-0	-245	-245	0	0	-231	-230	-1	-0
1988	-1598	-1588	-9	-0	-1111	-1103	-7	-0	-236	-237	1	0	-250	-247	-3	-1
1989	-1630	-1618	-12	-0	-1133	-1124	-9	-0	-226	-229	2	1	-270	-265	-5	-2
1990	-1662	-1648	-14	-0	-1154	-1144	-10	-0	-217	-221	3	1	-289	-282	-7	-2
1991	-1691	-1675	-15	-0	-1173	-1162	-10	-0	-208	-212	4	2	-309	-300	-9	-3
1992	-1716	-1699	-16	-1	-1187	-1177	-10	-0	-198	-204	5	2	-329	-318	-11	-3
1993	-1749	-1720	-28	-1	-1209	-1189	-20	-1	-188	-196	7	3	-351	-335	-15	-4
1994	-1767	-1738	-29	-1	-1216	-1197	-18	-1	-178	-187	9	5	-373	-353	-19	-5
1995	-1781	-1752	-29	-1	-1217	-1201	-16	-1	-167	-179	11	6	-396	-371	-24	-6
1996	-1793	-1765	-28	-1	-1218	-1205	-12	-1	-157	-171	14	8	-418	-389	-29	-7
1997	-1805	-1779	-25	-1	-1216	-1209	-7	-0	-146	-162	16	10	-442	-406	-35	-8
1998	-1802	-1793	-9	-0	-1201	-1214	12	1	-135	-154	19	12	-466	-424	-41	-9
1999	-1797	-1807	9	0	-1183	-1219	35	2	-123	-146	22	15	-490	-442	-48	-10
2000	-1793	-1821	28	1	-1166	-1223	57	4	-112	-137	25	18	-514	-460	-54	-11
2001	-1787	-1835	48	2	-1147	-1228	81	6	-100	-129	28	22	-539	-478	-61	-12
2002	-1759	-1849	89	4	-1106	-1232	126	10	-88	-121	32	26	-564	-495	-68	-13
2003	-1721	-1862	141	7	-1055	-1236	181	14	-77	-112	35	31	-589	-513	-75	-14
2004	-1684	-1875	191	10	-1004	-1240	235	19	-65	-104	38	37	-614	-531	-82	-15
2005	-1645	-1889	243	12	-952	-1244	291	23	-53	-96	42	43	-639	-549	-89	-16
2006	-1606	-1902	295	15	-900	-1247	346	27	-42	-87	45	51	-664	-567	-97	-17
2007	-1568	-1915	347	18	-848	-1250	402	32	-30	-79	49	61	-689	-584	-104	-17
2008	-1530	-1927	397	20	-796	-1254	457	36	-18	-70	52	74	-714	-602	-112	-18
2009	-1492	-1940	447	23	-745	-1256	511	40	-6	-62	56	90	-740	-620	-120	-19

	SILT ALL FUNDS				TOTAL											
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1982	-1609	-1589	-20	-1	-1756	-1734	-22	-1								
1983	-1541	-1521	-20	-1	-14701	-14448	-252	-1								
1984	-1434	-1414	-20	-1	-51199	-50922	-277	-0								
1985	-1325	-1305	-20	-1	-74394	-74216	-178	-0								
1986	-1465	-1445	-20	-1	-87618	-87878	259	0								
1987	-1654	-1635	-19	-1	-94421	-95452	1031	1								
1988	-1541	-1523	-18	-1	-104010	-106597	2587	2								
1989	-1424	-1410	-13	-0	-105307	-107695	2307	2								
1990	-1304	-1295	-8	-0	-107803	-108620	817	0								
1991	-1173	-1177	3	0	-103194	-105475	2280	2								
1992	-1025	-1051	25	2	-93912	-98597	4684	4								
1993	-1028	-930	-98	-10	-80542	-88798	8255	9								
1994	-835	-792	-42	-5	-65481	-76685	11203	14								
1995	-645	-648	3	0	-47273	-63853	16579	26								
1996	-440	-504	63	12	-25616	-48524	22907	47								
1997	-230	-359	129	36	-1065	-32839	31774	96								
1998	32	-217	250	114	25924	-17325	43250	249								
1999	309	-73	382	522	63447	-1746	65193	3733								
2000	575	71	504	710	97977	13839	84137	607								
2001	874	231	643	278	135107	29622	105484	356								
2002	1206	379	826	217	176097	46150	129946	281								
2003	1563	529	1034	195	224722	64175	160546	250								
2004	1919	673	1246	185	275900	82364	193535	235								
2005	2277	823	1454	176	327214	100693	226521	225								
2006	2635	973	1661	170	378850	119178	259672	217								
2007	2994	1124	1869	166	430628	137781	292846	212								
2008	3344	1275	2068	162	482533	156305	326228	208								
2009	3707	1426	2281	159	534547	175053	359493	205								

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Battlement Mesa is not an incorporated municipality, but rather a PUD, and public services are provided by the developer and by the county. It may be that significant growth would produce pressure for the incorporation of Battlement Mesa in order to provide higher levels of service.

The fiscal balances are shown for various funds and services provided by the City of Rifle. The Rifle water fund is structured so that it operates at a loss under all circumstances and the size of the negative balance will increase with rising demand. The sanitation fund and the general fund, on the other hand, are structured to show surpluses. The impact of the project on Rifle's general fund would be negative until 1994 when the deficit would reach minus 114 percent of the No-Action figure. This means that to this point, expenditures because of increased demand would exceed revenues. The balance would be helped in 1992 when Rifle would begin to receive severance taxes, estimated at $91,000 the first year. As these severance taxes increase to over $800,000 during full operation, by the year 2003, the negative impact of the project on the fiscal balance would decrease. By the year 2007, the impacts would be positive for the general fund, but they do not show a total positive difference in the all-fund account because of deficits in the water fund.

For Parachute, the situation would be similar to that outlined for Rifle. Increased demand would produce a proportional deficit in the fiscal balance until the severance tax comes on line, at which time a positive annual effect would result. During full operation, the severance tax would produce over $400,000 annually, about two-thirds of the expected total revenues. The size and duration of the negative fiscal balance before the severance tax becomes significant would not allow the general fund or the all-fund accounts to show a positive cumulative balance, although projections for a longer time period would. Silt would also show the influence of severance taxes on the cumulative fiscal balance, and by the year 2009, would record a positive impact of $2.2 million.

The effects on Mesa County and its jurisdictions would be somewhat different. The main differences are that no jurisdiction in Mesa County would qualify for property taxes from the Mobil Project, and severance taxes would never reach the same proportion of revenues as with Garfield County. Mesa County would obtain no direct increase in its assessed valuation base since the project facilities would be located in Garfield County, and its severance tax revenues would be quite modest, less than $200,000 (5 percent of the county budget) during full production. There would be an increase of up to $1.5 million annually in sales taxes. Mesa County's tax structure, with its emphasis on sales taxes, coupled with its position as the market center for the Western Slope, and especially the oil shale development area of south-central Garfield County, makes it possible to forecast a net fiscal balance gain with the Mobil Project.

Although most funds have shown deficits in the early years, the Mesa County municipalities (Grand Junction, Fruita, Palisade, and DeBeque) would all show net fiscal balance gains by the year 2009. The Grand Junction and DeBeque water funds would show negative impacts, which means that the annual deficits would be more severe with the added demands of the Mobil Project. Fruita water would show a balance where increased demand is paid for out of increased revenues. For the Palisade water fund, increased demand would produce a positive impact.

The general funds for Grand Junction and Fruita would show a steady positive impact that would increase once the severance tax begins to become a significant revenue source. For DeBeque and Palisade, a pattern of negative impacts would develop, until the severance tax revenues begin. However, the net balance by the year 2009 would be positive.

The capital facilities needs for these jurisdictions are outlined in Table 3.3-18. The capacities of current and committed facilities are included in the No-Action projections. Expansion of these capacities are made within the decision parameters reviewed and approved by CITF. The additional demand for capital expenditures through the year 2009 for the With Mobil as compared to the No-Action alternative is shown in the impact column. The most significant increases would be for Parachute, Rifle, and the Grand Junction General Fund. Not surprisingly, these areas are expected to be the location of significant population effects.

Table 3.3-18. Cumulative total capital expenditures, 1982-2009

	Expenditures ($000)		Impact	
Jurisdiction	No action	With Mobil	$	%
Mesa County				
All funds	$41,241.31	$41,807.54	$566.23	1.37
Grand Junction				
General fund	72,142.59	73,698.59	2,122.23	2.94
Water fund	23,943.96	24,900.89	956.93	3.99
Grand Junction City/County				
Sanitation	10,137.96	10,149.81	11.85	0.12
Fruita				
General fund	7,925.18	7,921.70	-3.48	-0.04
Water fund	2,657.94	2,656.68	-1.26	-0.04
Sewer fund	1,018.01	1,018.01	0	--
Palisade				
General fund	0	72.08	72.08	--
Utility fund	4,548.55	4,548.55	0	--
DeBeque				
General fund	431.08	449.07	17.99	4.17
Utility fund	111.55	139.37	27.82	24.94
Garfield County				
All funds	3,164.63	3,563.91	399.28	12.62
Rifle				
General fund	684.11	1,259.29	575.18	84.08
Water fund	64.24	577.92	513.68	799.63
Sewer fund	0	70.89	70.89	--
Parachute				
General fund	2,551.47	3,279.27	727.80	28.52
Water fund	233.34	812.10	578.76	248.03
Sewer fund	0	0	--	--

Source: FISPLAN, Bureau of Economic Analysis, 1983.

In summary, the total tax revenues expected to be generated by the Mobil Project would exceed the required expenditures by a substantial amount, over $360 million for the period 1983 to 2009. However, these fiscal benefits would not be equally distributed with the population which generates the expenditure demands. Garfield County would realize dramatic revenue increases while other jurisdictions would face either long- or short-term periods where projected expenditures exceed revenues. Capital expenditure needs are projected for most jurisdictions, but in each case they seem modest. The largest proportional increases would be in Garfield County, Rifle, and Parachute.

Social structure

The current study area social structure was outlined in Section 2.14.7, above. The basic attributes for defining functional groups and the activity patterns which distinguish intergroup relationships were discussed. Historical events, including the recent oil shale developments, have shaped the social structure in important ways. The discussion of the current social structure was concentrated on two distinct areas, south-central Garfield County and the Grand Junction metropolitan region of Mesa County.

The purpose of this section is to describe the social structure for the No-Action alternative, and then to distribute the effects of the With Mobil alternative to the groups. The types of effects distributed to the groups parallel those distributed to communities and jurisdictions; economic, demographic, housing, public facilities and services, and fiscal. Since there are no quantified data on the social groups as such, the distribution of effects and the probable response of the groups is qualitative.

Project-generated effects could be expected to produce social change within the groups and in the interaction patterns between groups. Change in both these dimensions could be expected to influence the evaluation of the project by the groups. In a number of cases, some project effects may be evaluated as positive and some as negative. The group values would determine the final assessment. The overall changes for the groups would effect some change in the interaction patterns between groups. All together, the intra- and intergroup changes describe the impacts of the project on the social structure.

Garfield County. Five groups were identified to help explain the social structure of south-central Garfield County. These groups were: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) other long-time residents, and (5) newcomers. The first four groups are dominated by natives and people who have been in the area for a considerable time. The newcomers, in contrast, are mostly oil shale people who recently have come into the area.

- No-Action alternative

Under the No-Action projections, growth rates for employment, income, and population are expected to be quite small; Garfield County's projection was for a 0.1 percent average annual rate of growth between 1985 and 2009. In fact, this is less than the rate of natural increase (births minus deaths) and implies annual out-migration. Therefore, there are no significant socioeconomic effects with the No-Action alternative that would, of themselves, produce important changes in the social structure. The major adjustment in the short term would be the decline and disappearance of the newcomers group as they leave the area for employment opportunities elsewhere or as they adapt and become long-time residents. There would be no replacement for this group under the No-Action alternative.

(It might be noted that there undoubtedly will be exogenous influence on these groups during the forecast period. Changes in the national, regional, or state economic, political, and social life can greatly affect local areas. Technological change alone has transformed rural life in the last few decades and might produce equal or greater impacts in the future. These exogenous factors may rearrange the study area groups and create entirely new intergroup patterns of behavior. However, the focus here is on factors that are specific to the study area and evaluation of the possible influence of these larger effects is beyond the scope of this analysis.)

- With Mobil alternative

A qualitative distribution of socioeconomic effects for the With Mobil alternative is based upon the distribution of the effects to groups, and their likely significance to the groups.

The farmers and ranchers who make up the majority of the agriculturalists group in Garfield County are not expected to benefit from the employment, income, purchases, or population effects. The most significant impacts would be those that influence land values and taxes. Property would be expected to rise in value because of increased demand for land, and some landholders may realize substantial gains. The addition of a major project to the county's assessed valuation could result in lower tax rates or higher levels of service, or both. Overall, the effects on the group are considered to be very important because of these two types of effects. The group evaluation would also include consideration of the overall effect on the agricultural lifestyle of the area, and on the relative position of farmers and ranchers in county politics. Both the lifestyle and the political position are likely to diminish in importance, although a substantial group presence would be expected to continue for the foreseeable future.

The businessmen and professionals group would not be directly employed on the project, but would benefit from the project purchases and especially from the nonbasic employment and income generated by the project. There would be some growth in the group size, and the overall housing demand would be important to the construction, finance, real estate, and legal sectors of the local economy. Public facilities and services should improve as a result of increased demand and because of the increased tax revenues. Overall, the businessmen and professionals group would experience significant but moderate effects. There would be some geographical distribution of impacts that could be important. For example, businesses in Parachute and Battlement Mesa would be more impacted by the Mobil Project than would those in Rifle, even though the economic benefits would be very important in Rifle. The group may attract new people who would not be directly dependent upon oil shale development. In some cases, these people may choose the area for its outdoor and recreational attractions, as well as for employment. This could lead to a vocal environmental segment within the business and professional community.

A large majority of the elderly group are either retired or not vitally interested in new economic opportunities. Therefore, no effects from employment, income, or purchases have been assigned to them. The size of the group would not decrease in numbers, but their proportion of the total population would decline because of the relative youth of in-migrants. For those who rent, increased housing costs because of rising demand may be a problem. The increased public facilities and services, along with the fiscal benefits, may be especially well-used by the elderly. Overall, the effects would be expected to be low. There may be concern among the elderly about how the community responds to project-related growth and its effect on family and community life.

The other long-time residents group would directly benefit from the onsite employment and wages the Mobil Project would generate, as well as from the increased nonbasic employment and income. There would be only a small effect on the group size for the first decade, but after that, their number would increase as newcomers become long-time residents (by definition). The housing effects would be low for those who owned, but more important for renters. The public facilities and services, and the fiscal effects would be low. Overall, because of the employment opportunities, the group effects would be relatively high. There may be some resistance to rapid growth within the group, especially by the nonbasic workers. They might feel that the lifestyle benefits they sought in moving to the area were being undercut by rapid growth.

The newcomers group would be the most impacted by the project; in fact, without the project, the group would most likely diminish greatly, or even cease to exist. With Mobil, it would become a significant presence in the social structure. The onsite employment would require worker in-migration, as would rapid expansion of the nonbasic portions of the economy, because of increased income and purchases. Population and housing effects would be directly responsive to employment. The public facilities and services and fiscal events would be important to the newcomers because they are the group that would generate increased levels of demand. Overall, the socioeconomic effects from Mobil would have a high level of impact on the newcomers group. Their jobs and residence in the area would be both directly and indirectly connected to the project.

- <u>Intergroup interaction</u>

The No-Action alternative would assume little change in the economic, political, and social relationships between the groups, since the growth in the economy and population would be very small. The With Mobil alternative would produce significant changes, mostly through the shift in the size and dynamics of the groups most responsive to rapid growth.

For the With Mobil scenario, the agriculturalists and the elderly could expect to lose political and social power as they become a smaller segment of the social structure. Their established positions could provide them with influence beyond their mere size, but overall, these two groups would decline in importance. The simultaneous erosion of their lifestyles and value system may provoke a negative evaluation of proposals and projects that would seem to be the cause of rapid growth.

The businessmen and professionals group is likely to be strongly pro-growth because of the economic benefits. They should strengthen their position on all levels, socially, politically, and economically. This is because they would realize significant economic benefits and because they tend to be well-organized in the civic, community, business, and political spheres. However, a minority of this group may oppose oil shale development on environmental grounds.

The other long-time residents and the newcomers group would increase in size most rapidly. Their links with each other would tend to merge the two groups within a few years. Although they make up the largest groups, they are less well-organized than the others on political issues, and less well-positioned for social and economic advancement. Numerous small subgroups would be expected to form, based upon occupation, residential location, family lifestyle, ethnic, or religious characteristics. Once the newcomers have been in the area for a decade or so, the other long-time residents group would increase with transfers, and the newcomers group would decline to include mostly replacement people.

Overall, the effect of the large number of newcomers would be very significant. These people would have to be integrated into the social structure, both as individuals and as a large, important new group. The result is likely to be a major realignment of the social structure where the numbers, income, and lifestyles of the working-class people become more important. The ability of the businessmen and professionals group to manage change and to adapt to the new social structure should work to their advantage.

Grand Junction and Mesa County. The context for the social structure in Mesa County is determined to a large degree by Grand Junction, which is the population, market, and service center for the Western Slope. Although there are many ties with the neighboring rural communities, the urban characteristics are marked and this fact has served to shape the social groups and their interaction patterns. In addition, Mesa County has a relatively large population and a history of assimilating growth. The five groups identified in Section 2.14.7, above, were: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) other long-time residents, and (5) newcomers.

- No-Action alternative

The projections for the No-Action alternative estimate that Mesa County will have a population of 89,173 in 1985 and this will increase to 98,149 by the year 2009. This would be a very modest growth rate, just under 0.4 percent average annual rate of increase. The natural population increase would be expected to be greater than this rate, with the result that there would be an out-migration of local workers who would have to seek jobs in other areas. Under these conditions, the group characteristics and the patterns of intergroup relationships would be unlikely to change significantly. The newcomers would become fewer and, as a significant group, they might disappear. There could be shifts within groups. For example, those in the business community devoted to building and development activities would be less active than they have been in the recent past. Overall, the projection of stable econcomic and population conditions also implies a stability on the part of the social structure.

- With Mobil alternative

Unlike Garfield County, where employment, income, and population impacts are projected to peak in the 40 to 70 percent range, for Mesa County, the level of impacts is much smaller. Employment could rise 10 percent and income 12 percent, but population would only be expected to increase by 4 percent over the No-Action alternative. While these increases are important and may mark the difference between a dynamic growing social structure and a stable or even stagnant one, the effects must be considered as moderate even at their peak. The qualitative distribution of these effects serves as the basis for the group-by-group discussion.

Four groups are assessed as likely to experience low overall impacts from the Mobil Project: the agriculturalists, elderly, Hispanics, and other long-time residents. The additional demand for land, residential, commercial, and industrial, would affect the agriculturalists, especially the orchardists east of Grand Junction. Whether this is viewed as a benefit or not will depend upon whether the group assesses increased land values as more important than the traditional agricultural uses. The current split in values on this issue within the group can be expected to continue into the future. A possible increase in rents may also affect the elderly and other long-time residents. Employment and income effects are likely for small numbers of the other long-time residents group, but unlikely for the elderly or agriculturalists. Project-generated purchases might produce some nonbasic employment and income for the other long-time residents group. Eventually, members of the newcomers group would become long-time residents. Little or no population effects are expected for the agriculturalists or the elderly. Since over 90 percent of the Mobil Project tax revenues would go to Garfield County, none of the Mesa County groups would be expected to experience significant fiscal gains. There would be only minor additional demand on public facilities and services as a result of diminished out-migration and modest in-migration.

The businessmen and professionals group was assessed as likely to experience a moderate level of effects overall. Employment, population, and fiscal effects were judged as low. Increased spending, because of higher overall income, and purchases on behalf of the Mobil Project would be a positive, but moderate benefit to this group. The housing impacts would mostly be felt in terms of a business response to rising demand.

The newcomers would be the most affected of all groups; their very presence in the area would depend upon the employment and income effects. The increase in population and housing would produce public facilities and services impacts, but these would be only modest increases.

- Intergroup interaction

At the current time, the social structure is dominated by the businessmen and professionals group. This is unlikely to change. The agriculturalists and the elderly would both become a somewhat smaller proportion of the population because of overall growth. However, the size of the population shifts would not be enough to change the relative position of these groups nor their established patterns of interaction. The other long-time residents would be stabilized with the increased employment and diminished out-migration. Eventually, the newcomers would increase the size of the other long-time residents group. In fact, over the life of the project, given the stability of the operations work force, the newcomers group would eventually be fully integrated as they become other long-time residents.

Premature shutdown

An understandable concern in the region is the possibility of delay, premature shutdown, or abandonment of the Mobil Project. Regional residents have a sophisticated understanding of the largely uncontrollable technological or economic factors that can suddenly alter a project's viability. If such conditions combine to force either temporary shutdown or premature abandonment of a project, what would be the impact on the region? The effects would be driven by large losses of jobs and tax base. If there were no substitute sources of employment, population could be expected to out-migrate from the region.

The public sector might face a particularly difficult situation because, in the transition period, service demands might actually increase while revenue sources might be falling. Over the longer term, service demand should decline, but a problem might exist if current residents have adjusted to the higher levels of service standards that resulted from the availability of resources. As those resources disappear, the downward adjustment of service standards might be painful. Further, there might be cases where large capital facilities would be involved and the service levels could not be adjusted. The result might be that the public sector would be forced to try to sustain oversized facilities.

Socioeconomic conclusions for the study area

The assessment of socioeconomic impacts has necessarily involved making numerous assumptions regarding future social and economic conditions. The reader is cautioned to keep these assumptions in mind when interpreting the following conclusions.

Construction employment is expected to exceed 3800 for a period of 7 years, 1993 through 1999. Operation employment is expected to increase to 3410 by the year 2002 and maintain that level for the rest of the projection period. Unemployment rates would be expected to drop. The labor force would increase as demand for workers would exceed local supply and would require in-migration of workers and their households to the study area.

Income from basic employment and purchases on behalf of the project would produce additional nonbasic employment and income in the study area. This nonbasic demand would also require workers in excess of local labor market availability. Total study area employment impacts are expected to rise to over 11,000, or a 20 percent increase by 1999; for the operation period, the increase is expected to be over 7200, or about a 12 percent increase. The nonbasic employment would also add households and population through in-migration and diminished out-migration.

Population increases are projected to be 14,771 in 1999, an increase of 12 percent over the No-Action alternative, and in the 10,000 to 12,000 range (8 to 9 percent increase) during operation. The population impacts would be expected to be greatest in Garfield County, increases of 25 to 40 percent, compared to about 4 percent for Mesa County. Battlement Mesa, with a 488 percent increase at peak employment in 1999 and a 267 percent increase during operation, would be the most impacted community, followed by Parachute, with 154 and 80 percent increases, and Rifle, with 66 and 46 percent increases.

The study area housing industry has demonstrated its ability to provide new units as demand increases. For the study area, the housing demand is expected to increase by over 5000 units during the impact period, 1987 to 2009. About 65 percent of this addition would be in Garfield County, with Rifle accounting for 1244 units, Battlement Mesa 695 units, and Parachute 289 units.

The increase in school-age population, ages 5 to 18, would follow the same pattern as population. Five school districts provide education. At peak employment, the impact is projected to be over 3200 children. More than two-thirds of these children would be in Garfield County school districts, 1180 in RE-16 and 1112 in RE-2. Joint District No. 49 and Mesa County District No. 50 would receive only minor impacts. About one-third of the the children would be in Mesa County District No. 51. The numbers of school-age children would decline somewhat during operation, but the proportional distribution to school districts would remain generally the same. Both Garfield County School District RE-16 (Battlement Mesa/Parachute) and Mesa County Valley School District No. 51 are expected to have demand exceed current capacity; in the past, RE-16 obtained substantial assistance from the Oil Shale Trust Fund and the oil shale developers to construct additional space.

The public fiscal impacts of Mobil would be significant and positive for the overall study area; the net cumulative balance by 2009 is projected to be almost $360 million. The most important revenue increases would be from the property tax, severence tax, and sales tax. Garfield County would realize over 93 percent of the fiscal benefits through property tax increases because of onsite improvements by Mobil. Property tax increases because of residential, commercial, and industrial uses for other jurisdictions, do not produce any significant positive fiscal balances. Severance taxes would make the difference between positive and negative fiscal impacts for several jurisdictions. The phasing in of the severance tax after production begins, means that during construction, negative fiscal balances are forecast for Rifle, Parachute, Silt, Palisade, and DeBeque. Sales tax revenues would mainly benefit Mesa County and Grand Junction, because of the tax rate and the role of the Grand Junction metropolitan area as the market center for the Western Slope. The positive fiscal balances from this source would be modest, but they contribute to Mesa County's projected $11.6 million cumulative balance by 2009.

The physical and service capacities of most jurisdictions are adequate, with the addition of currently committed capital projects, to accommodate both the No-Action and the With Mobil alternatives. Significant additional capital-funding needs for the With Mobil scenario were identified for Mesa County School District #51, RE-16, Grand Junction, DeBeque, Rifle, and Parachute.

Changes in the social structure would be expected to take place in both counties, but would be most significant in Garfield County, because of the size of the impacts and the relatively small size of the in-place social structure. In Garfield County, the large in-migration of newcomers would make them a major factor. The other long-time residents group would be strengthened through increased employment and income, and because of diminished out-migration. The businessmen and professionals group would be expected to increase its influence because of its strategic position and its organizational abilities. A declining position would be expected for the agriculturalists and the elderly. In Mesa County, the newcomers group would grow and become more important. However, the overall impacts would be modest and in-migrants should be readily integrated into the current social structure.

3.3.1.15 Transportation

General impacts

The major transportation impacts of the Mobil Project would affect motor vehicle transportation and the road system within the project region. The population growth that is projected as a result of the project, including the construction and operations workers and their families and the secondary population growth, would add traffic to the state, county, and local road system. Although significant increases in traffic are projected, the proposed action is not expected to cause significant congestion or delays. Air transportation would increase because of the increase in population; however, capacity is available to accommodate the growth. Rail traffic would increase as a result of shipping in of materials and supplies for the proposed action and other associated activity, shipping out of by-products, and the local shipment of syncrude from the project. These shipments should not significantly affect other rail transportation in the region.

Roads and highway impacts

The analysis of impacts on the road system was performed using techniques developed by BLM (1982). Data used in the calculations were obtained from the Colorado Department of Highways, from the overall socioeconomic impact assessment, and from the CCSOP EIS (BLM, 1983a).

The traffic impacts associated with project development are presented in Table 3.3-19. The impacts are expressed in terms of the ratio of the peak hourly traffic (PHT) to the capacity of the road segment at service level "C." This is the service level that is applicable to roads in rural areas. The locations of the road segments are identified in Figure 3.3-11 as segments A through E, which correspond to parts of Interstate 70. All of the ratios for project development would be below 0.8. This means that the road segments have adequate capacity to handle the anticipated traffic. In 1999, the peak year of project-related employment, the ratio for segment G would be greater than 1.0 for both the No-Action and the With Project cases, indicating significant delays. However, the project would increase the ratio by 5.0 percent. In 2009, the ratio for segment H rises above the 0.8 level as a result of the project. This indicates that momentary or minor road congestion may occur.

Airports

The increase in population as a result of the Mobil Project would cause increases in air traffic for both Walker Field at Grand Junction and the Garfield County airport at Rifle. The impact on air traffic would not be significant since recent or planned expansions and improvements in both airports would accommodate the expected increases. An increase in demand could cause renewal of commercial service to Garfield County airport.

Railroads

Incoming materials and supplies that would arrive by rail during construction would be off-loaded on a siding just east of Parachute. Ammonia and chemicals, shipments, and by-products of the retorting and upgrading process would be

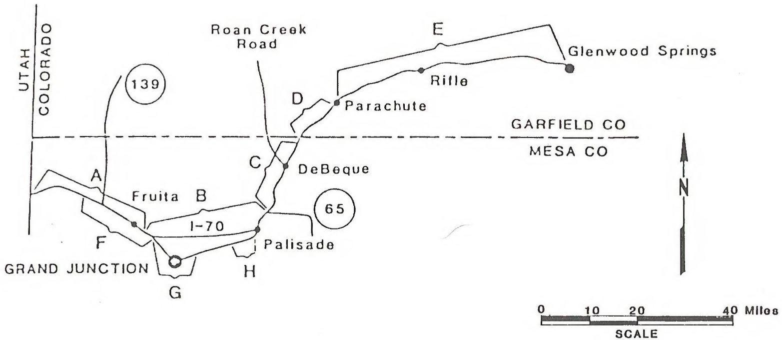


Figure 3.3-11. Traffic impact assessment segments

Table 3.3-19. Anticipated impact of Mobil Project on major highway segments (PHT/capacity ratio)[a]

Segment[b]	1999[c] No action	1999[c] With project	1999[c] Percent difference	2009 No action	2009 With project	2009 Percent difference
A	0.24	0.24	0	0.25	0.25	0
B	0.35	0.42	20.0	0.42	0.48	14.3
C	0.37	0.46	24.3	0.45	0.50	11.1
D	0.36	0.46	27.8	0.44	0.50	13.6
E	0.40	0.75	87.5	0.49	0.75	53.1
F	0.86	0.86	0	1.04	1.04	0
G	1.59	1.67	5.0	1.72	1.76	2.3
H	0.63	0.77	22.0	0.76	0.84	10.5

[a]Ratio of Peak Hourly Traffic to capacity.
[b]See Figure 3.3-10 for location of segments.
[c]Peak year of Employment.

shipped via rail. These shipments would not significantly affect rail traffic in the area. The impacts on at-grade crossings would not be significant, given the low level of rail traffic.

Pipeline

The syncrude would be transported to the Midwest or Gulf Coast via an industry pipeline such as the LaSal pipeline proposed by Exxon. Shipment in this way would greatly reduce any short-term impacts caused by rail shipment, which would be used primarily during initial stages of operation.

3.3.2 Unavoidable adverse impacts

Brief descriptions of unavoidable adverse impacts that would result from the proposed action are given below. An indication of their severity and the time span of occurrence is also included.

- There would be minor degradation of air quality during construction, particularly from particulates; moderate air quality degradation would occur during the operational period, particularly from TSP, NO_x, and SO_2.
- Moderate and short-term increases in noise levels would occur at particular locations during construction and operation.
- Existing topography would be disturbed through construction of plant facilities, roads, reservoirs, and dams; there would be strong alteration of existing topography by surface disposal of processed shale.

- The oil shale resource would be depleted through extraction during mining.

- Potentially valuable paleontological values in the Green River Formation would be lost.

- There would be a loss of soil cover and productivity; most losses would be recovered at abandonment but, that on the 540 acres used for the Main Elk Dam and Reservoir would be long term.

- Drying of surface springs and seeps might potentially occur on the Roan Plateau from dewatering the Mahogany Zone. This would be a long-term impact that would impact surface drainage flows and stock watering practices.

- Short-term use would be made of approximately 10,160 gpm of Colorado River water during full production operations.

- Degradation of water quality would potentially occcur because of erosion of processed shale embankments. After project abandonment, long-term erosional processes would cause loss of soil cover from the faces of the processed shale embankments. Contact of runoff with processed shale could cause water quality degradation in downstream surface waters because of dissolution of soluble minerals in the processed shale. Applying the Universal Soil Loss Equation (SCS and EPA, 1977), a theoretical erosion rate of 16 tons per acre per year was calculated for the 3.5:1 embankment faces, which would be a relatively high rate for the limited soil depth on the reclaimed surface. Increases in TDS, arsenic, fluoride, boron, molybdenum, zinc, and other heavy metals could potentially occur in Wheeler Gulch flows and, to a lesser extent, Parachute Creek flows. Mobil conducted preliminary leaching tests of Mobil shale retorted at the Anvil Points Paraho retort. Results indicated that, except for arsenic, the maximum amount of element leaching occurred within 24 hours. Based on these preliminary results, the effects on water quality would be temporary. However, if erosion continued to expose unleached processed shale, the impact would be a long-term effect. Future uses of surface waters originating in Wheeler Gulch could be affected while water quality in Parachute Creek would be less severely degraded, since Wheeler Gulch contributes only about 1.3 percent of the annual average flow in Parachute Creek above the mouth of Wheeler Gulch.

- The development of Main Elk Reservoir would result in the loss through inundation of about 2.2 miles of Main Elk Creek, a high quality stream habitat area.

- Populations of wildlife species would potentially be reduced through habitat loss, habitat degradation, and some direct mortality. These losses are expected to be major for the project site, but only moderate for the immediate region. They would be short term and would occur only during construction and operation.

- Terrestrial and aquatic habitats would be lost.

- Local displacements of sensitive wildlife species (raptors and big game) would potentially occur because of disturbances from project activities and increased human populations in the area.

- Destruction or disturbance of about 3919 acres of vegetation would occur during construction of the project; reclamation during the abandonment phase would replace this vegetation. Some 540 acres of riparian and agricultural vegetation in the Main Elk Reservoir area would be permanently lost.

- Moderate short-term impacts on visual resources would result from the presence of structures and adverse landform and vegetation alterations during project construction and operation.

- A significant long-term effect on visual resources would result from the construction of the access roads in Cottonwood Gulch; this would remain indefinitely.

- Agricultural land would be converted to other land uses. This would be an unavoidable adverse impact in terms of the region's concern for preservation of agricultural land.

- Degradation of regional wilderness would result from increased use by the larger population of people during the construction and operation phases.

- Users of junior water rights may not have water currently being used available after project development.

3.3.3 Irreversible and irretrievable commitment of resources

The irreversible and irretrievable use of various resources required for completion of this project are listed below. Resources that would be used during the construction and operation of the project, but then could be reconstituted or replaced, are not included.

- About 742 million barrels of shale oil would be produced during the life of the project; this resource would not be renewable.

- Paleontological resources would be lost through mining of the fossiliferous strata for its hydrocarbon content.

- About 540 acres of agricultural land would be covered by the water storage reservoir and dam; this would include about 150 acres of potentially prime agricultural land.

- There would be permanent changes in the hydrologic regimes and drainage courses of Cabin Water Gulch, Wheeler Gulch, and the streams above and below the Main Elk Reservoir dam.

- Riparian vegetation in the Main Elk Dam and Reservoir area along Elk Creek would be lost.

- Long-term or permanent changes in scenic quality would result from road cuts, talus slides, and processed shale embankments.

- Cultural and historical resources would be lost.

- Some degradation of air quality would occur in the area as a result of urbanization after abandonment.

3.3.4 Relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity

Short-term uses are those which would result directly and indirectly from construction and operation of this project, and would occur over approximately a 30-year period of time. Short-term uses and effects on long-term productivity of the environment are discussed below.

- The use of over one billion tons of rich oil shale from the Mahogany Zone to produce syncrude would occur during the short term and, as this resource would not be renewable, would affect long-term productivity. The energy provided by the oil would certainly fulfill part of the nation's needs in the short term. In addition, the new technology and knowledge gained through this process could allow future use of lower grade reserves and could elevate them to the status of potential resources. Thus, while large tonnages of ore would be used up, an even larger resource base could be made available by the project.

- Air emissions would use up some of the allowable air increments under PSD regulations. This could, in the short term, restrict other nearby development. There would be no effect on long-term productivity, however, as emissions would cease at abandonment.

- The construction of the dam on Main Elk Creek and filling of the Main Elk Reservoir would allow storage and use through the year of runoff normally released downstream. This use would cause annual reductions in the downstream flow regime, slightly elevated salinity percentages, and reductions in water available to junior water rights. All of these uses would be short term. Water used by the project would again be available when the project ceases; thus, there would be no effect on long-term productivity from changes in water quantity and availability. However, since the reservoir would remain after the project ceases, the more steady and predictable flow provided by the reservoir might increase long-term productivity through use of water for new projects.

- Uses of ground water in wells and from springs and seeps might be changed if the underground mine interception of ground-water aquifers changes their water balance or their water quality. These would be long-term changes that could alter patterns of productivity and also increase or decrease it.

- Use of grazing lands on the Roan Plateau and Mahaffey Ranch for industrial purposes would reduce the regional carrying capacity through the loss of soil, vegetation types, and wildlife habitat. This would be a short-term effect which would affect long-term productivity positively or negatively, depending on the success of reclamation efforts. The changes in topography resulting from processed shale in Wheeler Gulch might, in the long term, increase the productivity of the area for domestic grazing animals, but decrease productivity for native species that now occupy specialized habitats in the gulch.

- Use of the terrestrial and stream habitats inundated by Main Elk Reservoir would be eliminated; these changes would be long term, since the reservoir would remain after abandonment. The existing habitats would be replaced by aquatic reservoir habitats, with resultant changes in long-term productivity.

- Use of recreational facilities in the project vicinity would increase because of population growth. The changes in use related to this project would be short term. However, the people who came to the area for this project might remain, extending short-term changes in use into the long term.

- Employment by the Mobil Project would reduce area unemployment and bolster the local economy. This short-term direct effect of the project could extend into an indirect long-term effect on the regional economy and productivity, if most of this population remained in the area. Associated with the population increase would be the development of an infrastructure of facilities and organizations in surrounding counties. This infrastructure could enhance the long-term productivity of the region.

3.3.5 Committed mitigation

Mitigation is defined as avoiding, minimizing, compensating, rectifying, reducing, or eliminating an adverse environmental impact (BLM, 1981a). Rights-of-way across public lands will contain site-specific stipulations which will mitigate known impacts.

3.3.5.1 Recreation

The Bureau of Land Management will require public access to and public use of the Main Elk Reservoir, in accordance with a recreation management plan approved by the Bureau of Land Management and coordinated with appropriate local and state governmental agencies.

3.3.5.2 Wildlife

Mobil shall be required to mitigate for loss or displacement of wildlife habitats in accordance with applicable law and regulations.

Prior to each construction phase, the applicant shall provide a habitat recovery and replacement plan which would analyze the site-specific loss or displacement of wildlife habitats due to oil shale recovery operations. Such analyses shall employ best current practices and shall be approved by BLM after consultation with USF&WS and CDW and will involve participation by project sponsors. These evaluations shall be conducted within a sufficient time frame to ensure that all affected habitats will be fully evaluated prior to disturbances and to ensure that appropriate mitigation measures are identified and committed to.

Prior to initiation of construction activities, applicant shall develop a mitigation plan that will detail how applicable mitigation measures identified in the FEIS, ROD, or the habitat recovery and replacement plan will be implemented.

The habitat recovery and replacement plan shall include the following:

(1) A habitat analysis of the area affected by construction which:

(i) identifies the important wildlife species and important plant communities which occupy the project area, and

(ii) includes an analysis of the quality and quantity of the habitats under pre- and post-project condition.

(2) A detailed description of the methods available to mitigate habitat loss, together with comparative analyses of alternative methods which were considered and rejected by the applicant and the rationale for the decision to select the proposed methods.

The methods used by the applicant for recovery and replacement may include, but not limited to, the following techniques:

(i) Avoidance of critical/high quality habitats.

(ii) Increasing the quantity and quality of forage available to wildlife.

(iii) The acquisition of critical wildlife habitats.

(iv) Manipulation of low quality wildlife habitat to increase carrying capacity for selected wildlife species.

(v) Recovery, replacement, or protection of important wildlife habitat by selected control methods.

(3) A timetable will be developed which details when the work will be done and which demonstrates the tie-in with the overall project plan.

(4) A description of the means by which mitigation progress and success will be monitored.

To the extent practical, BLM, USF&WS, and CDW will assist project proponents in development and monitoring of wildlife mitigation efforts.

3.3.5.3 Cultural resources

As indicated in Section 3.2.10, five prehistoric sites were identified in the project area which require further study to determine their significance in terms of National Register of Historic Places' criteria. Mobil will be required to determine their significance before they are affected by any construction activity.

If any sites eligible for the National Register of Historic Places will be affected by the project, Mobil will be required to propose a data recovery plan of excavation, with catchment and paleoenvironmental sample analysis, artifact analysis, and C-14 dating. Methodology and research questions will be approved by the BLM and State Historic Preservation Officer.

3.3.6 Uncommitted mitigation

The mitigation measures discussed below are uncommitted actions suggested by the BLM for consideration by Mobil, or by regulatory agencies in their permitting processes. They are measures that have been used in the past for projects with similar features and could reduce the impacts discussed in Section 3.3.1.

3.3.6.1 Climate and air quality

Mobil has outlined a detailed program of control and/or mitigative actions to minimize atmospheric emissions and ensure compliance with BACT and NSPS requirements. For mining and material handling emissions, mitigative measures include covered conveyors, baghouses, scrubbers, water-sprays, cyclones, and dilution ventilation. For process emissions, mitigative measures include high efficiency cyclones, wet scrubbers, baghouses, a sulfur recovery plant, and flue gas desulfurization (FGD) equipment. Hydrocarbon control includes an incinerator to reduce hydrocarbon concentration, fixed and floating roof tanks as appropriate, pressurized spheres, and a specific maintenance program. No additional specific mitigative measures are proposed; however, it is incumbent upon Mobil to ensure that the above program is effective and that regulatory requirements are met. Mitigative measures may be further refined at the time of application of a PSD permit.

3.3.6.2 Topography, geology, and mineral resources

Topography

Topographic impacts would be minimized by proper engineering design of roads, facility sites, and reservoir sites, and by proper emplacement of processed shale piles. Further reduction of topographic impacts would be made by appropriate recontouring and reclaiming of the disturbed areas after the cessation of project activities.

End hauling plus construction, design, and building features should be employed where practical to minimize impacts of the access road.

Geology and mineral resources

Possible impacts from unstable ground, rockfalls, and faults may be reduced or avoided by following currently accepted engineering procedures, including avoiding unstable ground, grouting areas in the vicinity of faults, installing barriers in areas of potential rockfall, and installing proper drainage in landslide areas and talus slopes. Unmined oil shale in the Mahogany Zone lost through mining, pillars in the Mine Zone, and thick deposits of lower grade oil shale above the Mahogany Zone may possibly be recovered through an in situ extraction method.

3.3.6.3 Paleontology

Avoidance is the primary means of mitigating potential adverse impacts to known fossil locations. An option is the salvage of identified fossil resources, which should be completed prior to initiation of construction in paleontologically sensitive areas. Any fossils found during construction should be brought to the attention of appropriate state and Federal agencies and impacts to these discoveries should be properly mitigated. Systematic monitoring of excavations in paleontologically sensitive units will expedite any necessary mitigation procedures.

3.3.6.4 Soils and reclamation

Impacts to soils by the project (except for the soils under the processed shale and waste disposal sites, and the reservoir) would be mitigated by existing reclamation plans. These include topsoil stripping and stockpiling; stockpiled soil protection from erosion; dismantling of project installations; regrading to achieve favorable land surfaces; placement of stockpiled topsoil; and the establishment of an effective vegetative cover of adapted plants which are primarily natives.

To minimize erosion of the processed shale, prevention of livestock grazing on embankment slopes would be essential. Erosion is discussed further in Section 3.3.6.6.

3.3.6.5 Ground water

Disturbance to the hydrogeological regime during the construction, operation, and abandonment phases of the Mobil Project is unavoidable; however, if the disturbance to the existing ground-water regime is minimized, the associated impacts will also be minimized. The degree of disturbance can be minimized, for example, by avoiding areas where the water table is at or close to the ground surface.

Dewatering/depressurization of the Mahogany Zone during mining could adversely affect the discharge from some springs and seeps along the valley walls and in the area overlying the mine. If the discharge from a spring or seep which, for instance, is used for stockwatering purposes, the provision of an alternative water supply may be the required mitigative action.

The processed shale disposal site and other waste handling, storage, and disposal sites are areas that would have a high potential for contamination and degradation of both surface-water and ground-water quality. Conservatism in the design and construction of the facilities for both liquid and solid wastes would help to minimize the potential for adverse impacts. Of importance is the design and construction of the liner system for the processed shale disposal pile, and the provision of an underdrainage system to collect any leachate generated within the pile and to prevent the buildup of the ground-water table within the pile itself and within the valley walls adjacent to the pile.

Background ground-water data have been collected for the Mobil Project and are included in Mobil (1982a). Prior to the initiation of construction, a comprehensive ground-water monitoring program should be implemented. The objective of this monitoring program would be to assess ground-water quality and hydraulic conditions prior, during, and after mining and plant operations. The monitoring should be designed to detect any changes in the character of the ground-water system, and to assess if these changes are significant and are the result of project development and operations. If significant ground-water quality degradation is detected, appropriate mitigative actions should be undertaken. This could entail source elimination, containment of the spill or contaminants by physical or hydraulic means, and removal and treatment or disposal of the contaminated ground water. Depending on site-specific circumstances, this could involve the installation of a slurry wall or grout curtain separately or in combination with one or several pumping wells to contain and remove the contaminated ground water.

3.3.6.6 Surface water

Mitigation would include sound engineering design of pipelines, dams, drainage crossings, and transportation routes to minimize erosion and the likelihood of contamination of surface water from spills as well as adequate precautions in the transport and handling of materials. Specific measures to mitigate the effects of spills should include a smoothly implemented spill prevention, control and countermeasures plan, installation of automated pipeline monitoring equipment, and inventory management for all product, by-product, and fuel storage tanks.

The high erosion rate on the processed shale embankment slopes of 16 tons per acre per year and the eventual degradation of surface-water quality from contact with exposed processed shale could be ameliorated by revisions to the design of the completed, reclaimed embankments. Some combination of design revisions intended to meet the following goals could be used:

- Reduce the annual embankment face erosion rate to an acceptable level (less than 5 tons per acre per year) by reducing the embankment slope and the vertical distance between benches.

- Consideration of installation of an underdrain between the compacted liner and the processed shale pile.

- Provide water-control structures (e.g., water bars) on roads.

- Limit all roads to less than 10 percent pitch grades.

- Measures other than design modifications could include: 1) the use of mine backfilling to reduce the volume of processed shale requiring surface disposal, and 2) continuing processed shale disposal area management after abandonment of the remainder of the project areas.

Operation of the Main Elk Reservoir should include flushing flow releases.

3.3.6.7 Aquatic ecology

Placement of special fishing regulations on Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch could be used to control overharvest of Colorado River cutthroat trout. The regulations would need to control harvest and could include: reduced creel limit, restrictive size limits, catch and release streams, or closing the streams to fishing.

Seasonal instream flows below the Main Elk Dam and Reservoir should be maintained for riparian habitats and the fishery.

Potential blockage of fish movement by the Colorado River diversion dam could be minimized by use of best technology currently available (BTCA). A notch in the diversion dam should provide a passageway for fish migrating upstream.

Designing the water intake according to BTCA would mitigate most impingement and entrainment of aquatic organisms. The incorporation of fish protection devices on the intake would further reduce impingement of fish. Intake screens with 3/8 inch or smaller openings would reduce entrainment. The intake should be constructed during periods which avoid fish spawning.

Impacts associated with increased fishing pressure created indirectly by project-related population growth, could be mitigated by increasing the number of fish in the area through creation of additional habitat or by stocking more fish. Main Elk Reservoir would provide additional aquatic habitat; by establishing a fishery and permitting public fishing on the reservoir, a portion of the increased fishing pressure impacts would be mitigated. To mitigate increased fishing associated with construction, about 267,280 fish would have to be stocked annually; about 351,600 fish would be needed annually during project operation.

3.3.6.8 Vegetation

All unique and irreplaceable habitats, including those of threatened and endangered species of plants, should be avoided whenever possible. Mitigation for plant communities and habitats that have been disturbed or destroyed would be accomplished by a detailed reclamation plan for all disturbed areas. These areas would be planted with species adapted to the region, which would eventually create stable and productive plant communities. The BLM will require mitigation of habitat losses on public lands.

Some mitigation for special-status species could occur by transplanting established plants to suitable habitats on the project site, but only when research has provided appropriate establishment techniques, and when plants are available.

Releases from Main Elk Reservoir should include flushing flow releases.

3.3.6.9 Wildlife

Possible procedures for mitigating the impacts of project development on wildlife include: siting options, buffer zones, seasonal timing of construction, wildlife-oriented construction features, established road and off-road vehicle restrictions, improvement of existing habitat, recreational restrictions, and wildlife-oriented reclamation.

Wildlife-oriented construction features could include scheduling construction activities to avoid critical big game habitats during key periods of time (e.g., nesting, fawning), minimizing fencing so as to not exclude wildlife except from hazardous areas, and electrocution-proof transmission towers to protect perching raptors.

Vehicle speed limit restrictions on established roads and the use of mass transportation vehicles for project personnel would reduce the number of road kills. Best technology available could be employed to minimize road kills of big game if road kill frequency exceeds 10 per mile per year (may include fencing and construction of big game passageways). Off-road vehicle use restrictions would reduce stress to wildlife, particularly during critical periods in wildlife life cycles such as raptor nesting periods and winter/early spring use of big game feeding areas.

In concert with a reservoir fluctuation plan to improve nesting success, islands and nesting structures could be established at Main Elk Reservoir for waterfowl.

Improvement of habitat beyond the area of disturbance through chaining, brush beating, clear-cutting or selective thinning of forests, nitrogen fertilization, control of grazing pressure or addition of water sources would be a potential option to improve its carrying capacity and allow it to accommodate some wildlife displaced from the area of disturbance.

Control of recreational activities such as hunting and snowmobiling would reduce stress to wildlife. A company firearm policy could be implemented to curb employee possession of weapons while at work and while commuting to and from the project site. Wildlife protection education could be promoted as part of employee orientation.

Revegetation programs could utilize shrub and other species of importance to wildlife as part of the seed or live-planting mix to enhance wildlife food and cover. Roadway shoulders and borrow ditches should be reseeded with unpalatable vegetation to lessen attraction of big game to these reseeded areas.

In consultation with the Colorado Division of Wildlife and the USF&WS, and in recognition of funding limitations, Mobil could develop an in-house regional wildlife monitoring program to include, where needed and appropriate, such studies as habitat condition and trend, big game population distribution and movements, and nesting raptor distribution and status.

In addition to the above, the following policies could be adopted:

- No activity will occur within a 0.5 mile buffer zone of any occupied or active raptor nest except as approved by USF&WS and CDW.
- No destruction of raptor nests will occur except as specifically permitted by USF&WS and CDW.
- Reclamation for wildlife will be a principal priority in the final decommissioning of the shale oil project.
- Restore at a minimum the premining level of interspersion of shrub, grassland, and forest cover in consultation with BLM, USF&WS, and CDW.
- Monitor bald eagle roost sites and nest locations in reservoir vicinity. Allow construction only during periods which would not adversely affect bald eagles.

3.3.6.10 Cultural resources

Areas designated for construction activities that have not been inventoried for cultural resources must have site file searches and field surveys undertaken in advance of construction as directed by BLM and the Colorado State Preservation Officer (SHPO). For known sites, the preferred mitigation method is avoidance. If avoidance is not possible during construction, BLM would consult with the SHPO to determine the most satisfactory means of mitigating damage. Types of mitigation would include excavation, analysis, and recording through collection or photographs before disturbance. These procedures would ensure adequate mitigation of direct and indirect adverse effects on cultural resources.

3.3.6.11 Visual resources

Access road

The Cottonwood Gulch access roads would result in significant adverse visual impacts in a sensitive and highly visible area. Because reclamation may not be possible on rocky areas at higher elevations, the impacts would be irreversible and affect many viewers from a number of sensitive viewpoints. For these reasons, other access road routes would be preferable from a scenic viewpoint.

The following measures would mitigate visual impacts of the access road:

- End hauling of material during access road construction in all highly visible areas.
- Routing of the access road from the mine bench to the Roan Plateau in a less visible location.
- Use of materials for cribbing and other road construction that will blend with surrounding natural features.

Water supply

To minimize visual impact the exposed rock material on the downstream face of the dam should be harmonious in color to the adjacent ridges.

Pipelines and utility corridors

Pipeline placement can sharply reduce adverse visual impacts. However possible, pipelines should be routed in "out-of-sight" areas, and areas of deep or readily revegetated soils. Where clearing of vegetation is required, the edges should be treated so as to avoid the appearance of straight lines and unnatural angles or patterns. Clearing additional vegetation beyond that necessary should be considered in order to create a more natural appearance.

Consideration should be given to relocating the utility corridor centerline approximately 1000 feet to the northeast in order to use topographic features to limit visual impacts.

Transmission lines

Conductors should be nonspecular and insulators should be a dark color rather than light or transparent.

Consideration should be given to a power line grid system with Public Service Company and other oil shale companies.

Funicular railroad

Visible portions of the funicular railroad should be treated, through use of natural materials or paint, to match the colors of the surrounding landscape when viewed from the River Road or Morrisania.

General

All metal structures should be painted with a dull finish, neutral color compatible with the surroundings. As an uncommitted mitigation, color choices may be selected in consultation with the BLM VRM coordinator.

All facilities should be fit to the form and line of the landscape as well as practicable, considering, in particular, minimizing visibility from sensitive viewpoints.

Despite the most conscientious project design and mitigation, the project would be visibly evident in various areas. Many people would consider the project an adverse industrial impact in a scenic and well-traveled part of the state. In order to minimize the adverse visual effects and enhance public acceptance it is suggested that Mobil, or Mobil in conjunction with other oil shale development companies in this region, develop a public interpretation facility to explain the project purpose and process in simplified terms, and the nature of visible project components relative to the overall project.

3.3.6.12 Noise

No recommended mitigative measures.

3.3.6.13 Land use and recreation

There should be coordination with local governments to limit impacts of industrial development on important agricultural lands.

3.3.6.14 Socioeconomics

Several mitigation measures have been assumed as part of the socioeconomic impact analysis. These include Mobil's single-status camp and its commitment to encourage employee location in those areas that can best accommodate growth (e.g., Battlement Mesa). These measures are part of Mobil's socioeconomic impact mitigation policy which is based on the following principles:

- The Mobil Project would provide an enhanced tax base and would contribute additional resources to local governments in the execution of their role of providing public facilities and services for the residents of the area.

- The Mobil Project is planned to be developed in an incremental phased approach to reduce the short-term adverse effects as much as is reasonably possible.

- Mobil will assist the affected jurisdictions in overcoming the front-end financing lag created between the time impacts occur and when additional tax revenues are received.

- Specific mitigation techniques would be dependent on the actual needs of the communities at the time the Mobil Project proceeds. Recognizing that growth in the communities will occur without the Mobil Project, a mitigation description at this early stage of the project needs to provide for flexibility and adjustment to meet unknown future socioeconomic conditions.

- Mobil will work cooperatively with local governments and organizations to develop and implement specific mitigation measures that are the most efficient and effective in dealing with socioeconomic impacts.

- Garfield County, through its adopted Fiscal Impact Mitigation Program, land use permitting process, and intergovernmental agreement with Mesa County, has addressed the need for socioeconomic impact mitigation. Selection of specific impact mitigation measures would be the result of completing these regulatory procedures and reaching agreeable solutions to anticipated impacts at the time of project development.

- Mobil would make every reasonable effort to employ qualified local residents during the construction and operation of the project.

- Many people and businesses would make decisions to relocate or commence new ventures in the general project vicinity. Such decisions are recognized as being made, independently of Mobil's actions, on the basis of individual assessments of the area's economics and growth potential.

- After completion of the Fiscal Impact Mitigation Program and the issuance of local land use permits, Mobil would undertake a comprehensive monitoring program to ensure that actual impacts reflect the planned mitigation techniques.

The actual selection and application of specific mitigation measures will be based on negotiation with local officials at the time the project is developed. The following techniques for housing, finance, land use, community infrastructure, and project closure will be reviewed by Mobil with local governments and organizations in developing a mutually acceptable mitigation plan.

Housing

Mobil will consider:

- Advising local housing developers of the expected project schedule and work force requirements;

- Assisting with incentives to help encourage employees to locate in specific locations;

- Providing guarantees for construction financing and occupancy of specific units;

- Assisting the local housing industry with capital;

- Providing land for housing development;

- Working with local developers to direct permanent growth to appropriate areas designated in locally adopted land use plans; and

- Developing a single status camp for the construction work force.

Government finances

Fiscal modeling has shown there is generally a front-end lag between the time major projects are operational and the time when local tax revenues catch up with local government expenditures. This lead time gap also varies jurisdictionally among affected local governments. Mobil will work cooperatively with local governments to help alleviate this jurisdictional mismatch of revenues and expenditures and strive to achieve a more balanced flow of funds through local revenue sharing. A key element in fiscal impact mitigation is the ability to make prepayments of future tax liabilities or development fees where legally allowable. Also significant is the provision of management and technical assistance to help analyze the various levels of public services and, if warranted, recommend alternative methods to provide a more economical and efficient service pattern consistent with any potential restructuring of the local tax base.

Specific fiscal impact mitigation measures will be formulated through the use of Garfield County's Fiscal Impact Mitigation Program after the fiscal impact analysis is completed. In shaping the mitigation plan, the following techniques will be reviewed and considered for use in addition to those already stated:

- Local bank deposits as an infusion of capital;

- Loans to assist in alleviating the revenue-expenditure time gaps;

- Contingent liability if the local government has need to enter the short- or long-term debt market;

- Technical and management assistance to pursue intergovernmental or any other available funding;

- Direct financial assistance in the form of grants;

- In-kind professional help; and

- Investments in the communities such as through the purchase of local debt securities.

Land use

Mobil's operations will be consistent with all applicable local land use regulations and ordinances.

Infrastructure

Mobil intends to consult with the responsible governments to determine that future operation and maintenance funding is stable and certain before participating in any mitigation measures that result in the construction of new public facilities or creation of new public agencies.

Socioeconomic mitigation measures are location and time-specific, and dependent on actual community impacts that cannot be accurately determined until they occur. It is, therefore, difficult to forecast actual community needs prior to a detailed infrastructure assessment. However, the kinds of infrastructure service that could be affected by impacts and mitigation measures include, but are not limited to: law enforcement; fire protection; medical services; human services; education facilities and services; sewage collection and treatment; water service; electrical and gas service; libraries; cultural facilities; transportation; streets, roads, and bridges; and recreational facilities.

Project slowdown or closure

A specific plan for project slowdown or closure is a requirement of the Garfield County Fiscal Impact Mitigation Program and is the responsibility of the local permitting process. What adverse events would actually cause a temporary termination or suspension of the project cannot be accurately forecast with any degree of confidence. Therefore, the types of action that Mobil will consider for the slowdown plan will be dependent on the current local and regional economic climate at the time the project commences construction and operation.

As with any large construction projects, its completion or termination can result in the separation of a large number of employees from the project work force. Mobil will honor any separation agreements that may have been made at that time and will communicate in good faith with all affected local governments to minimize any potential short-term adverse effects. Mobil will make every reasonable effort to minimize any negative effects of a temporary suspension or closure.

Local governments, in particular, would have to be careful to protect themselves against the possibility of premature shutdown. Two strategies would be relevant. First, it might be advisable for local governments to require guarantees with respect to obligations necessitated by a project and only able to be sustained if the project proceeds as scheduled. Second, local governments could make optimal use of short-term, flexible solutions to service delivery needs, rather than longer-term solutions which would run the risk of being inappropriately sized.

3.3.6.15 Transportation

Measures that could be considered to mitigate possible impacts on the transportation systems in the area include:

- upgrading and widening of bridges
- road construction and improvements
- rail crossing upgrades
- bus transportation or some other form of mass transit for workers
- shift scheduling to reduce congestion

These measures could be implemented through working arrangements with the relevant jurisdiction or transportation authorities.

3.3.6.16 Summary of impacts and mitigation

Table 3.3-20 summarizes potential impacts, design controls, and potential mitigation measures for the Mobil Project. Mobil's overall design includes measures to minimize environmental impacts. Major control measures are listed in Table 3.3-20.

3.4 ENVIRONMENTAL COMPARISON OF ALTERNATIVES

The Mobil Project would include 31 components which are organized by major categories and listed in Table 3.1-9. Of these components, 21 have one or more reasonable alternatives, which have been compared environmentally with the proposed action.

An interdisciplinary evaluation and comparison of reasonable alternatives was performed through the coordination and integration of discipline-specific analyses and concerns. Each component was evaluated independently of the others; thus, conclusions regarding alternatives for one component did not affect the evaluation of alternatives for other components. The procedure followed was a modified Delphi process. This process was used because it facilitated the orderly, defensible assessment and comparison of alternatives by the large group of principal investigators, each of whom is an expert in a specific environmental discipline.

3.4.1 Procedure followed

Based on descriptions of alternatives (including the proposed action) and discipline-specific issues (e.g., impacts on wildlife), each principal investigator developed a set of criteria (e.g., number of acres of habitat or winter range affected) to methodically and rigorously assess the impacts attendant to each alternative. In most instances, principal investigators established more than one criterion to rate alternatives. Where multiple criteria were developed, principal investigators generally assigned weightings to each criterion. The weighting was used to define the relative importance of each criterion in establishing an overall rating of the alternative by that discipline. An intradisciplinary score was then assigned to each alternative by the principal investigator according to the criteria and weightings he had established. A complete discussion of the criteria used for each discipline and the weighting system used for each criterion is included in the Impact Analysis Guide (IAG) prepared for this EIS (Dames & Moore, 1983a).

The Delphi procedure involved a meeting of all principal investigators for the project who collectively determined the weight to be assigned each discipline being considered for a particular component.

Table 3.3-20. Summary of potential impacts and mitigation

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Air quality	Construction	Fugitive dust	To be specified in permitting, including minimal surface disturbance, minimal traffic, surface wetting
	Malfunctioning air pollution control equipment	Increased emissions	To be specified in permitting process; will be minimized by conservative design and maintenance
	Exposure of untreated wastewater	Increased aromatic nitrogen compounds, volatile organics, and others	Design control includes enclosure of wastewater
	Operation	Degradation of air quality and/or visibility	Covered conveyors, bag houses, scrubbers, water sprays, cyclones, flue gas desulfurization, roof tanks, pressurized spheres, maintenance program
	Facility abandonment	Fugitive dust	Reclamation, including revegetation
Topography, geology, and mineral resources	Construction/operation	Changes in topography	Recontouring and reclamation
Paleontology	Construction/operation	Loss of resource	Monitoring/reporting, salvage as appropriate
Soils	Construction/operation	3539 acres disturbed	Topsoil stripping and stockpiling; protection of piles by establishing vegetative cover
Ground water	Construction	Dewatering of aquifers through interception	Standard engineering practices, to include grouting
	Mining	Decreased flow from springs and seeps	Supply alternative water sources if necessary
	Processed shale disposal	Degradation of water quality	Compacted shale liner
	Mine closure	Degradation of water quality in springs and seeps	Nonsubsidence design; steps to be defined in Abandonment Plan, including removal of all potentially contaminated materials and closure of access
Surface water	Operation pipelines, road crossings, transportation	Surface water degradation	Spill prevention, control, and countermeasure plan; pipeline monitoring equipment; inventory control
	Processed shale pile	Surface water degradation	Redesign embankment face; channel water away from embankment face; install cover over face; underdrainage
	Main Elk Creek Dam failure	Damage to New Castle	Conservative design and approval of State Engineer

Table 3.3-20 (continued)

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Surface water (continued)	Depletion of Colorado River water	Increased salinity	Minimal water use, maximum water re-use
	Oil spills	Stream water degradation	Spill Prevention Control and Countermeasures (SPCC)
	Abandonment Shale disposal pile erosion	Water quality degradation	Same as under shale pile-operation
Aquatic ecology	Construction	Increase in fishing of 66,820 fishing trips per year	Stocking with 267,280 trout annually
		Overharvest of Colorado River cutthroat trout	Placement of special fishing regulations to control harvest
	Construction of dam	Loss of 1500 ft of fishery in Main Elk Creek	Fishery in Main Elk Reservoir and downstream tail water
	Operation	Increase in fishing of 87,910 fishing trips per year	Stocking with 351,600 trout annually
		Change in streambed below Main Elk dam	Flushing flows
		Overharvest of Colorado River cutthroat trout	Placement of special fishing regulations to control harvest
	Operation of intake structure	Entrainment or impingement of larval fish	Design of intake structure, location of intake structure; design control includes an intake velocity of 0.5 ft per second
	Operation of diversion dam	Barrier to upstream fish movement	Construction of a fish diversion
	Filling of Main Elk Reservoir	Inundation of 2.2 miles of fishery in Main Elk Creek	Creation of additional fisheries habitat
			Stocking of 351,600 fish annually
			Creation of a tail water fishery below Main Elk Dam
Vegetation	Construction/operation	Elimination of 3539 acres of existing vegetation	Reclamation in accordance with detailed reclamation plan for all disturbed areas
		Loss of individual plants of some special-status species	Avoidance, transplanting, or other procedures endorsed by USF&WS and CDW
		Loss of important riparian vegetation	See Wildlife
Wildlife	Construction Overlap of critical wildlife periods	Increased mortality of important wildlife	Seasonal timing of construction, as appropriate
	Traffic	Road kills	Vehicle speed limit, mass transportation, seeding road-side with unpalatable grass

Table 3.3-20 (continued)

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Wildlife (continued)	Operation Plant site location	Habitat loss	Habitat recovery and replacement plan[a]
	Processed shale disposal	Habitat loss	Habitat recovery and replacement plan[a]
	Linear disturbance	Interference with deer migration routes	Help develop regional wildlife management plan
	Linear disturbance	Habitat loss	Habitat recovery and replacement plan[a]
	Main Elk Dam	Loss of riparian and other habitats	Habitat recovery and replacement plan[a] Create nesting structures
	Operation - general	Interference with wildlife	Minimize fencing, electrocution-proof transmission towers; offroad vehicle restrictions; institute company firearm policy; employee education program; no activity allowed within 0.5 mile of raptor nests; do not allow destruction of raptor nests
Cultural resources	Construction	Loss of sites in Wheeler or Cottonwood Gulch	Avoidance or excavation, and/or recordation in accordance with SHPO[a]
Visual resources	Construction/operation of access road	Visual contrast would exceed VRM Class II guidelines	Reclamation and revegetation of cuts and fills; end hauling; rerouting; use of low visibility materials
	Construction/operation of water supply	Change in character of the area	Exposed rock material on downstream face of dam harmonious in color to adjacent ridges
	Construction/operation of pipelines/utility corridors	Visual contrast would exceed VRM Class II guidelines	Routing of pipelines in out-of-sight areas and areas deep or readily revegetated soils clearing additional vegetation to avoid straight lines
	Construction/operation of transmission line	Visual contrast would exceed VRM Class II guidelines	Nonspecular materials, helicopter construction
	Construction/operation of funicular railroad	Visual contrast would exceed VRM Class II guidelines	Treating of visible portions to match surrounding landscape
	Construction/operation of retorting facilities	Visual contrast would exceed VRM Class II guidelines	Reclamation and revegetation of construction areas; siting of facilities; use of low visibility materials
	Construction/operation of processed shale disposal in Wheeler Gulch	Visual contrast would exceed VRM Class II guidelines	Reclamation, including contouring and revegetation
	Abandonment	Remaining visual impact of access road	Continued maintenance
Noise	Construction/operation	Limited instances of noise in excess of 75 dBA at property line	Meet OSHA requirements

Table 3.3-20 (continued)

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Land use and recreation	Construction/operation	Convert 2274 acres of rangeland and 716 acres of cultivated land to industrial use	To be determined by county permitting procesa; reclamation plan includes returning areas to original use
		Conversion of 1401 acres of agricultural land to urban commercial/residential use	To be determined by county permitting process; reclamation plan includes returning areas to original use
		Change of Parachute Block and Mahaffey Ranch from roaded natural ROS class to semiurban clasa	To be determined by county permitting process; reclamation plan includes returning areas to original use
		Displacement of four occupied residences	Compensation of Dawsons and compliance with lease agreements
	Construction	Increase of up to 250,600 activity days of recreation use in region	Stock about 267,200 fish annually
	Operation	Increase of up to 329,820 activity days of recreation use in region	Stock about 351,600 fish annually
			Recreational use of Main Elk Reservoir in accordance with management plan[a]
			Tail water fishery below Main Elk Reservoir
Socioeconomics	Construction, operation, abandonment	See 3.3.1.14	See 3.3.5.14
Transportation	Construction, operation, abandonment	See 3.3.5.15	See 3.3.5.15

[a]Committed mitigation; see Section 3.3.5.

3.4.2 Description of Delphi process

The Delphi session was an interactive iterative group process and involved the accomplishment of several tasks at the session. These tasks included:

A. Definition of Impact Issues
B. Importance Ratio Assignment*
C. Statistical Analysis and Review*
D. Group Discussion*
E. Group Stability
*Repeated in each round.

3.4.2.1 Definition of impact issues

Once the group of principal investigators was assembled, a definition of each of the impact issues (including criteria) was presented for the alternatives of a given component (step 1). Each issue was discussed until the group felt it had a common understanding of the impact and its components. This did not mean that the group necessarily accepted the issue or criteria breakdown, rather it meant that the participants had achieved a basic understanding of the impact, so that subsequent steps might proceed on the assumption that all participants were operating from a common information base. Each participant was able to comment on the validity of each issue by assigning values during the assessment process.

3.4.2.2 Importance ratio assignment

At the conclusion of issue definition, each participant was provided with materials for importance ratio assignment and instructions for further activities. The participants then assigned an importance ratio to each impact issue (step 2). The importance ratio defined how many times more or less important one issue was with respect to another issue. The importance ratio did not reflect the absolute importance of an issue in isolation, but rather the "exchange rate" between issues. If, for example, one issue was assigned an importance ratio of "3" and a second issue was assigned a "1," then it could be said that the difference between alternatives with respect to the first issue was three times more important than the difference between alternatives with respect to the second issue.

The process of assigning importance ratios began by assigning the least important issue relative to the alternatives of a given component a base value of 1. The most important issue was then selected from the remaining issues, and a value assigned to it according to how many times more important it is than the least important one. The participant was not limited to selection of a single least- or most-important issue. Certain issues could be equally important or equally unimportant. Some issues might be completely irrelevant, for which a weight of 0 was used; or a participant might reserve judgment, in which case a weight of NR (No Response) was assigned.

The importance ratios assigned to the most-important and least-important issues defined the limits of importance ratios for all remaining issues. To complete the assignment of importance ratios, each remaining issue was assigned a value greater than the least important issue. The value of each intermediate issue was compared to one that had higher importance and to one that had lower importance. This helped to ensure that the intermediate values were correctly positioned in terms of relative relationship to other issues.

After importance ratios were developed for all issues, each participant tested or refined his scheme by successively comparing and questioning the importance ratios of the next least important and the next most important issues. For example, was wildlife really twice as important as ground water and air quality, and was recreation less important than wildlife but more important than ground water and air quality? This process was repeated until the participant was satisfied with the relationship that had been established among all the issues.

Once all participants had concluded the importance ratio assignment activity, the Delphi moderator initiated a statistical summary of the results.

3.4.2.3 Statistical analysis

The next task was to compile the results of all participants' importance ratios and perform a statistical analysis. (Each importance ratio scheme was initially normalized to permit other computations, step 3.) Worksheets were then returned with an entry showing the average values of the group for each issue (step 4). Other statistics on the importance ratios were computed, including the mean, mode, and standard deviation (to indicate convergence or divergence) as a test of the process and for use by the moderator. As the Delphi process was composed of several rounds of value assignments, the statistical summary was cumulative. By having successive columns for each round, each participant was aware of how the group values were changing throughout the Delphi process.

3.4.2.4 Group discussion

The group discussion (step 5) was conducted in two parts. First, each participant was allowed to present views or arguments concerning each issue, giving him the opportunity to try to persuade the other members of the group to change a specific importance ratio. Participants presented arguments without rebuttal from the group.

Once each participant had been given the opportunity to speak, an open discussion was held. During this discussion, the moderator exercised control over the group and discouraged participants from arguing on points that had already been presented. New ideas and new points about a particular issue of concern were encouraged.

Once all participants were given a chance to speak, the value-assigning process was repeated. Each participant assigned new values based on what had occurred during the previous round (step 6). The statistics were computed again and reported to the group (step 7). After review of the group statistics, each individual was aware of how the group value had changed and would then develop additional arguments or restate previous arguments in an attempt to persuade the group to move a value in a desired direction (step 9). The group discussion was reconvened, and the entire process was repeated (steps 10-12).

3.4.2.5 Achieving group stability

The first round of the procedure was considered to be primarily a learning round. Each individual, who was usually conversant with only some of the impact issues, would learn about the other issues.

During subsequent rounds, as the participants began to learn more, new ideas occurred to them, new thoughts about the relative importance of issues were presented, and a greater exploration or a more comprehensive view of each potential impact was achieved. After the process was repeated several times, with the moderator continually monitoring several key statistical indicators, the group average opinion would stabilize.

One of two types of stability would occur for each issue: consensus or polarization. Consensus would occur when, after several rounds, there was a small standard deviation. This was a result of everybody assigning close to the same value to an issue round after round. Polarization would occur when the group average stayed the same over several rounds, but the standard deviation remained high. In this case, one faction of the group had consistently assigned a high value to the issue in question, while another faction had consistently assigned a low value.

In the case of polarization, the Delphi moderator sought to examine those issues for which polarization had occurred, in that it might reveal that the issue had not been properly defined. More thorough discussion of this issue would, in most cases, after reassessment, result in a consensus. In other cases, the group would conclude that there was honest disagreements resulting from different points of view and the group opinion was recognized as the final judgment of the group.

Upon achieving a stabilized group opinion or importance ratio for each issue, the Delphi session was complete, and the final group averages were considered to be the collective group judgment concerning the importance of each of the issues of concern. These importance ratios were then applied as weightings in comparing project alternatives.

3.4.3 Results

Table 3.4-1 indicates individual scores for each alternative by discipline. These individual discipline scores were obtained by multiplying two factors: the intradisciplinary score assigned that alternative by the principal investigator; and the interdisciplinary weighting assigned to each discipline during the Delphi meeting of the principal investigators. Disciplines that would not be affected by particular components are indicated in Table 3.4-1 as being not applicable (NA).

Table 3.4-1. Environmental evaluation of alternatives

Component/ alternative	Climate and air quality	Topography and geology	Paleontology	Soils	Ground water	Surface water	Aquatic ecology	Vegetation	Wildlife	Cultural resources	Visual resources	Noise	Land use and recreation	Transportation	Total
Retorting Method															
TOSCO II, Union B, and Paraho DH[c]	8.7	NA	NA	5.4	7.6	8.9	NA	4.3	1.4	NA	1.3	NA	NA	NA	37.6
Chevron STB, Lurgi, Circular Grate[c]	8.7	NA	NA	5.4	7.6	8.9	NA	4.3	1.4	NA	1.3	NA	NA	NA	37.6
Upgrading Facilities Location															
Roan Plateau[c]	6.2	1.9	0.9	3.9	3.2	4.6	NA	3.5	6.9	1.7	2.9	NA	2.2	NA	37.9
Mahaffey Ranch[c]	4.1	1.9	0.8	2.7	2.5	4.7	NA	4.3	2.0	1.7	1.8	NA	1.1	NA	27.6
Processed Shale Disposal Location															
Wheeler Gulch (upper and lower)[b]	1.5	2.1	0.4	4.6	1.9	5.4	NA	5.8	1.7	1.8	0.6	NA	1.3	NA	27.1
Wheeler Gulch (lower only)	1.5	2.3	0.6	3.1	1.9	4.9	NA	5.6	2.2	2.4	0.6	NA	1.3	NA	26.4
Processed Shale Transportation															
Belt conveyor plus	58.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.8	NA	NA	80.5
Truck plus[a]	19.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.8	NA	NA	41.4
Solid Waste Disposal (nonhazardous)															
Sanitary landfill plus processed shale	0.9	0.6	1.5	3.2	2.3	4.8	NA	1.5	2.7	1.4	NA	NA	1.5	NA	20.4
Processed shale alone	0.9	0.6	1.5	3.2	2.3	4.8	NA	2.6	2.7	1.8	NA	NA	1.5	NA	21.9
Sanitary landfill alone	0.9	1.6	1.5	3.2	2.3	4.5	NA	1.5	2.7	1.4	NA	NA	1.5	NA	21.1
Offsite[d]	0.9	1.6	1.5	5.3	2.3	5.5	NA	2.6	2.7	1.8	NA	NA	1.9	NA	26.1
Hazardous Waste															
Offsite[d]	0.9	1.6	1.5	5.3	2.3	6.0	NA	2.6	2.7	1.8	NA	NA	1.9	NA	26.6
Onsite	0.9	1.6	1.5	3.4	2.3	4.5	NA	1.3	2.7	1.8	NA	NA	1.5	NA	21.5
Processed Shale Reclamation															
30-inch cover	3.0	NA	NA	16.1	3.6	10.7	NA	11.9	7.7	NA	3.3	NA	NA	NA	56.3
12-inch cover	3.0	NA	NA	13.8	3.6	9.3	NA	9.5	4.9	NA	3.1	NA	NA	NA	47.2
No cover plus leaching	3.0	NA	NA	9.2	3.6	9.8	NA	7.1	2.0	NA	1.2	NA	NA	NA	35.9
Water Supply[e]															
Main Elk Reservoir	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruedi Reservoir	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Onsite ground water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Water Conveyance from Source															
Stream flow[c]	NA	1.7	1.0	3.6	0.7	2.0	2.6	3.6	3.4	1.6	2.6	NA	1.4	NA	24.2
Pipeline[b,c]	NA	1.1	1.0	2.1	0.7	1.5	3.8	2.8	1.1	1.2	2.0	NA	1.2	NA	18.5
Water Diversion System															
Overflow weir	NA	NA	NA	2.7	1.7	2.4	7.5	4.5	4.4	NA	NA	NA	2.4	NA	25.6
Crib	NA	NA	NA	3.2	1.7	2.1	10.2	4.5	4.4	NA	NA	NA	6.0	NA	32.1
Side-channel intake	NA	NA	NA	3.5	1.7	3.3	8.4	4.5	4.4	NA	NA	NA	6.0	NA	31.8

Table 3.4-1 (continued)

Component/ alternative	Climate and air quality	Topography and geology	Paleontology	Soils	Ground water	Surface water	Aquatic ecology	Vegetation	Wildlife	Cultural resources	Visual resources	Noise	Land use and recreation	Transportation	Total
<u>Water Diversion Location</u>															
Mahaffey Ranch 1	NA	2.4	NA	1.9	1.3	8.6	7.8	4.5	4.4	2.1	NA	NA	4.8	NA	37.8
Mahaffey Ranch 2	NA	2.4	NA	1.9	1.3	8.2	7.8	4.5	4.4	2.1	NA	NA	4.8	NA	37.4
Parachute	NA	2.4	NA	1.9	1.3	8.2	7.8	4.5	4.4	1.6	NA	NA	4.8	NA	36.9
<u>Water Conveyance to Roan Plateau</u>															
Cottonwood Gulch	NA	0.8	1.3	3.4	1.0	2.9	NA	3.8	1.5	1.5	1.4	NA	1.4	NA	19.0
Wheeler Gulch[b]	NA	0.8	1.3	3.4	1.0	2.8	NA	3.0	1.5	1.1	1.4	NA	1.4	NA	17.7
<u>Access Road and Mine Portal Location</u>															
Cottonwood Gulch	1.7	1.7	1.0	3.8	0.7	2.5	NA	5.4	2.1	2.9	2.2	0.5	1.9	2.4	28.8
Wheeler Gulch	1.7	1.6	1.0	3.2	0.7	2.3	NA	4.1	2.1	2.9	2.8	1.6	1.9	1.4	27.3
<u>Contractor's Road</u>															
Mahaffey Ranch	1.7	1.9	1.1	3.8	0.7	2.5	NA	6.6	1.6	3.6	9.1	0.5	1.9	2.4	37.4
Anvil Points	1.7	1.7	1.2	3.8	0.7	2.5	NA	4.0	1.7	3.6	8.3	1.6	1.9	1.4	34.1
Cow Creek	1.7	3.4	1.2	5.8	0.7	2.5	NA	4.0	1.7	3.6	10.9	1.6	1.9	1.4	40.4
JQS Trail	1.7	3.4	1.2	5.8	0.7	2.5	NA	4.0	1.7	3.6	10.9	2.6	2.2	1.4	41.7
Colony Access	1.7	3.4	1.2	5.8	0.7	2.5	NA	4.0	5.9	3.6	10.9	2.6	1.9	1.4	45.6
<u>Electrical Power Supply</u>															
Roan Plateau[b,c]	6.8	2.8	1.6	2.4	NA	4.7	2.7	1.5	1.7	1.5	0.6	0.6	1.6	NA	28.5
Offsite[d]	6.8	2.9	1.6	4.0	NA	5.2	4.5	1.9	1.9	1.9	2.5	3.0	2.0	NA	38.2
<u>Electrical Power Transmission Line Route</u>															
Hayes Gulch[b]	NA	1.2	1.8	3.4	NA	1.5	NA	2.0	0.8	1.9	2.1	2.5	1.7	NA	18.9
Cottonwood Gulch	NA	1.2	1.8	1.9	NA	1.5	NA	2.5	0.8	1.1	2.1	2.5	1.7	NA	17.1
Wheeler Gulch[b]	NA	1.2	1.8	1.9	NA	1.4	NA	2.0	0.8	1.5	2.1	2.5	1.7	NA	16.9
<u>Product Shipment</u>															
Tie-in to the LaSal Pipeline[b]	NA	1.1	0.8	1.7	NA	2.1	1.6	1.5	1.7	1.0	2.8	3.9	1.4	2.5	22.1
Tie-in to the SOPS Pipeline[b]	NA	1.1	0.8	1.7	NA	2.1	1.6	1.5	1.7	0.7	2.8	3.9	1.4	2.5	21.8
Unit Train[d]	NA	1.3	0.9	2.8	NA	1.9	1.1	1.9	1.7	1.0	0.8	2.3	1.6	1.5	18.8
<u>Product Feeder Pipeline Route</u>															
Helm Gulch	NA	1.6	1.3	3.4	0.8	2.5	NA	3.3	1.5	1.5	3.5	NA	1.4	NA	20.8
Cottonwood Gulch[b]	NA	1.1	1.3	2.2	0.8	2.5	NA	3.0	1.5	1.9	1.4	NA	1.4	NA	17.1
<u>Natural Gas Pipeline Route</u>															
Helm Gulch	NA	1.6	1.3	3.3	0.8	2.5	NA	3.3	1.5	1.5	3.5	NA	1.4	NA	20.7
Cottonwood Gulch[b]	NA	1.1	1.3	2.2	0.8	2.5	NA	3.0	1.5	1.9	1.4	NA	1.4	NA	17.1
<u>Utility Corridor</u>															
Cottonwood Gulch	NA	0.8	1.3	2.2	0.8	2.5	NA	3.8	1.5	1.9	1.4	NA	1.4	NA	17.6
Wheeler Gulch[b]	NA	0.8	1.3	3.3	0.8	2.5	NA	3.0	1.5	1.5	1.4	NA	1.4	NA	17.5
<u>Personnel Transportation</u>															
Funicular Railway	4.3	2.4	NA	NA	NA	NA	NA	3.0	3.3	2.5	2.0	4.4	NA	NA	21.9
Bus	4.3	1.9	NA	NA	NA	NA	NA	3.0	2.5	2.5	4.2	2.6	NA	NA	21.0

[a]The meteorology score assumes full production.
[b]The vegetation score is based on worst-case assumptions.
[c]The visual resources score is based on worst-case assumptions.
[d]The scores assume an existing facility will be used and that there will be no new construction or disturbance.
[e]See Section 3.4.3.8 for explanation.

The individual discipline scores were totaled for each alternative to provide a final score for that alternative. These final scores were ranked for the alternatives of a particular component to identify the "best" or "least adverse" alternative. The highest score was best; the lowest score was worst. The final scores are not amenable to statistical analysis regarding significant differences. However, the closer the final scores are to one another, the less choice there is among alternatives of a given component from an environmental viewpoint.

The absolute point values of the final scores given in Table 3.4-1 are important only in comparing alternatives within a given component; no conclusions can be reached by comparing the scores for alternatives of different components. The following paragraphs discuss the evaluation of alternatives by component.

3.4.3.1 Retorting method

The alternative using the TOSCO II, Union B, and Paraho DH methods and the alternative using the Chevron STB, Lurgi, and circular grate methods both yielded the same scores. A worst-case scenario was used for air emissions and other environmental features that could be affected by different mixes of the various proposed retorts. However, at this time, accurate comparable information on air emissions, retort size, water use, quantity of processed shale, and other factors that may be different are not available for all types of retort methods. Thus, based on existing information, no environmentally preferred method or combination of methods can be identified.

3.4.3.2 Upgrading facilities location

The proposed Roan Plateau location would be environmentally preferred to a location at the Mahaffey Ranch. The preferred location scored far better in the disciplines of wildlife and air quality, and substantially better in the disciplines of soils, ground water, surface water, visual resources, and land use and recreation. The higher wildlife scores for the Roan Plateau location reflect minimal adverse impact to the winter deer herd, no disturbance of important or unique wildlife habitat, and location of the high-volume traffic road where large numbers of big game cross only during migration. The higher scores in air quality reflect the fact that atmospheric emissions would be subject to greater dispersion and would be less apparent to the public on the Roan Plateau than if the facilities were at the Mahaffey Ranch location. The maximum percentage of Ambient Air Quality Standards (AAQS) or Prevention of Significant Deterioration (PSD) Class I or Class II increments for Roan Plateau emissions would be 66 to 80 percent. At the Roan Plateau location, there would only be a moderate potential for ground-water contamination. The facility would not be highly visible to the public if located on the Roan Plateau and would be highly compatible with land use management policies.

If the upgrading facilities were located at the Mahaffey Ranch, it is estimated that atmospheric emissions would represent a maximum of 81 to 95 percent of AAQS or PSD Class I or II increments. At the Mahaffey Ranch, there is a greater probability of encountering significant quantities of ground water, a high potential for ground-water contamination, and a greater potential for impacts to the ground-water to surface-water communication system than at the Roan Plateau location. The Mahaffey Ranch location would also result in more mule deer winter range being disturbed. Locating upgrading facilities at the Mahaffey Ranch would result in their being highly visible to the public and having a low compatibility with land use management policies.

3.4.3.3 Processed shale disposal location

The proposed action, which would use both upper and lower Wheeler Gulch for processed shale disposal, would be slightly better environmentally than the alternative using only lower Wheeler Gulch, although the total scores were very close.

The proposed action scores were higher for soils because of the lower gradients on the embankment faces and reduced potential for erosion of two shallower embankments compared to a single higher and steeper embankment. It scored higher in vegetation because there would be less disturbance of special-status species habitat. However, more mule deer winter range would be disturbed and a greater number (3 to 5) of cultural resource sites would be affected than with the alternative. Eligibility for listing in the National Register of Historic Places (NRHP) is currently being determined for the cultural resource sites.

The alternative of using only lower Wheeler Gulch scored slightly higher for topography and geology because there would be no embankment on top of shale to be mined and, hence, no concern about a potential need to increase pillar size and restrict the amount of ore mined. (Engineering analyses by Mobil indicate no increase in pillar size would be required.) The higher scores in paleontology, cultural resources, and wildlife for the alternative using only lower Wheeler Gulch reflect the disturbance of fewer acres and hence, smaller adverse impacts. Less mule deer winter range would be disturbed and only 1 or 2 cultural resource sites would be affected. Eligibility for listing in the National Register of Historic Places (NRHP) is currently being determined for the cultural resource sites. Disadvantages of this alternative include a greater potential for erosion and less potential for revegetation, which would require costly earthwork, moisture control, and seedbed preparation.

3.4.3.4 Processed shale transportation

The proposed action to use belt conveyors would be environmentally preferred to the alternative of truck transport. Differences between these two transportation methods were considered applicable by only two disciplines, air quality and noise.

At full production, truck transport of processed shale would generate quantities of dust that would clearly exceed total suspended particulate allowances; it was agreed that this issue was most important. Noise levels would be somewhat higher with truck transport than with conveyors, but this was not considered to be a significant difference.

3.4.3.5 Solid waste disposal

The environmentally best alternative would be offsite disposal, assuming such disposal was to a nearby existing and licensed facility. Such disposal would be considered superior because waste would be completely removed from the site, and there would be no impact to new areas. Use of an existing landfill would be highly compatible with existing and planned land uses and would minimize the probability for geologic hazards. It would not significantly affect future mineral exploration and would cause no impacts on known cultural resources. Significant impacts on air or water quality would not be expected. Reclamation potential would be excellent at a valley location with deep (>60 inches) soils.

The next best alternative would be to dispose all solid waste in the processed shale area. This alternative would avoid additional surface disturbance and attendant adverse impacts on vegetation, cultural resources, and surface-water quality. However, disposal in the processed shale would be on unstable geologic material.

The alternative of using a sanitary landfill alone was ranked third. Because of the additional surface disturbance for a separate landfill, there would be greater adverse impact on vegetation, surface-water quality, and potentially on cultural resources than the other two alternatives discussed.

The proposed action, using a sanitary landfill plus the processed shale embankment scored the lowest. It would have the same disadvantages as use of the sanitary landfill alone plus those of disposal in processed shale alone (e.g., disposal on unstable geologic material).

3.4.3.6 Hazardous waste

The environmentally best alternative would be offsite disposal at an existing hazardous waste facility in the vicinity. This alternative would eliminate the need to construct a new onsite area, and would eliminate any potential for contamination from that site. From an environmental viewpoint, a centralized facility for wastes from several projects would be far superior to a number of separate sites. Siting such a centralized facility would be more flexible without the constraints of project boundaries, and should allow it to be located where conditions would be most favorable for isolation of the hazardous wastes. Impacts from surface disturbance could be better controlled because of a wide choice of potential sites. A separate EIS would be required for such a hazardous waste facility before it could be constructed and operated. Use of an offsite facility would, accordingly, be highly compatible with existing and planned land uses.

A regional offsite location is not now available, but could be licensed and developed prior to completion of the initial retort facility in Year 8.

3.4.3.7 Processed shale reclamation

It is assumed that the probability for successful revegetation would increase with depth of soil cover. Therefore, the proposed action of a 30-inch soil cover was selected as the environmentally best alternative, the 12-inch soil cover as next best, and the no-cover alternative as worst. The 30-inch soil cover was judged to be clearly superior relative to soils, surface water, vegetation, wildlife, and visual resources.

The potentially greater productivity of the deeper soil is expected to produce denser vegetation. This would result in a less adverse scenic impact and greater protection from erosion of the processed shale. Denser vegetation would also provide better habitat for wildlife.

3.4.3.8 Water supply

Since publication of the DEIS, it has been determined that neither the ground-water nor the Ruedi Reservoir alternatives could provide sufficient water to supply the needs of the project. Both alternatives would still require construction of the Main Elk Reservoir in order to assume an adequate water supply. Because the major impacts would be associated with Main Elk Reservoir, the environmental impacts for all alternatives would be essentially the same.

3.4.3.9 Water conveyance from source

The proposed action, using streamflow for water transport from the reservoir to the site, would clearly be environmentally superior to the alternative of constructing a pipeline for transporting water.

Surface disturbance associated with pipeline construction would result in adverse impacts on soils, surface water, vegetation, wildlife, cultural resource, and visual resources. There would be minor changes in topography and minor affects on land use. However, the pipeline alternative would eliminate the need for an intake structure on the Colorado River and, thus, eliminate entrainment and impingement impacts on aquatic life.

3.4.3.10 Water diversion systems

The alternative of a crib intake in the main stream of the river would be environmentally more favorable than the proposed action of an overflow weir, primarily because of impacts of the latter on recreation and aquatic ecology. The major difference in aquatic ecology and recreation would be the impediment of a weir extending across the river to upstream and downstream movement of fish, and of boats and canoes. Thus, it would be relatively incompatible with existing and planned land uses. An intake crib would allow the river to flow around it and present no impediment to movement of fish and boats. The crib would entail less stream disturbance during construction and would not impede fish migration.

The side-channel intake alternative would also not involve a structure extending across the river. However, a greater percent of fish larvae and other aquatic organisms would be subject to impingement and entrainment. As noted previously, larval fish densities in rivers may be several times higher along the shore than in mid-channel.

3.4.3.11 Water diversion location

The proposed action for water diversion at the Mahaffey Ranch No. 1 location was rated best, the Mahaffey location No. 2 slightly lower, and the Parachute location lowest. The scores were close because environmental differences would be minor. Nearly all disciplines gave all three alternatives identical scores. Only in cultural resources and surface water were differences noted.

The Parachute alternative would require the longest pipeline (from Parachute to the treatment facilities on the Mahaffey Ranch) and construction of this could cause adverse impacts to archaeological sites that might occur close to the river.

In surface water, the proposed action (Mahaffey No. 1) was rated best because of better stream bank stability and lower erosion potential at this location than at the other alternative locations.

3.4.3.12 Water conveyance route from treatment facilities to Roan Plateau

The proposed route through Cottonwood Gulch is the environmentally preferred route. The alternative through Wheeler Gulch would be longer and result in greater adverse impacts on surface water, vegetation, and cultural resources.

The Wheeler Gulch alternative would cause greater disturbance of soils and vegetation, and probable increases in erosion and sedimentation, because this route would be longer. Wheeler Gulch has more known cultural resource sites which could potentially be affected than Cottonwood Gulch.

3.4.3.13 Access road and mine portal location

The proposed Cottonwood Gulch route would be environmentally superior to the Wheeler Gulch route. Because the Cottonwood Gulch route is shorter, there would be less geological disturbance and less impact on productive soils and plant communities. The traffic volume would be less than 80 percent of the road's capacity whereas that using Wheeler Gulch would be 80 to 100 percent of capacity. There is generally a heavier snowpack and runoff in Wheeler Gulch, which could potentially cause greater erosion problems and affect water quality.

Nevertheless, the road would be far less visible from I-70 if it were in Wheeler Gulch and noise would be less likely to reverberate than in Cottonwood Gulch. It is anticipated that L_{eq} noise levels in Cottonwood Gulch would exceed Colorado standards and would require mitigation; the L_{eq} noise level in Wheeler Gulch is estimated to be up to 5 dBA below Colorado standards.

3.4.3.14 Contractor's road

The proposed route through the Mahaffey Ranch is considered to be environmentally inferior to all other alternatives except the Anvil Points route. A major disadvantage of the Mahaffey Ranch route is the increased surface disturbance which would result from new construction. Though not defined, it is anticipated that the amount of new construction required for the Mahaffey Ranch route would well exceed that of the other three more preferable alternatives. Thus, there would be greater disturbance of wildlife habitat than with the other routes, including mule deer winter range. Although less severe than with the Anvil Points route, the Mahaffey Ranch route is in a rockfall area and it is considered to be the worst route from a noise standpoint. It is estimated that L_{eq} sound levels would exceed Colorado standards along the Mahaffey Ranch route. This route was considered to be the best from a transportation viewpoint because it would have the lowest volume to capacity ratio (<0.8).

The Anvil Points route would also require considerable construction, would be in a rockfall area, and would be highly visible to the public. Noise would be less noticeable than along the Mahaffey Ranch route, L_{eq} sound levels are estimated to be up to 5 dBA less than Colorado standards.

The Colony access route is rated the best environmentally, particularly since it would not adversely impact low-elevation winter deer herds, this being the most important difference between this route and the JQS Trail and Cow Creek alternatives. The Colony route would require very little modification and would minimize impacts associated with surface disturbance. The L_{eq} noise levels along the Colony route and JQS trail are expected to be no more than 5 dBA greater than background whereas the L_{eq} level along the Cow Creek route is expected to be within 5 dBA of the Colorado standards.

3.4.3.15 Electrical power supply

Based on the assumption that no new construction would be required to generate additional power for the project, the offsite alternative would be environmentally superior to generation on the Roan Plateau. A transmission line route to the plateau would be required in either case, but the offsite supply would eliminate other adverse impacts associated with construction and operation of an onsite power plant. There would be no disturbance of soils, vegetation, or wildlife habitat. There would be no wind or water erosion impacts and a minimization of project water requirements which, in turn, would minimize impacts on surface water and aquatic ecology. The use of offsite power from an existing generating unit would be highly compatible with existing and planned land use.

Construction of a power plant on the Roan Plateau would adversely affect soils, vegetation, wildlife, and cultural resources because of land disturbance and destruction of existing ecosystems. It would potentially have adverse affects on surface water and aquatic ecology. The visibility of a new plant would adversely affect visual resources. Noise levels around the main plant site would be increased from power plant operation; the estimated L_{eq} noise level would exceed Colorado standards and would require mitigation. Finally, the onsite power plant would only be moderately compatible with existing and planned land uses.

3.4.3.16 Electrical power transmission line route

Three alternatives were evaluated for this component. The proposed action through Hayes Gulch is considered best environmentally because the shorter route would cause less disturbance of soils and have less erosion potential, and the alignment is in an area that is poor in cultural resources. Impacts on visual resources were not considered to be significantly different among the three alternatives.

The Cottonwood Gulch alternative is considered to be slightly better than Wheeler Gulch because there would be less disturbance. In addition, the Cottonwood Gulch route was favored from the viewpoint of vegetation because it would be least likely to impact sensitive plant species. However, there would potentially be greater impact to cultural resources because of the larger number of known sites in Cottonwood Gulch.

3.4.3.17 Product shipment

Either pipeline tie-in alternative would be environmentally better than the unit train alternative because of the lesser risk of spills and leakage, minimal visual impact, and negligible noise production.

The proposed tie-in to the LaSal pipeline route was rated slightly better than the SOPS alternative because the former would potentially disturb a smaller number of cultural resource sites than would the latter. The LaSal pipeline and SOPS tie-in alternatives were considered comparable in all other respects. Environmental impacts of the LaSal and SOPS pipelines are described in BLM (1981d) and BLM (1976), respectively.

3.4.3.18 Product feeder pipeline route

The proposed Helm Gulch route was scored environmentally more desirable than the Cottonwood Gulch alternative because of its shorter length, lesser disturbance, and location. Thus, impacts to topography, soils, and vegetation would be less in Helm Gulch and there would be no significant impact on visual resources. However, it is anticipated that there could be adverse impacts on cultural resources in Helm Gulch.

Because of its greater length, construction along the Cottonwood Gulch route would cause greater adverse impacts to soils and vegetation. It would also be located on unstable geologic material and would have a greater affect on the landscape than in Helm Gulch; however, there would be no affect on cultural resources.

3.4.3.19 Natural gas pipeline route

Because this pipeline route would be alongside the product feeder pipeline, the impacts would be virtually identical. The proposed route through Helm Gulch is environmentally preferred for the reasons given above for the product feeder pipeline.

3.4.3.20 Utility corridor

The proposed Cottonwood Gulch route is considered to be slightly better environmentally than Wheeler Gulch. Primarily because the former is a shorter route, there would be less disturbance of vegetation and, potentially, less sedimentation. In addition, there is a potential for impacts on known cultural resources in Wheeler Gulch but no known cultural resource sites in Cottonwood Gulch. However, because of soil differences, revegetation in Wheeler Gulch is expected to have a greater probability for success than in Cottonwood Gulch. Impacts on visual resources are not expected to differ significantly among the two alternatives.

3.4.3.21 Personnel transportation

The proposed action of a funicular railway is environmentally preferred over the bus alternative. However, scores for both alternatives were very similar, indicating little environmental preference between them. The bus alternative scores assumed a completed access road so there would be no road construction, only bus travel. The funicular railway scores reflected both construction and operation.

Advantages of the proposed action include avoidance of rock falls and better stability, lack of wildlife road kills that would occur from heavy bus travel, and quieter and better-shielded railway operations. Buses would be traveling over a route where large numbers of big game cross during daily movements to and from feeding areas. However, the approximately 3500-foot length of the funicular railway that would be on the surface would exceed visual resource management objectives for a Class II area, whereas bus transportation would meet visual resource management objectives.

3.4.4 Bureau of Land Management's preferred alternative

The Council on Environmental Quality (CEQ) Regulations state in Section 1502.14(e) that the lead agency must "Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternatives in the final statement unless another law prohibits the expression of such a preference."

Additional guidance is provided to agencies in the CEQ's March 16, 1981 memo, entitled, "Questions and Answers about the NEPA Regulations." The agency preferred alternative is explained as "The alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors. The concept of the "agency's preferred alternative," is different from the "environmentally preferable alternative," although in some cases one alternative may be both. It is identified so that agencies and the public can understand the lead agency's orientation." BLM's selection of the preferred alternative reflects their mandate as described in the Federal Land Policy and Management Act of 1976. Consideration has been given to agency mission, national policy, technical issues and the physical and human environments. The preferred alternative does not dictate final agency action.

The following is BLM's preferred alternative for the Mobil Project.

- <u>Retorting Method</u>
  TOSCO II, Union B, and Paraho DH
- <u>Upgrading Facilities Location</u>
  Roan Plateau
- <u>Processed Shale Disposal Location</u>
  Wheeler Gulch (upper and lower)
- <u>Processed Shale Transportation</u>
  Belt conveyor plus
- <u>Solid Waste Disposal (nonhazardous)</u>
  Sanitary landfill plus processed shale
- <u>Hazardous Waste</u>
  Offsite
- <u>Processed Shale Reclamation</u>
  30-inch cover
- <u>Water Supply</u>
  Main Elk Reservoir
- <u>Water Conveyance from Source</u>
  Stream flow
- <u>Water Diversion System</u>
  Crib
- <u>Water Diversion Location</u>
  Mahaffey Ranch 1

- <u>Water Conveyance to Roan Plateau</u>
  Cottonwood Gulch

- <u>Access Road and Mine Portal Location</u>
  Cottonwood Gulch

- <u>Contractor's Road</u>
  Cow Creek

- <u>Electrical Power Supply</u>
  Roan Plateau

- <u>Electrical Power Transmission Line Route</u>
  Hayes Gulch

- <u>Product Shipment</u>
  Tie-in to the LaSal Pipeline

- <u>Product Feeder Pipeline Route</u>
  Helm Gulch

- <u>Natural Gas Pipeline Route</u>
  Helm Gulch

- <u>Utility Corridor</u>
  Cottonwood Gulch

- <u>Personnel Transportation</u>
  Funicular Railway

4 The Pacific Project

4.1 PROPOSED ACTION AND ALTERNATIVES

This section contains a description of the proposed action (Section 4.1.1) and a description and comparison of alternatives to the proposed action (Section 4.1.2) for the Pacific Project.

4.1.1 Description of the proposed action

4.1.1.1 Introduction and overview

The Pacific Shale Project (Pacific), a joint venture of the Sohio Shale Oil Company, Cliffs Oil Shale Corporation, and the Superior Oil Company proposes to construct and operate an oil shale mining and processing facility that would attain a production capacity of 100,000 barrels per stream day of raw shale oil. The project would be located in Garfield County, Colorado, approximately 10 miles north of the community of DeBeque, as shown in Figure 4.1-1.

The project area is shown in Figure 4.1-2. The major project components are planned to be located on land owned by Pacific. The project would include a room-and-pillar underground mine, oil shale retorts, shale oil upgrading facilities, power generation, retorted shale disposal, and support facilities and services.

The proposed siting of project facilities is shown in Figure 4.1-3. The mine portal bench would be located in upper Deer Park Gulch at an elevation of 6500 feet. This portal would be the mine entrance and exit for all personnel and materials. The raw shale would be conveyed from the mine portal down-valley to near the retorting area where the shale would be split into the amount required to supply the retorts and the excess which would be diverted to a storage area. The raw shale would be screened into the size fractions necessary for optimal retorting. Retorting, to separate the oil and gas from the shale would be conducted in two types of retorts located near the mouth of Deer Park Gulch. After retorting, the shale would be conveyed to the head of Deer Park Gulch for permanent disposal.

Oil and gas retort products would be conveyed by pipeline via an intraplant corridor to the oil and gas processing facilities in the Scott Gulch area. The raw shale oil would be upgraded in a hydrotreating facility. Retort product gas would be combusted to produce steam for power generation.

Raw water from the Colorado River would be pumped to a terminal reservoir shown in Figure 4.1-2, and then distributed to the various plant areas for treatment as required for the particular water use. All wastewater would be collected and treated as necessary for recycling and reuse. No process waters or potentially contaminated waters would be discharged to the natural surface-water or ground-water environment. Natural runoff from areas upstream of the plant facilities would be diverted around the facilities to the natural drainage system.

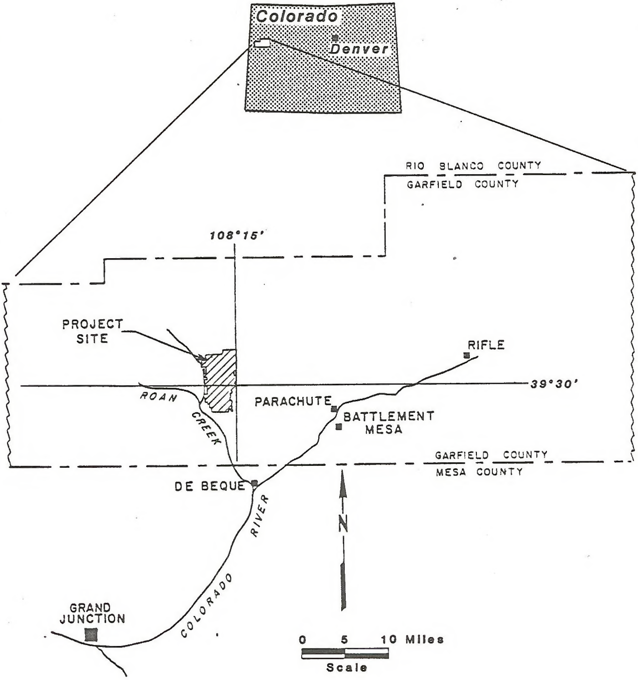


Figure 4.1-1. Pacific Project

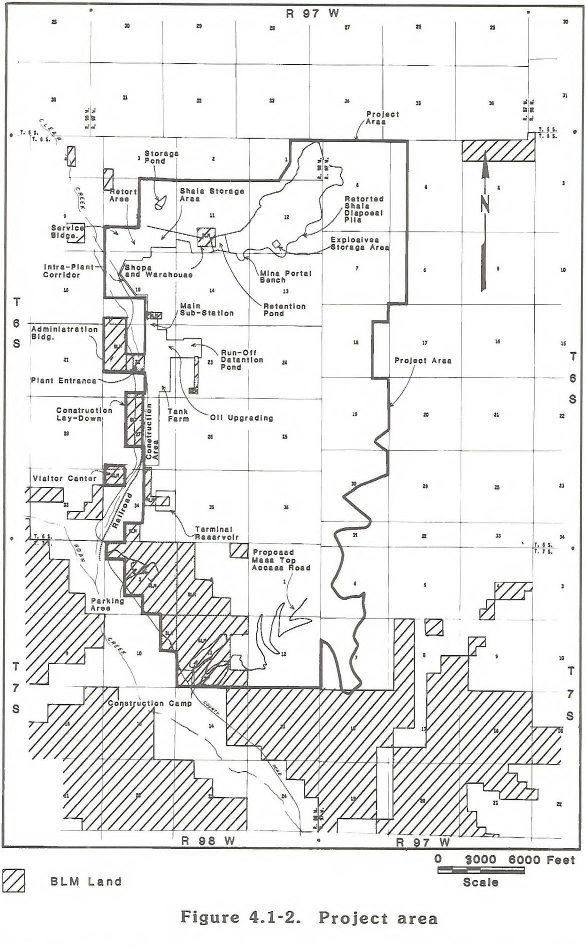


Figure 4.1-2. Project area

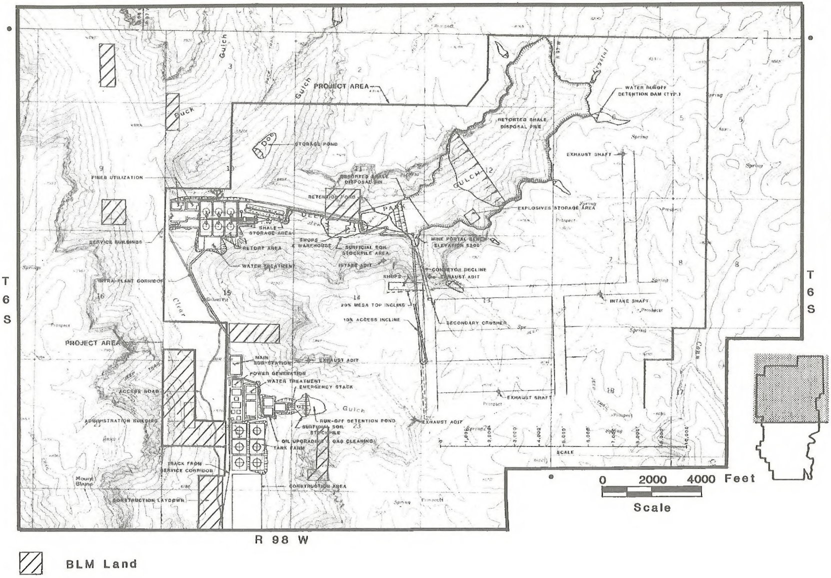


Figure 4.1-3. Site plan, process area

Best Available Control Technology (BACT) would be used to mimimize project air emissions.

Other support facilities and services necessary for project operation would include service and administration buildings, a visitors center, construction areas, a construction camp, product tank farm, and a mesa-top access road. The Pacific Project would participate in the Roan Creek Corridor which would contain an access road, water pipeline, and an electrical transmission line. A natural gas supply pipeline and a product oil pipeline would support the project.

The proposed project includes plans for the stripping, stockpiling, and conservation of surficial soils (topsoil). Site recontouring would be conducted during construction, and interim stabilization and revegetation would be conducted as appropriate during operation. When project operation is terminated, the surface facilities would be removed; final site recontouring and stabilization would be conducted; and the surficial soils would be redistributed and revegetated.

The project would be built and become operational in phases. The schedule for development of the project is shown in Figure 4.1-4. Construction of surface facilities is proposed to begin about 1985 and would extend for a period of about 13 years. The first oil shale retort would begin operation about 1990 and the last of the retorts would come on line at the end of the construction period.

Key project flow rates are listed in Table 4.1-1. Ultimately, the proposed facility would produce 100,000 barrels per stream day of raw shale oil which would be upgraded to 107,000 barrels per stream day of hydrotreated shale oil.

Table 4.1-1. Approximate flow rates[a]

Key streams	
- Shale mining rate, TPD	165,000
- 60-m retort feed rate, TPD	148,000
- Shale fines, TPD	16,500
- Retorted shale, TPD	140,000
- Crude oil, BPD	100,000
Products	
- Hydrotreated oil, BPD	107,000
- Ammonia, TPD	500
- Sulfur, TPD	150
- Generated power, MW	240
Utilities	
- Consumed power, MW	300
- Water, gpm	14,400
- Natural gas, 10^6 Btu/hr (LHV)	6,800
- Diesel fuel, gallon/week	190,000

[a]Values shown include all facilities related to operation of the mine, surface plant, and retorted shale disposal area.

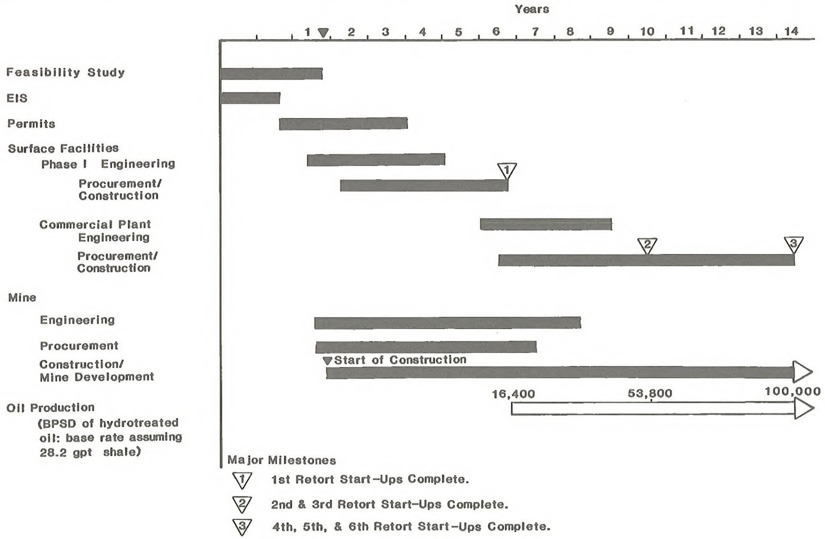


Figure 4.1-4. Pacific Project schedule for 100,00 bpd facility

Based on recoverable oil shale reserves of 880 million tons and an average oil grade of approximately 28 gallons per ton, it is estimated that about 590 million barrels of oil would be recovered by the Pacific Project during the project life.

Project manpower requirements, as shown in Table 4.1-2, would peak at 3435 employees. The post-construction manpower requirement during full commercial plant production would be 3365 employees.

Table 4.1-2. Pacific Project total site manpower loading schedule 100,000 BPSD facility

Year	Mine development and construction	Mine operations	Surface construction	Surface operations	Total
1985	140	--	90	--	230
1986	220	--	330	--	550
1987	180	110	1475	50	1815
1988	85	270	2050	185	2590
1989	55	460	830	440	1785
1990	90	590	1700	480	2860
1991	130	670	2000	550	3350
1992	130	800	1735	715	3380
1993	25	880	1300	945	3150
1994	40	960	1200	1055	3255
1995	40	975	1200	1100	3315
1996	80	1245	890	1215	3430
1997	5	1540	290	1425	3260
1998	25	1850	--	1515	3390
1999	70	1850	--	1515	3435
2000	10	1850	--	1515	3375
2001	0	1850	--	1515	3365
2002	40	1850	--	1515	3405
2003	55	1850	--	1515	3420
2004	10	1850	--	1515	3375
2005	--	1850	--	1515	3365
	.	.	.	.	.
	.	.	.	.	.
	.	.	.	.	.
	.	.	.	.	.
2011	--	1850	--	1515	3365

The following sections describe the various components and phases of the proposed project in greater detail.

4.1.1.2 Shale mining and preparation

The oil shale resource to be mined is located between the valley floor and the mesa top in the Parachute Creek Member of the Green River Formation. The mine portal bench would be located about two-thirds of the way up Deer Park Gulch at an elevation of approximately 6500 feet, as shown in Figure 4.1-3. Mining personnel and materials entering the mine would be transported from the mine portal to the mining horizon at approximately 7300 feet via the main access incline. The crushed raw shale would be conveyed from the mining horizon to the mine portal via the conveyor decline. Both the access incline and the conveyor decline would be located underground.

The mine plan, as shown in Figure 4.1-5, would include a system of main access entries and production mining panels. Initially, the main entries would be developed and would be used as ventilation airways, haulage roads, and conveyor routes. After development of the main entries, over 95 percent of the oil shale to be produced would be mined in the production panel areas. Where mining approaches the deposit outcrop, panel layouts would conform to the outcrop contour. A barrier of unmined shale would be left between the underground mine workings and the shale outcrop.

The deposit would be mined by conventional underground room-and-pillar mining methods, as shown in Figure 4.1-6. Rooms would be approximately 55 feet wide and have an average height of approximately 60 feet. For long-term stability, 64-foot-square pillars would be left in place for ground support. The mine plan would permit an overall resource recovery of approximately 62 percent.

A two-pass mining technique known as "top heading and bench" (Figure 4.1-6) would be used in mining the production panels. A 25-foot-high top heading would be mined during the first pass and bench mining would follow at an appropriate distance to remove the lower 35 feet of the mining zone. Bench mining would create a floor line common with the main entries. The mining sequence would involve drilling, charging and blasting, loading, hauling, and scaling. Roof bolting would be conducted during mining of the main entries and the top headings.

At full production, approximately 165,000 tons per day of oil shale would be mined, which average approximately 28 gallons of oil per ton. Mining would encompass approximately 7500 acres. This would include approximately 870 acres underground for the main access entries and mine service and utility areas (maintenance shop, ventilation shafts, and adits), and 6650 acres in the underground mining panels.

Fresh air would be circulated through the mine to dilute and remove diesel exhaust fumes and dust generated by mining. Air would be drawn into the mine through intake shafts and adits, circulated through the mine, and exhausted by fans located at exhaust shafts and adits. Baffled settling and water would be used to control dust during mining.

Shale crushers and conveyors would be located in the mine. Ultimately, six separate primary-crusher stations would be required and each would be located underground near an active mining area. Trucks would deliver the mined oil shale to a primary-crusher station where the shale would be reduced to less than 8 inches in size. The primary-crusher product would then be transported by belt conveyor to a centrally located secondary crusher. Secondary-crusher product (less than 4 inches) would be transported to the mine portal bench on two parallel-decline belt conveyors. The conveyors would be covered to control dust.

Raw shale would be conveyed from the mine portal, west toward the mouth of Deer Park Gulch to where the raw shale stockpiles, screening stations, and the

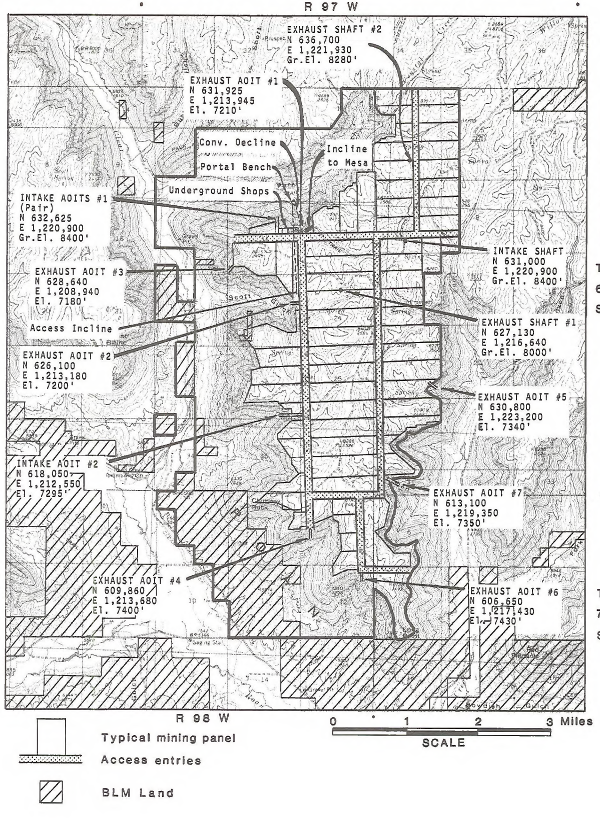


Figure 4.1-5. General mine plan

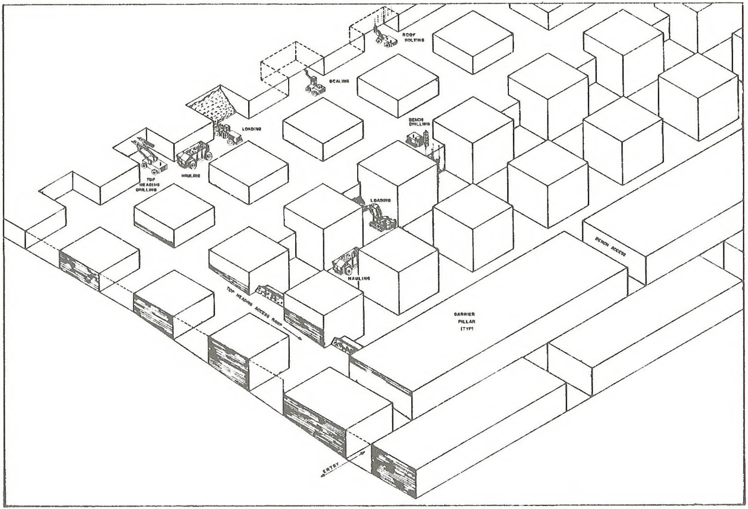


Figure 4.1-6. Room and pillar heading and bench mining concept

retort area would be located. Figure 4.1-7 is a schematic of the proposed raw shale handling system. Crushed raw shale would be conveyed to splitter-hoppers which would split the shale into the amount needed to support the retorts (about 165,000 tons per day), and would divert the balance to a storage pile. The storage pile (approximately 600,000 tons capacity) would provide storage and surge capacity between the mine and the retorts.

Raw shale from the splitter-hoppers or the storage pile would be conveyed to the screening stations where the shale would be separated into four size fractions. The three coarse shale fractions would be conveyed to the primary retorts. The fines fraction (less than 0.25 inch) would be conveyed to the fines retorts.

Dust would be controlled at all dust generating sources (crushers, conveyor transfers, screening stations, feeders, etc.) by baghouse dust collectors. Baghouse dusts would be transferred by truck to remote worked-out mine panels for retention in the mine or would be retorted with the finer raw shale in the fines retorts.

4.1.1.3 Retorting

The oil shale retorting area, to be located near the mouth of Deer Park Gulch, would consist of six Superior Retorting Process retorts and two TOSCO II fines retorts. The retorts would process approximately 165,000 tons per day of shale and produce approximately 100,000 barrels per day of oil.

As depicted in Figure 4.1-8, the Superior Retorting Process is a doughnut-shaped structure. The grate diameter is 60 meters (197 feet) and the unit is sealed (top and bottom) with water seals. The three shale-size fractions, segregated by screening, would be placed in distinct layers upon a continuously rotating circular grate. Each of the retorts would receive approximately 8200 tons per day of each of the three size fractions. The circular grate would rotate through consecutive zones of heating to release the oil and gas, cooling, and shale dumping. Figure 4.1-9 is a simplified diagram showing the Superior Retorting Process.

Retorting of shale fines and baghouse dusts (approximately 16,500 tons per day) would be accomplished using the TOSCO II process, as illustrated on Figure 4.1-10 (Vawter and Waitman, 1977). In this process, raw shale would be mixed with hot ceramic balls which would heat the shale to release the oil and gas. After retorting, the ceramic balls, retorted shale, and gaseous vapors would be separated.

The following streams would be produced during retorting: wastewater that would be treated prior to reuse; raw shale oil that would be upgraded prior to marketing; retorted shale that would be disposed of onsite; and gases that would be used as fuel.

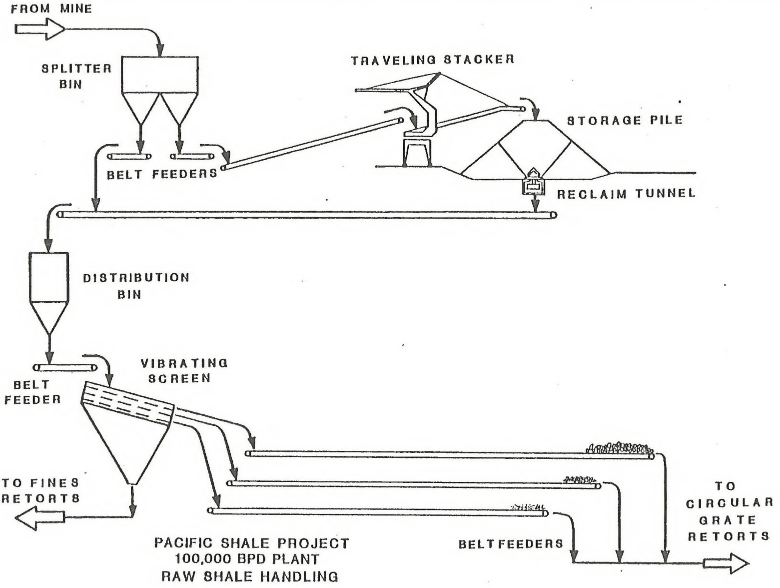


Figure 4.1-7. Raw shale handling

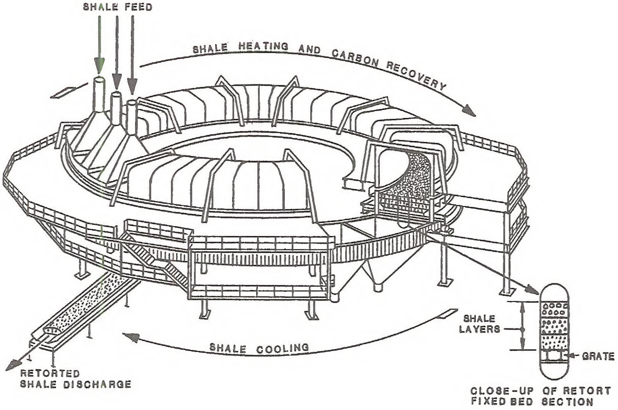


Figure 4.1-8. Sketch of Superior's retorting process

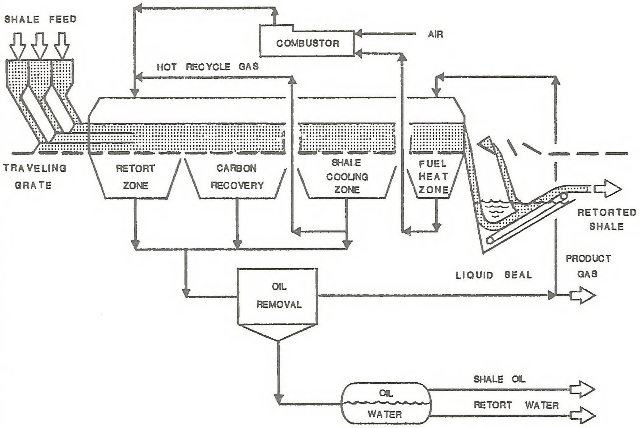


Figure 4.1-9. Superior retorting process

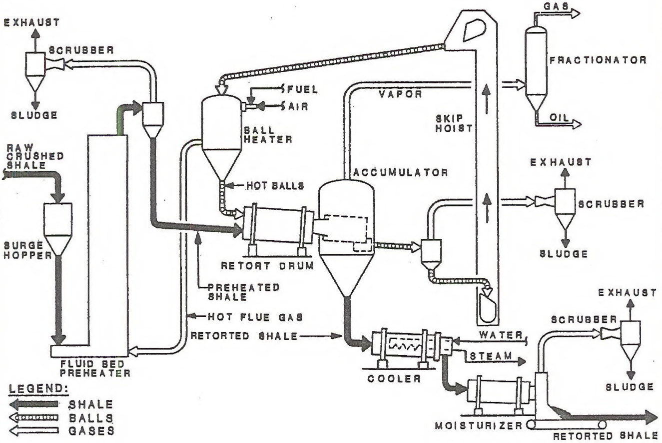


Figure 4.1-10. TOSCO II retorting process

4.1.1.4 Oil upgrading and gas utilization

Just as Deer Park Gulch would be the solids processing area of the plant, Scott Gulch and adjacent land along Clear Creek would serve as the gas and oil processing areas. An intraplant corridor would connect the two gulch areas and would be used to route retort product gas and oil from Deer Park Gulch to Scott Gulch. Power, water, and control signals would also be conveyed from gulch-to-gulch via this corridor.

The raw shale oil would be upgraded at the hydrotreating facility located in Scott Gulch. The oil upgrading process is shown in Figure 4.1-11. The initial upgrading step would involve removal of suspended solids and dissolved metals from the raw shale oil. The oil would then be heated, mixed with hydrogen, and sent through the hydrotreating reactor to reduce the nitrogen content of the product oil. The products leaving the hydrotreating reactor would then undergo several steps to cool, scrub, and separate the effluent into several streams including oil that would be stored at the nearby tank farm facility or pipelined to existing refineries; wastewater that would be treated for reuse; product gases; and acid gas that would be processed. In this process, acid gas would be ducted from the hydrotreating area to a Claus-type sulfur recovery unit which would recover 99.8 percent of the sulfur. The unit would comply with New Source Performance Standards for Claus Plants.

Retorting of oil shale would generate significant quantities of product gas which would be combusted to produce steam and generate electric power. Gas flow to the power generator would total approximately 3.2 million pounds per hour. In addition, natural gas would be used as a supplemental fuel to support combustion of the low-Btu product gas. About 10 percent of the total firing duty in the combustor would be supplied by natural gas.

The product gas utilization/power generation process is shown on Figure 4.1-12. The power generation process would consist of several parallel trains of boilers-turbogenerators. Onsite power generation would vary between 240 and 290 megawatts (MW), depending on retort operations. This would supply in excess of 90 percent of the total power requirements of the plant.

Retort product gas would contain sulfur compounds which would be converted to SO_2 gas upon combustion. A flue gas desulfurization (FGD) system is proposed to ensure an acceptable level of SO_2 in the flue gas. This unit would scrub the SO_2-laden gas with a limestone slurry, thereby removing a large percentage (in excess of 90 percent) of sulfur from the gas and generate a gypsum by-product.

4.1.1.5 Support facilities and services

Several other facilities and services would be required to construct and maintain operation of the main plant. Support facilities and services would include, but would not necessarily be limited to, a construction camp, a sand and gravel quarry, a solid waste disposal system, water systems, precipitation runoff control, service and administration buildings, and transportation, utility, and service corridors.

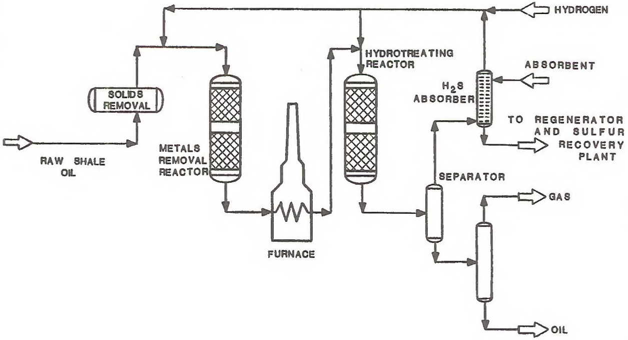


Figure 4.1-11. Oil upgrading process

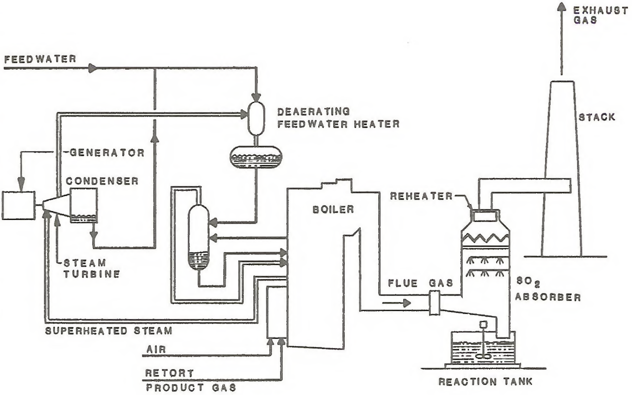


Figure 4.1-12. Product gas utilization/power generation process

Construction camp and construction areas

Pacific would provide a construction camp which would be located in the southwestern portion of the project area. The camp would encompass approximately 100 acres. The proposed size of the construction camp is based on the assumed spatial needs of the construction work force. The camp would have the capacity to house approximately 50 percent of the nonlocal construction workers. It is anticipated that the camp would consist of bachelor units (approximately 50 percent), mobile homes (approximately 25 percent), and recreational vehicles (approximately 25 percent). Also included in the camp would be meal services for the occupants of the bachelor units, recreational facilities, and other support facilities and services.

Construction laydown and construction areas would be located near Scott Gulch. Mine and plant equipment, building materials, and construction equipment and supplies would be off-loaded and stored in the laydown area until required. Equipment would be erected and prepared for placement into the mine and process facilities in the construction area.

Support buildings

During construction, numerous buildings would be erected to support the project. A visitors center would be built to receive all visitors to the project; an administration building would be built for management, administrative, and clerical offices; service buildings would be built for fire protection and safety services, equipment servicing and maintenance, employee services, water treatment, and other services.

Sand and gravel quarry

Pacific owns the surface and mineral rights to a large, high quality, gravel deposit along the Colorado River approximately 3 miles south of DeBeque, Colorado, as shown in Figure 4.1-13. This deposit would be developed primarily for use by the Pacific Project.

The total area of the property lying between the Interstate 70 right-of-way (I-70 ROW) and the Colorado River is approximately 400 acres. The mining plan would allow a ±1300-foot-wide buffer in the low lying area between the gravel pit and the river, a 50-foot-wide buffer along adjacent property and a 400-foot-wide strip along the I-70 ROW. The mineable area would be 208 acres with the depth to bedrock varying from 20 to 50 feet and with an average of 4 to 8 feet of soil overburden. The preliminary estimate of recoverable sand and gravel is 5,370,000 cubic yards. The water table varies seasonally from near surface to 6 or more feet below surface and most of the proposed gravel pit area is within the 100-year floodplain of the Colorado River.

The area supports primarily greasewood, sage, native grasses, and stands of cottonwoods and willows along the river and in lowlands. The property is currently leased and used as winter cattle range.

The quarry would be developed in phases and the mining would progress from west to east. The western boundary of the quarry would be controlled by the location of the cottonwood and willow stands and the existing ponds, neither of which would be disturbed. A 30-foot-wide main access and haulage road with a

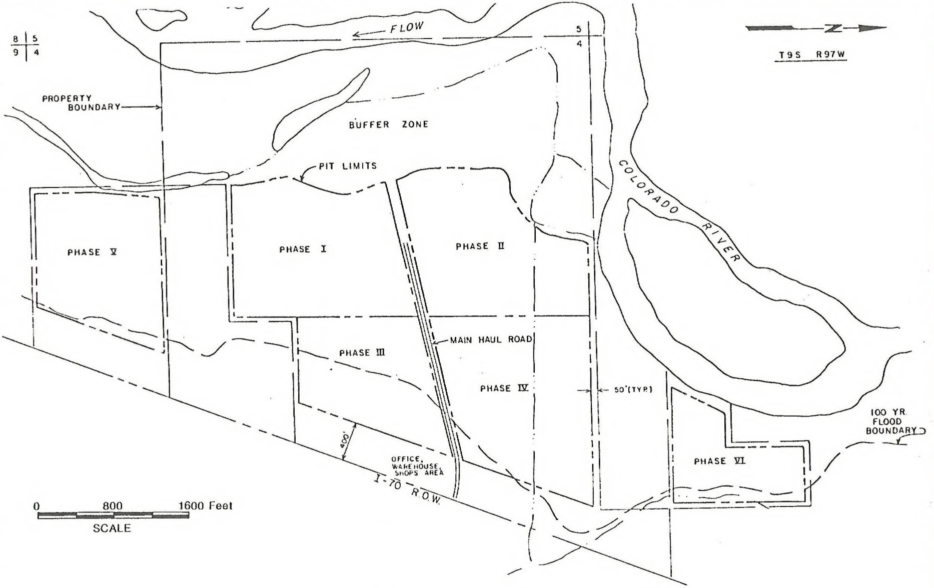


Figure 4.1-13. Gravel mining plan

gravel surface would be constructed in an east-west direction near the center of the pit area. The road would be removed in sections as the mining retreats. The two isolated parcels, Phase V and Phase VI, would be serviced by separate access and haulage roads at the time of their development.

Prior to mining the sand and gravel for each phase of the mining plan, the soil overburden would be stripped from the area and stockpiled for use during final reclamation. The reclamation plan would be approved by the Colorado Mined Land Reclamation Division and each phase would be reclaimed as it is completed.

The sand and gravel would be mined using diesel-engine, wheeled, front-end loaders feeding directly into a portable crusher where practical or into diesel-engine dump trucks where longer hauls would be required. Haul roads would be maintained by motor grader and dust control would be by water spray. Production rates would vary throughout the life-of-pit to meet demand and seasonal restrictions. Pit operations would cease during excessively high flood flows. The life-of-pit is estimated to be 20 years.

The pit would be dewatered by sump and pump methods and all water pumped from the pit would be passed through a desiltation pond prior to release to the Colorado River drainage. Water used in the washing process would also be collected in a desiltation pond prior to release.

The mined materials would be used as run-of-pit fill or processed by a combination of crushing, screening, and/or washing to produce various grades of sands, gravels, and aggregates for specific uses such as road base or bituminous concrete aggregate. The processing plant would consist of conventional portable sand and gravel processing equipment which would be located near the area being mined and would be relocated as the quarry is developed from one phase to another. Processed material would be stockpiled as near the processing plant as practical by conveyor or conveyor to dump truck methods. Dust emissions would be controlled by appropriate methods.

All permanent structures such as offices, shops, warehouses, and scales would be located within the 400-foot-wide zone along the frontage road which is above the 100-year floodplain boundary. All process equipment and materials would be removed from the floodplain area prior to flood flows.

Solid waste disposal

Various types of solid waste materials would be generated by the project. The source, type of material, quantity, and disposition of the solid wastes are summarized in Table 4.1-3.

Retorted shale disposal. During the operational life of the project, approximately 684 million tons of retorted shale would be disposed of in the upper portion (northeast end) of Deer Park Gulch, as shown in Figure 4.1-3.

Prior to disposal, the retorted shale would be moistened at the retorting facility to cool the shale and control dust. The shale would be transported from the retorting facility via an enclosed conveyor to a transfer bin at the disposal site. At the disposal site, the retorted shale would be loaded into bottom-dump trucks, and would then be spread on the disposal pile surface to form a compacted landfill.

Table 4.1-3. Anticipated solid wastes

Source	Material	Quantity	Disposal method
Retorting	Retorted shale	140,000 tons/day	Lined disposal in upper Deer Park Gulch
Hydrogen generation	Spent catalyst	6,800 cubic ft/yr	Onsite hazardous waste disposal
Hydrotreating	Spent catalyst	51,000 cubic ft/yr	Onsite hazardous waste disposal
Sulfur recovery	Spent catalyst	2,210 cubic ft/yr	Onsite hazardous waste disposal
Sour-water treatment	Spent packings	Not available	Onsite hazardous waste disposal
Construction: garbage and scrap	Concrete, metal, wood, etc.	23 tons/day	Offsite landfill
Operation: garbage and scrap	Concrete, metal, wood, etc.	12 tons/day	Offsite landfill
Decommissioning: garbage and scrap	Concrete, paving materials, etc.	Not available	Onsite landfill
	Trash, wood, debris, etc.	Not available	Onsite or off-site landfill
Mine development	Waste rock	Not available	Mine portal bench construction
Wastewater treatment	Biological sludge	109 tons/day	Onsite land treatment or landfill
	Oily sludge	10 tons/day	Onsite hazardous waste disposal
FGD (Flue gas desulfurization)	Gypsum	180 tons/day	Liner of retorted shale disposal pile

The retorted shale disposal pile would be constructed as a highly compacted earthen dam, as shown in Figure 4.1-14. The embankment portion of the dam would be designed to withstand and retain the lateral forces of the upstream landfill. The entire disposal area would be underlain with a 10-foot thick impervious liner of compacted retorted shale, possessing a permeability ranging from 1×10^{-7} to 1×10^{-6} cm/sec. Retorted shale can be compacted to a permeability of 1×10^{-6} cm/sec which is considered to be impermeable (Bureau of Mines, 1976).

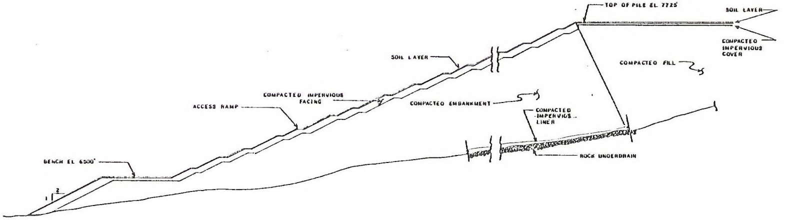


Figure 4.1-14. Typical section, retorted shale disposal pile

Gypsum produced by flue gas desulfurization would be mixed with the retorted shale to increase the stability and the impermeability of the liner.

The front slope of the embankment would have 2-foot horizontal to 1-foot vertical inclinations with compacted impervious horizontal benches at 25-foot vertical increments. The 3-foot-wide benches would be sloped toward the pile at approximately a 1 percent grade and would be equipped with berms to retain precipitation and runoff.

Retorted shale would be spread on the pile surface by bottom dump trucks. The liner and embankment portions of the pile would be compacted by smooth-drum vibratory compactors; whereas, the fill portion of the pile would be compacted by controlled routing of the haulage trucks. The average annual lift thickness of the retorted shale fill would be sufficient to absorb and retain the 100-year recurrence interval precipitation event. Therefore, during operation there would be no migration of leachate from the retorted shale disposal pile.

During construction and operation, surface-water runoff and ground-water discharge from the drainage area upstream of the Deer Park Gulch retorted shale disposal site would be intercepted and diverted around the disposal pile in a series of lined channels located along the periphery of the pile and would then be routed to Clear Creek. Controlled release retention dams would be used to reduce peak storm flows to the equivalent of the 10-year precipitation event.

Precipitation falling directly on the retorted shale disposal pile would be retained on the top of the pile, on the embankment benches, or would be routed to an evaporation retention pond located at the toe of the embankment. The evaporation-retention pond would be used as a small surge reservoir for water collection and control and as a water source for retorted shale moisturization.

The diversion of surface-water runoff and ground-water discharge away form the retorted shale disposal pile would eliminate recharge to the alluvial aquifer in the valley-bottom area of the disposal pile. Site-specific hydrology studies indicate that there are no additional ground-water or surface-water sources in the area of the proposed retorted shale disposal pile. If it is determined that water discharge and flow occur in the area proposed for the retorted shale disposal pile, Pacific would construct a rock fill underdrain or other appropriate structures beneath the bottom liner of the retorted shale disposal pile, as shown in Figure 4.1-14. The necessity for and the design of the underdrain would be finalized during the permitting process with the Colorado Mined Land Reclamation Division and other agencies.

An operational monitoring program would be developed and conducted in compliance with the applicable Federal, state, and local laws; regulations; and permits. It is anticipated that aquifers beneath the retorted shale disposal pile would be monitored for water quality via monitor wells accessing the aquifers.

Dust control would consist of a wet-suppression system, wet scrubbing, and total enclosure with water sprays in the conveying system.

Hazardous wastes. Hazardous wastes would be generated during the course of the operation. These wastes would be disposed of in an onsite landfill. The hazardous waste disposal facility would be located, designed, and operated in accordance with licensing requirements. These requirements would be defined during the permitting process. Disposal of spent catalysts in the onsite landfill would allow the opportunity to reclaim them in the future, if warranted by market conditions. An onsite hazardous waste landfill would also provide an essential backup disposal alternative in the event that a contract disposal site would shut down. This added flexibility would be important because of the relatively small number of available disposers and reprocessors in the region.

Other solid wastes. Common garbage and scrap wastes (concrete, metal, wood, glass, paper, etc.) would be disposed of in an offsite sanitary landfill. There are currently three permitted sanitary landfills in Garfield County which could accept the wastes. One landfill is located 4 miles north of Carbondale, the second is the South Canyon landfill 4 miles west of Glenwood Springs, and the third is the West Garfield sanitary landfill 5 miles west of Rifle. Development of the West Garfield sanitary landfill was based upon the need for a regional disposal facility for the oil shale industry. The landfill is designed for 25 years of service, assuming full development of the oil shale industry.

During mine construction, development rock that does not contain sufficient oil for retorting would be used to develop the mine portal bench. During operation, biological sludges from wastewater treatment would be applied in liquid form to the retorted shale pile for cooling and compaction; they would be used as soil conditioner to aid reclamation; or they would be disposed of in an onsite landfill. Gypsum produced by flue gas desulfurization would be used in the construction of the liner for the retorted shale disposal pile to further decrease the permeability.

During project decommissioning and site reclamation, all exposed concrete foundations, slabs, paving materials, etc. would be used as fill in existing pits, basins, and evaporation ponds prior to recontouring. Trash, unsalvageable scrap metal, wood, and extraneous debris would be properly buried onsite or would be disposed of in an offsite landfill.

Water systems

Water supply and storage. Pacific owns sufficient water rights on the Colorado River and its tributaries to supply the plant with the necessary 21,000 acre-feet of water per year. However, some storage would be required during periods of low flow. Three alternatives are currently being considered for project water storage:

- Alternative I - Private reservoirs on the Colorado River and its tributaries;
- Alternative II - Federal reservoirs on the Colorado River and its tributaries, and
- Alternative III - The proposed Getty-Cities Service-Chevron (GCC) Reservoir in the Roan Creek area.

All three of the storage alternatives involve direct diversion of water from the Colorado River near DeBeque. In the first two alternatives, the diversion would be continuous year-round at a nominal rate of 32 cubic feet per second with augmentation during low river flow by releases from one of the private or Federal reservoirs. The third alternative would consist of regulating diversions at up to approximately 48 cubic feet per second into GCC's Roan Creek Reservoir. As necessary, water would be supplied by the Roan Creek Reservoir during low-flow periods on the Colorado River.

The water supply system would include an intake structure and low-head pumping station beside the river, a nearby desiltation facility and main pumping plant, and a buried pipeline to convey the water to a small terminal reservoir near the plant site. The location of these proposed facilities is shown in Figure 4.1-15.

The intake structure would be located on property owned by Pacific on the north bank of the river, adjacent to and upstream from the highway bridge at DeBeque, as shown in Figure 4.1-16. The intake would include a concrete pad extending into the river at the elevation of the existing river bottom. A rock-filled gabion structure, also at the river bottom elevation, would be placed across the river to maintain the fixed-river bottom and prevent erosion from channeling the river flow away from the intake structure. Water would be pumped from the diversion structure through a pipeline passing under the railroad tracks to the desiltation facility to be located on Pacific property just north of the railroad.

The desiltation facility would consist of a pond with a surface area of approximately 3.5 acres. The pond would provide storage for approximately 3 months of sediments under worst case conditions.

From the pond, the water would be pumped through a pipeline to a terminal reservoir near the plant site (Figure 4.1-2). The terminal reservoir would be an excavated pond-type reservoir constructed on a gently sloping alluvial fan at the mouth of an unnamed gulch. The reservoir would have a surface area of approximately 9 acres and a depth of approximately 45 feet. The reservoir would be a regulation and distribution point for water to the various plant facilities and would provide a water supply during interruptions in the pumping system.

The water supply system at the plant site would be composed of two subsystems: raw water treatment and use, and wastewater treatment and reuse. The overall water balance is shown in Figure 4.1-17. The estimated water consumption by the various project facilities is shown in Table 4.1-4. Figure 4.1-18 schematically diagrams the water flow. The water balance and the water flow schematic are based on a zero-discharge concept. After use, there would be no water discharged from the plant site. Used water would be treated, recycled, and reused.

Raw water treatment and use. Raw Colorado River water would be supplied from the terminal reservoir to raw water ponds located in Deer Park Gulch and Scott Gulch. These ponds would serve as surge capacity for the water treatment area and as sources for fire water. From the Deer Park Gulch pond, raw water would be pumped to the mine and the retorts for use by these facilities.

At both gulches, raw water would be clarified to provide service water. Alum, caustic, and polymer solutions would be mixed with the raw water. Alum would react with the alkalinity to form a floc, and the polymer would be used to stabilize the floc for better removal. Alkalinity would also be added in the form of caustic to aid the flocculation. The clarified water would be used service water and would be stored in tanks or pumped to its users as needed.

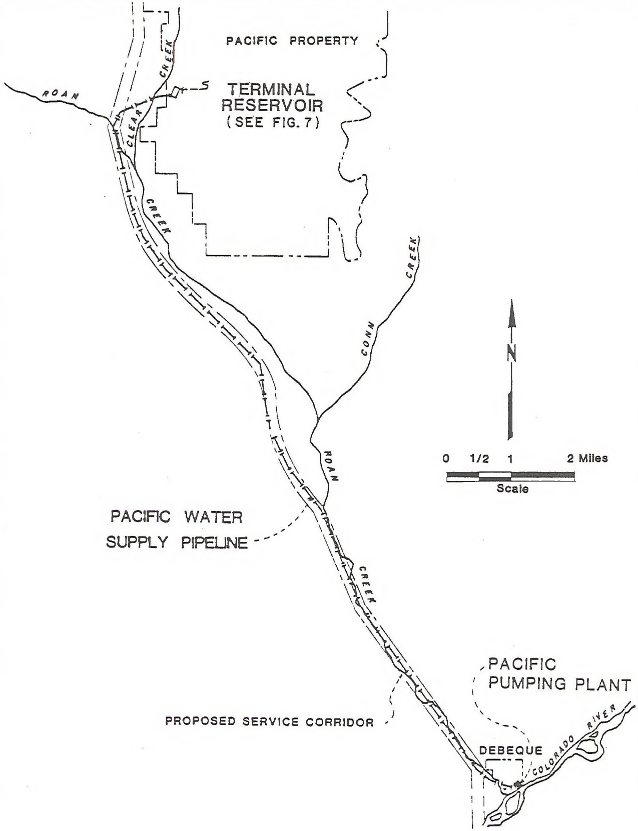


Figure 4.1-15. Water supply system

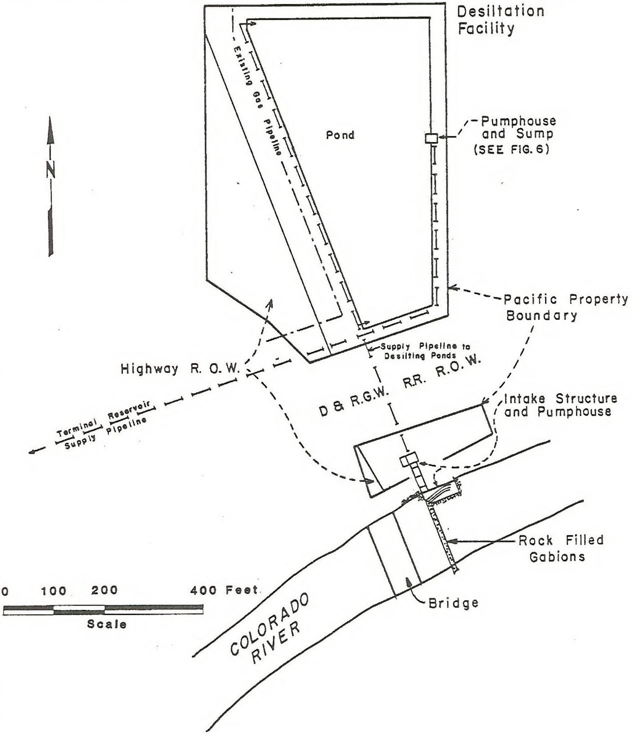


Figure 4.1-16. Water supply intake structure, desiltation facility, and pumphouses

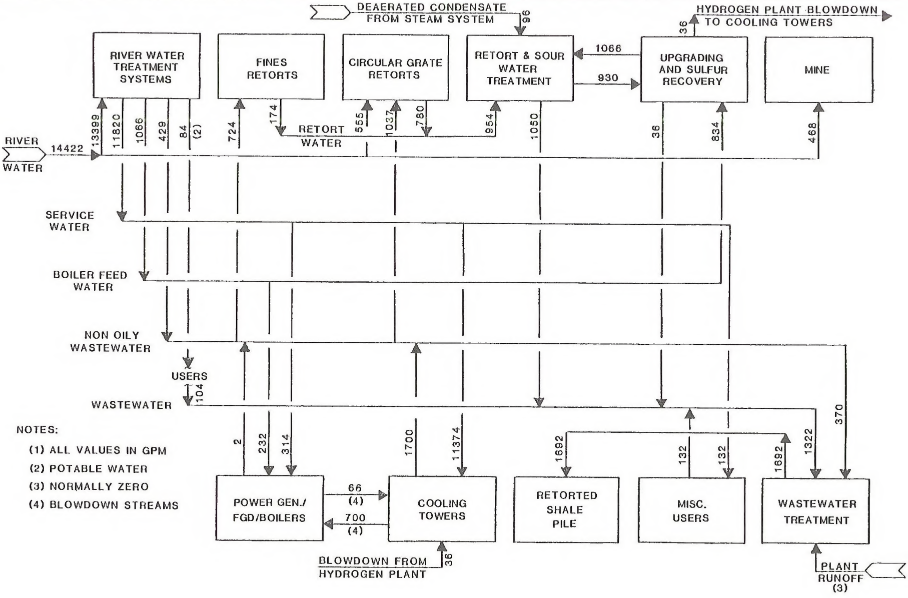


Figure 4.1-17. Overall water balance

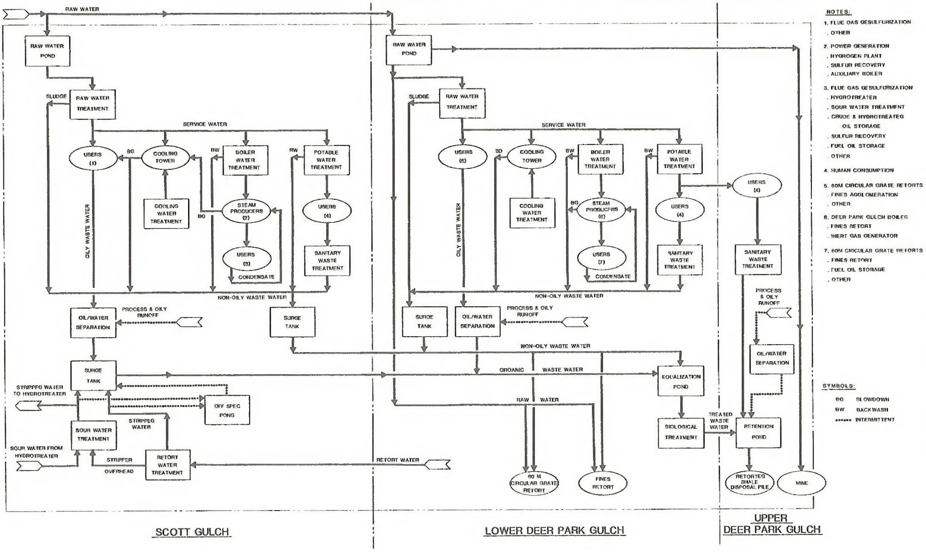


Figure 4.1-18. Water flow schematic

Table 4.1-4. Estimated water consumption by project facilities

Facility	Consumption (gallons per minute)
Circular grate retorts (Superior)	812
Fines retorts (TOSCO)	550
Retort and sour water treatment	136
Upgrading and sulfur recovery	626
Mine	468
Power generation, flue gas desulfurization, and boilers	1,082
Cooling towers	9,076
Retorted shale disposal	1,692
Potable use	-20
Total	14,422

Some of the water would be pumped to potable water and boiler water treatment systems for further treatment.

Each gulch would have a potable water treatment system. In lower Deer Park Gulch, potable water would also be produced for the mine. Service water would be pumped to a breaktank to provide a break between the potable water supply and any other water that might contaminate it. Potable water feed pumps would deliver the water to pressure sand filters. Powdered activated carbon would be added to the water filters to absorb objectionable tastes and odors. The sand filters would remove suspended solids and any carbon entrained in the water. Chlorine would be injected into the water after filtering for bacterial disinfection. Potable water would be stored in storage tanks and supplied to users as required.

Boiler water would be required in each gulch for different users. In Deer Park Gulch, boiler water of sufficient quality would be required for steam production. Boiler water would be required in Scott Gulch for power generation and hydrogen generation. Boiler water treatment in Deer Park Gulch would consist of pressure sand filters and zeolite softeners. Water would be taken from the clarified water surge tank and sent through the sand and granular carbon filters. The zeolite softeners used in Deer Park Gulch would decrease the scaling tendency of the boiler water. Organic and inorganic particles would be removed in Scott Gulch by deposition on ion exchange resins.

There would be a cooling water system in each gulch. The systems would be open, recirculating systems. The water would be cooled by evaporation in cooling towers. In Deer Park Gulch, the retorts would be the largest users of cooling water. In Scott Gulch, the majority of the cooling water would be used by the hydrogen plant, hydrotreater, and power generation facilities.

Cooling towers would be continuously blown down to stay within the maximum allowable solids concentration. The blowdown from the Deer Park Gulch cooling tower would be pumped to the nonoily wastewater surge tank. In Scott Gulch, approximately 70 percent of the blowdown would be used as make-up water for the flue gas desulfurization system. The rest would be pumped to the nonoily wastewater surge tank.

Recirculated cooling water would be conditioned to control deposits and biological growth. A dispersant would be used to prevent buildup of particles on surfaces and keep the solids suspended. A scale and corrosion inhibitor would be used to inhibit scale deposits and establish a protective coating on the heat transfer surfaces. To control biological growth, a chlorine residual would be maintained in the cooling tower basin. An acid feed system would be used to control alkalinity.

Cooling water make-up would be received from the service water storage tank in each gulch. In Scott Gulch, make-up water would also be received from boiler blowdowns in the hydrogen plant and power generation areas.

Wastewater treatment and reuse. The wastewater collection system would collect wastewater from users and deliver it to wastewater treatment facilities. The collection system would also have surge capacity to allow for retention of wastewater.

Storm-water runoff ditches would encircle the outermost limits of the site to direct rainwater runoff (exterior to the plant perimeter) to Clear Creek. Diversion ditches around the retorted shale disposal pile in upper Deer Park Gulch would direct the runoff toward the surface facility in lower Deer Park Gulch. A retention pond in upper Scott Gulch would collect rainwater runoff from that area. Process and oily runoff would be routed by an underground sewer to the oil-water separation system.

Surge tanks would be placed in Scott Gulch and lower Deer Park Gulch to collect nonoily and organic wastewater. Organic wastewater in Scott Gulch would be collected in the surge tank and pumped to the equalization pond in lower Deer Park Gulch. Nonoily wastewater would be pumped from its tank in Scott Gulch to the equalization pond. Nonoily wastewater produced in lower Deer Park Gulch would be collected in a surge tank and pumped to the equalization pond or the retorts.

The equalization pond would serve as a surge for the biological treatment area. It would have mixers to keep the various wastewaters well mixed and would provide a constant feed composition to the treatment system.

There would be an off-spec pond in Scott Gulch to collect stripped retort or sour water that would not be of acceptable quality for direct treatment. The water would be slowly released into the organic wastewater system.

There would be three sanitary waste treatment systems. One unit each would be located at the surface facilities in Scott Gulch and lower Deer Park Gulch, and at the mine in upper Deer Park Gulch. Sanitary waste from each area would be collected in the sanitary sewer network and pumped to the area's respective unit. The treatment systems would be package units and would employ chlorine tablet disinfection. The mine would have underground sanitary facilities that would route the empty waste to the mine treatment system. Portable toilets would be located at the retorted shale disposal area and would also be emptied into the mine's unit. Treated sanitary wastewater from the surface facilities would be pumped to the respective nonoily wastewater surge tanks.

Retort water from the retorts would be delivered to Scott Gulch for treatment via the retort water intraplant pipeline. Oil and grease would be removed from the retort water in an oil-water separator and a dissolved air flotation unit. The retort water would be pumped to a retort water stripping column and caustic would be added to free fixed ammonia. Ammonia, carbon dioxide, hydrogen sulfide, and water vapor would be stripped overhead and sent to a condenser. The condensed liquid would be used as column reflux or would be sent to sour water treatment for further stripping and ammonia recovery. Stripped retort water leaving in the bottoms would be sent to the organic wastewater surge tank in Scott Gulch. If the stripped water was not of acceptable quality, it would be sent to an off-spec pond in Scott Gulch. It would then be slowly released into the organic wastewater system.

The sour water treatment area would be based on the Chevron Wastewater Treatment (Chevron WWT) system. The Chevron WWT system takes sour-water streams and produces anhydrous ammonia, ammonia-free acid gas, and stripped water. Sour water would be received primarily from the hydrotreater and retort water stripper. In addition, a small sour-water stream would come from the sulfur recovery area. These streams would be combined in a common degasser where light hydrocarbons would be removed. A recycle stream of ammonia water would be mixed with the sour waters to keep the acid gases in solution. Hydrocarbon vapors from the degasser would be sent to the thermal oxidizer. Sour water would be heated by heat exchange with the ammonia stripper bottoms and would be fed to the acid gas stripper. This stripper would be a steam reboiled distillation column. Carbon dioxide and hydrogen sulfide would be stripped overhead and water washed to remove ammonia. Acid gas would be sent to the sulfur recovery area. The acid gas stripper bottoms would be fed to the ammonia stripper. This stripper would also be a steam reboiled distillation column. Stripped water would leave with the column bottoms and would be cooled by heat exchange with the sour-water influent. Most of the stripped water would be returned to the hydrotreater for ammonia and hydrogen sulfide removal. The rest of the water would be sent to the organic wastewater surge tank in Scott Gulch. If the stripped water was not of acceptable quality, it would be sent to an off-spec pond in Scott Gulch. It would then be slowly released into the organic wastewater system.

The surface facilities in Scott Gulch and lower Deer Park Gulch, and the mine in upper Deer Park Gulch would each have an oil-water separation system. Oily water would be collected by the process and oily water runoff sewer, and sent to the oil-water separator. Separator underflow would go to the dissolved air flotation unit for further removal of emulsified oil. Oil floating on top of this unit would be combined with the separator's oil effluent. In Scott Gulch, the water effluent would flow to the organic wastewater surge tank. At lower Deer Park Gulch, it would be pumped to the equalization pond. In upper Deer Park Gulch the water effluent would be pumped to the retention pond.

The biological treatment plant would be designed to reduce the organic content of the organic wastewater before the water is used for retorted shale disposal. Organic wastewater would be collected in the equalization pond. It would be composed of stripped sour and retort waters, process water from the oil-water separation areas, and nonoily wastewater. Water from the equalization pond would be combined with a recycle stream from the bioreactor. Phosphoric acid would be added as a source of nutrient for the microorganisms. Oxygen, produced by an oxygen plant, would be dissolved in the water. Biological digestion would occur in the reactor and treated water would be pumped to the retention-evaporation pond in upper Deer Park Gulch at the toe of the retorted shale disposal pile.

Water from the retention-evaporation pond would be used for moisturization and dust control during retorted shale disposal. Excess water discharged to the pond could be evaporated or used for dust control in mining. If additional water was needed for retorted shale disposal, raw water could be used.

Precipitation runoff control

A precipitation runoff control system for the project must be capable of controlling both natural (uncontaminated) and contaminated waters. Therefore, two distinct systems would be required to achieve this control: a system to divert natural runoff water around the plant area, and a system to collect contaminated runoff water.

With the natural runoff diversion system, all sites would be sloped to provide proper drainage. Runoff would be intercepted in ditches and diverted around the mine site and process facilities. The system would be constructed with erosion protection and energy dissipators, and would be designed to contain a Probable Maximum Precipitation event. In the Deer Park Gulch area, lined channels would be constructed to divert natural runoff around the retorted shale disposal site. The natural runoff diverted around the retorted shale disposal site, the mine, and other project facilities would flow into Clear Creek.

Precipitation falling in the various plant areas would be collected, treated, and used within the plant. Runoff from process areas and oily runoff would be collected and routed by an underground gravity sewer to an oil-water separation area. The oil and water would be separated and the water would be treated. After treatment, all contaminated runoff water would be piped to the retorted shale disposal area. Precipitation runoff from the mine area and from the retorted shale disposal pile would be collected in an evaporation-retention pond located at the toe of the retorted shale disposal pile embankment, or would be retained on the embankment benches. Contaminated runoff after treatment, and runoff from the mine and retorted shale disposal areas would be used by the retorted shale disposal system.

Corridors

Roan Creek Corridor. The Pacific Project proposes to participate in and use the Roan Creek Corridor as described and analyzed in the CCSOP DEIS (BLM, 1983b). The corridor would extend from the DeBeque area up the Roan and Clear Creek valleys and beyond the Pacific Project area, going around the GCC Roan Creek Reservoir. It would contain an access road, a water pipeline, and an electrical transmission line, which would service the Pacific Project.

An existing approximately 25-foot wide road within the Roan and Clear Creek valleys extends from Interstate 70 through the outskirts of DeBeque and beyond the proposed project area. The road would be upgraded through replacement of several bridges, general widening, and paving. Upgrading of the roadway would be conducted early in the construction schedule.

The corridor would contain a water pipeline from the water diversion and desiltation facility to the terminal reservoir. The 36-inch diameter pipeline would be buried, the land would be recontoured, and the surface would be revegetated.

An electrical switching station would be constructed near DeBeque to connect into an existing 230-kilovolt transmission line. A 230-kilovolt transmission line would be constructed in the Roan Creek Corridor to link the switching station to the Scott Gulch plant site.

Mesa-top access road. A 6.3-mile long mesa-top access road would be constructed in a corridor approximately 100 feet wide from the Roan Creek Corridor access road in the valley to the top of the mesa, where it would connect with existing access roads. The location of the road is shown in Figure 4.1-2. The road would have a grade of approximately 8 percent and would be approximately 20 feet wide with ditches and culverts to provide adequate drainage. The road would be used to access environmental monitoring sites and to service project facilities such as mine vents. It is not planned to be used as a mine haul road or a personnel access road for mine workers.

Product oil pipeline. A product oil pipeline would be required to transport upgraded shale oil product from the project to the proposed Shale Oil Pipeline Study (SOPS) pipeline. Pacific would either jointly or singly construct and operate the product pipeline. This short connecting pipeline would be located in one of the product transport corridors, the Roan Creek Corridor, or both, as described and analyzed in the CCSOP DEIS (BLM, 1983b).

Natural gas pipeline. Natural gas requirements for the project could be as high as 160 billion Btu per day. A natural gas supply pipeline would be constructed from the project area to an existing main natural gas pipeline which is located parallel to Colorado Highway 139 between Rangely and Mack, Colorado, approximately 30 miles west of the project area. The proposed pipeline would be constructed in corridors described and analyzed in the CCSOP DEIS (BLM, 1983b) and the Final EIS on the Proposed Development of Oil Shale Resources by the Colony Development Operation in Colorado (BLM, no date). From the Pacific Project area, the pipeline would follow the Roan Creek Corridor to the Clear Creek Valley-Roan Creek Valley confluence; follow Roan Creek Valley to the Big Salt Wash Corridor; and follow the Big Salt Wash Corridor and the LaSal Pipeline Corridor to the intersection with the existing main natural gas supply line.

By-product ammonia and sulfur

The project would produce approximately 500 tons per day of by-product ammonia from gas and water treatment systems. The ammonia would be stored onsite at ambient temperatures in spherical tanks. The ammonia would be transported to users by truck or rail, or would be used onsite to produce ammonium nitrate for other purposes.

Approximately 150 tons per day of by-product sulfur would be produced by the Claus-type sulfur recovery unit. This sulfur would be stored onsite. When a feasible market exists for sulfur, it would be transported to users by truck or rail.

Transportation and parking

The highest traffic density in the corridor to the project would occur during the arrival or departure of the day shift work force. Based on the projection of a maximum of approximately 3400 employees, it is estimated that there could be 1100 people traveling to and from the project for the day shift. After deducting 20 percent which might travel by commercial bus service, and then assuming two people per car, the projection would be 450 cars traveling up to the plant parking area over a 1-hour period. During that same period, there could also be four buses and six trucks that would travel to the project.

During construction, truck traffic in the Roan Creek Corridor will consist of approximately 20 truck trips per day transporting materials between a railroad spur at DeBeque and the project area. During operation, approximately 25 truckloads of ammonia and 8 truckloads of sulfur will be transported daily from the site. In addition, approximately 12 trucks per day will transport other materials to and from the site. Each truck will be transporting about 20 tons of materials during construction and operation.

Employee parking would be provided near the entrance to the project area. It is assumed that approximately 40 acres would be required for this purpose. Shuttle service would be provided from the parking areas to the various work locations. In addition, parking spaces would be provided at the visitors center, administration building, and other locations as necessary.

4.1.1.6 Site development, interim stabilization, decommissioning, and reclamation

Site development

Site development would consist of stripping, stockpiling, and conservation of surficial soils; recontouring and terracing of the plant site and support areas; and installment of the water diversion and control systems. It is estimated that approximately 4 million cubic yards of surficial soils would be stripped and stockpiled. During recontouring, approximately 8.7 million and 4.4 million cubic yards of subsoil material would be cut and filled, respectively.

Interim stabilization

During the phased development and operation, soil stockpiles and applicable disturbed areas would be stabilized and revegetated to the extent practical. The stabilization and revegetation would minimize wind and water erosion and impacts to air and water quality.

Surface facilities, decommissioning, and removal

At completion of the operating phase, all surface facilities would be removed from the project area. Prior to shutting down, all equipment would be emptied and all materials would be removed from the area. All piping and equipment that contained shale oil, fuels, or other volatile materials would be flushed and purged. All underground piping systems and manholes would be flushed clean and sealed with concrete. Any equipment providing essential services would be shut down after the need for those services no longer existed. Utilities, fire protection, and safety facilities would be the last to be dismantled.

Mine abandonment

All mine openings would be sealed with 18-inch-thick structural steel-reinforced concrete plugs, except for eight ventilation adits whose portals are located above the grade of the mine floor. These eight adits would be plugged with mine rock. Concrete plugs would not be necessary to prevent seepage, as these eight adits slope downward towards the mine floor.

Concrete plugs would be constructed at the surface for the ventilation shafts and within 20 feet of the other openings. Rock and earth materials would be backfilled against the plugs to camouflage and reclaim the openings. The plug at the portal entrance for the access incline would be provided with weep holes to allow water to drain. This water would be routed from the access incline opening on the portal bench to Clear Creek via a concrete-lined ditch. Treatment of this water should not be necessary as it naturally flows from springs that currently feed Clear Creek.

Retorted shale disposal pile abandonment

After all retorted shale has been disposed of in the retorted shale disposal pile, the surface fill (approximately 36 inches) of the disposal pile would be compacted to provide an impermeable cap (1×10^{-7} to 1×10^{-6} cm/sec permeability) on the disposal pile. The impermeable surface would limit precipitation and surface runoff entering the fill area of the pile and leaching the retorted shale after site abandonment. The impermeable cap would limit root penetration, salt uptake and transport, and topsoil contamination by salt-tolerant plant species. The surface cap, the embankment and the liner would provide an impermeable encapsulation of the retorted shale. Approximately 36 inches of surficial soil that would be stripped from the retorted shale disposal site prior to development of the pile would be redistributed on the impermeable embankment face and on the surface cap. Since there would be insufficient topsoil available to comprise the entire soil profile, the balance of the surficial soils would consist of granular talus material.

Detention dams would be removed and diversion ditches would either be removed or upgraded to contain 6.5 inches of precipitation per hour. During preparation for abandonment, a system of large, lined channels would be constructed across the top and down the embankment face of the retorted shale disposal pile. The lined channels would collect surface-water runoff and precipitation. The collected and contained runoff would be routed to Clear Creek. The lined channels would limit erosion and water infiltration into the retorted shale disposal pile.

Over a long period of time (1000 years) there is potential for differential settling of the retorted shale disposal pile which could damage the impermeable cap, and there is potential for the lined water channels across the retorted shale disposal pile to break or deteriorate and release water to the retorted shale disposal pile. (Refer to Section 4.3.1, Impact on affected environment.) Therefore, the Pacific Project is considering the installation of drains immediately above the bottom liner of the retorted shale pile, or at other appropriate locations in the disposal pile. Drains installed above the bottom liner could preclude pile failure that could be caused by water buildup above the liner. Drains or other controls installed at higher elevations in the disposal pile could preclude water leaching the shale.

Surface reclamation and revegetation

Disturbed areas would be recontoured and graded to slopes compatible with the surrounding topography. These areas would be graded to provide terraces that minimize erosion and prevent sedimentation from contaminating surface streams. The terraces would also encourage the establishment of a vegetative cover.

Detention dams would be removed and diversion ditches would be upgraded to handle the probable maximum precipitation event (6.5 inches/hour).

Surficial soils that had been stripped from the surface and stockpiled prior to construction would be redistributed over all disturbed surfaces in the project area. Relatively level surfaces would be reseeded using a seed drill, while embankment slopes would be hydroseeded. During the second year of reclamation, seedlings would be transplanted on the retorted shale pile. Tables 4.1-5 and 4.1-6, respectively, list seed and seedling mixtures that could be used during revegetation. These revegetation mixtures could change because of regulatory requirements, seed availability, and other factors, prior to revegetation. During reclamation, fertilizer and mulch would be used as required to promote revegetation and prevent erosion.

4.1.1.7 Net energy analysis

Table 4.1-7 summarizes calculation of the net energy yield projected for the Pacific Project.

Table 4.1-5. Tentative seed mixture (first year)

Species	Common name	Seeding rate (lbs/acre)
Grasses		
Agropyron dasystachyum	Critana thickspike wheatgrass	1.0
Agropyron desertorum	Crested wheatgrass	1.0
Agropyron elongatum	Tall wheatgrass	1.0
Agropyron riparium	Streambank wheatgrass	1.0
Agropyron smithii	Western wheatgrass	2.0
Agropyron spicatum inerme	Beardless bluebunch wheatgrass	1.0
Agropyron trichophorum	Pubescent wheatgrass	1.0
Elymus cinereus	Basin wildrye	1.0
Elymus junceus	Russian wildrye	1.0
Festuca ovina duriuscula	Hard fescue	2.0
Sporobolus airoides	Alkali sacaton	0.1
Forbs		
Achillea millefolium	Yarrow	0.2
Hedysarum boreale	Utah sweetvetch	0.1
Melilotus officinalis	Yellow sweetclover	0.5
Shrubs		
Artemisia tridentata	Big sagebrush	0.1
Atriplex canescens	Fourwing saltbush	1.0
Chrysothamnus nauseousus	Rubber rabbitbush	1.0
Cowania mexicana stansburiana	Stansbury cliffrose	0.1
Krascheninnikovia lanata	Winterfat	0.5

Table 4.1-6. Tentative shrub seedling mixture (second year)

Species	Common name	Seedlings/acre
Amelanchier utahensis	Utah serviceberry	20
Prunus virginiana	Chokecherry	38
Purshia tridentata	Antelope bitterbrush	40
Quercus gambelii	Gambel's oak	38
Rosa woodsii	Woods rose	20
Symphoricarpos oreophilus	Snowberry	50
Total		206

Table 4.1-7. Calculation of total trajectory net energy (Btus)

Final Products:	
Hydrotreated Oil	0.627×10^{12}
Sulfur	0.336×10^{9}
Ammonia	0.606×10^{9}
Subtotal	0.628×10^{12}
Direct External Energy:	2.329×10^{9}
	0.078×10^{9}
	8.749×10^{9}
	26.370×10^{9}
	102.540×10^{9}
	0.636×10^{9}
Subtotal	0.141×10^{12}
Total Losses:	541.000×10^{9}
	4.100×10^{9}
	1.393×10^{9}
	153.400×10^{9}
	66.370×10^{9}
	68.100×10^{9}
	102.000×10^{9}
Subtotal	0.936×10^{12}
Initial Principal Energy: (Resource)	1.423×10^{12}
Net Energy Yield:	
Principal Energy	1.424×10^{12}
Total Losses	0.936×10^{12}
Net Yield	0.488×10^{12} Btu

The project trajetory has been divided into six modules, as summarized below.

MODULE I: MINING SHALE

A. Equipment and Facilities Included

- Hydraulic drill jumbos
- Large haulage trucks
- Front-end loaders
- Rock bolt machines
- Ventilation fans
- Water trucks
- Lubrication and fuel trucks
- Powder and ANFO loading trucks
- Pumps
- Maintenance vehicles and equipment
- Men and materials transport vehicles

B. Data Base

- 165,000 tpd of oil shale is mined from a room-and-pillar mine using a "two-pass" mining method (25 ft top heading, 35 ft lower heading).

- Shale is transported to the primary crusher via truck.

C. Assumptions

- Only direct energies are considered.

D. Efficiency and Losses

- All fuel and electrical power are considered losses from the module.

- Overall resource recovery is 62 percent.

MODULE II: CRUSHING, SCREENING, STOCKPILING, AND RECLAIMING

A. Equipment and Facilities Included

- Primary crushers
- Secondary crushers
- Conveyors
- Scalpers and screens
- Reclaimer

B. Data Base

- 165,000 tpd of oil shale is processed through the primary crusher system to yield ore less than 8".
- Secondary crushing processes ore to less than 4".
- Ore is stockpiled for later reclaim and feed to the retorts.
- The screening plant separates ore into three size fractions and fines (-1/4").

C. Assumptions

- Only direct energies are considered.

D. Efficiency and Losses

- All electrical power supplied is considered lost from the module.
- All shale fed to this module is ultimately fed to the retorts.

MODULE III: DIRECT HEAT GAS FLOW RETORTS

A. Equipment and Facilities Included

- Six (6) Superior circular grate retorts
- Two (2) TOSCO II fines retorts
- Gas handling blowers
- Oil recovery system
- Liquid handling equipment

B. Data Base

- Raw shale feed to the retorts is 165,000 TPD. No portion of the shale is discarded.

- Crude shale oil production is 100,000 BBL/Stream Day.

- Fischer Assay of the raw shale is approximately 28.2 GPT.

- Approximately 139,000 tpd of retorted shale exits the module.

C. Assumptions

- For simplification, all shale is assumed to be processed using Superior process information since only 10 percent of the shale is processed through the TOSCO II retorts.

- Only direct external energies are considered.

- Certain utility energies are dedicated to this module, i.e., air, cooling tower, water treatment, intraplant corridor, and miscellaneous.

D. Efficiency and Losses

- Oil recovery is approximately 92 percent of Fischer Assay.
- Losses from the retort module include:

    1. Electrical energy input to the module.
    2. Natural gas fed to the module.
    3. Recycled product gas stream.

MODULE IV: POWER PLANT

A. Equipment and Facilities Included

- Boilers
- Steam turbines and generators
- Water pumps
- Blowers
- Cooling towers

B. Data Base

- Surplus retort offgas is the primary fuel; about 10 percent natural gas is added.

- 121.7 MW of power generated by the power plant supplies approximately 95 percent of the entire electrical requirement of the plant. The remaining 5 percent of normal power requirements and startup power are supplied from external sources.

C. Assumptions

- Only direct energies are considered.

D. Efficiency and Losses

- All electrical power to the module is considered lost; retort offgas and natural gas are converted by a specified efficiency factor to electric power.

MODULE V: UPGRADE SHALE OIL

A. Equipment and Facilities Included

- Hydrogen plant
- Hydrotreater
- Oil transfer
- Flue gas desulfurization
- Sour water treatment
- Sulfur recovery
- Miscellaneous

B. Data Base

- 100,000 bpd of crude shale oil is processed to remove solids and metals. The crude is then hydrotreated to remove nitrogen, which generates 107,000 bpd of high grade synthetic feedstock.

C. Assumptions

- Only direct energies are considered.

D. Efficiency and Losses

- All electrical power to the module is considered lost. A portion of the natural gas values are assumed to be converted to synthetic feedstock through hydrogenation.

MODULE VI: SHALE DISPOSAL

A. Equipment and Facilities Included

- Conveyors
- Off-road belly dump trucks
- Compactors
- Revegetation irrigation systems
- Grinding ball mills

B. Data Base

- All retorted shale from the retorts is disposed of at the rate of 139,000 tpd.

- Retorted shale is transported to the shale pile area by conveyor, then distributed on the pile by belly dump trucks.

- Topsoil distribution and irrigation is carried out as the pile progresses.

C. Assumptions

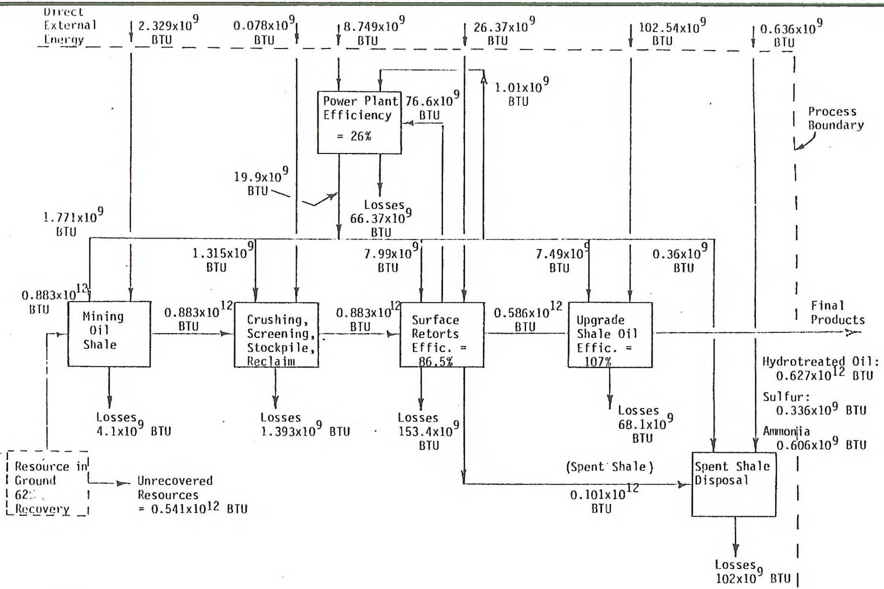
- Only direct energies are considered.

D. Efficiency and Losses

- Losses from the module include:

  1. Electrical and diesel fuel energy.
  2. Principal energy in unrecovered carbon.

The energy balance, modules, and trajectory are shown on Figure 4.1-19.



NOTE

1. All units are in BTU per stream day

Figure 4.1-19. Energy balance

4.1.2 Description of alternatives

The following sections describe reasonable alternatives that have been considered. In all cases, alternatives for this project would remain under review. As technology for the oil shale industry develops, the proposed action would be subject to continuing evaluation.

4.1.2.1 Selection of alternatives for detailed consideration

Table 4.1-8 indicates all alternatives given initial study and those that were eliminated from further consideration. The reasons for the rejection of the eliminated alternatives are noted in the table. Additional supporting material is on file and available from the BLM.

In the remainder of this section, all reasonable alternatives are discussed. Alternative descriptions are presented only to the level required to understand the differences among them.

4.1.2.2 Mining

The proposed action is to mine by the room-and-pillar method. Room-and-pillar mining is a widely accepted and proven method of extraction in bedded-type deposits. It is a very suitable technique where the roof and floor are strong. However, several different methods were considered to be reasonable alternatives for mining the Pacific oil shale. These include:

- Chamber-and-pillar.
- Sublevel stoping.
- Vertical crater retreat.
- Longwall.

The following are brief descriptions of these alternatives.

Chamber-and-pillar

Chamber-and-pillar mining largely resembles room-and-pillar mining except that, in chamber-and-pillar mining, pillars would be left in long rows rather than broken into rectangular blocks.

Pillar width would be decreased and resource recovery would be slightly improved. The method would allow mining in areas of deposit irregularities. The elimination of numerous crosscuts would enhance ventilation and backfilling capabilities. However, development costs to bring a mine to production would be significantly higher than those for room-and-pillar mining.

Sublevel stoping

Sublevel stoping is a mining method generally applied to steeply dipping deposits, but could be adopted to flat deposits thick enough to provide multiple mining levels. The shale would have to be strong enough to permit benches to

Table 4.1-8. Alternatives analyzed for the Pacific Project

Project component	Alternatives	Reasonable (R) or Eliminated (E)	Reason for elimination from detailed analysis
Mining Method	Room and Pillar	R	
	Chamber and Pillar	R	
	Sublevel Stoping	R	
	Vertical Crater Retreat	R	
	Longwall	R	
	Block Caving	E	Technology not adequately developed.
	Sublevel Caving	E	Technology not adequately developed.
	In Situ	E	Technology not adequately developed.
	Surface	E	Economically unreasonable. Environmentally unreasonable.
Main Plant Site Location	Deer Park Gulch and Scott Gulch	R	
	Entire Plant in Deer Park Gulch	R	
	Entire Plant on Mesa Top	R	
	Entire Plant in Scott Gulch	E	Not sufficient space.
Upgrading (Hydrotreater) Plant Site Location	Main Plant Site	R	
	Merchant Hydrotreater	R	
	DeBeque Area	E	Environmentally unreasonable.
Electric Power Supply	Onsite: Retort Product Gas Fueled-Steam Generated	R	
	Purchase and Import from Offsite Utility	R	
	Onsite: Coal Fueled-Steam Generated	E	Unreliable fuel supply. Air emission impacts.
	Onsite: Natural Gas Fueled-Steam Generated	E	Unreliable fuel supply. Uneconomical.
Retort Technology	Superior and TOSCO	R	
	Superior	R	
	Union	R	
	Paraho	R	
	Petrosix	R	
	Paraho Indirect	R	
	Lurgi	R	
	Chevron STB	R	
	In Situ	E	Technology not adequately developed.
Upgrading Technology	Two-Stage Fixed-Bed Hydrotreater	R	
	Single-Stage Fixed-Bed Hydrotreater	R	
	Ebullated-Bed Hydrotreater	R	
	Coking	E	Decreased product recovery. Increased solid waste.
	No Upgrading	E	Product not marketable. Difficult to transport.
Hazardous Solid Waste Disposal			
Oily Sludges	Onsite Disposal	R	
	Offsite Disposal	R	
	Reprocessing	R	
	Onsite Land Treatment	E	Technology not adequately developed.
Spent Catalysts	Onsite Disposal	R	
	Offsite Disposal	R	
	Offsite Regeneration	R	
	Offsite Metals Reclamation	R	

Table 4.1-8 (continued)

Project component	Alternatives	Reasonable (R) or Eliminated (E)	Reason for elimination from detailed analysis
Nonhazardous Solid Waste Disposal:			
Garbage and Scrap	Offsite Landfill	R	
	Onsite Landfill	R	
Biological Sludge	Onsite Landfill	R	
	Combined with Retorted Shale for Cooling and Compaction	R	
	Soil Conditioner	R	
	Offsite Landfill	E	Uneconomic due to volume.
Retorted Shale Disposal	Deer Park Gulch	R	
	Mesa Top/Head-of-Hollow	R	
	Mine Backfill	R	
	Scott Gulch	E	Not sufficient area. Unreasonable transport distance.
Mesa Top Access Road Location	Cliff Route	R	
	Conn Creek Route	R	
	Chimney Rock Route	E	Winter exposure and maintenance problem. Cap rock crossing problem.
	Scott Gulch Route	E	Winter exposure and maintenance problem. Cap rock problem.
	Deer Park Gulch Route	E	Winter exposure and maintenance problem. Cap rock problem.
	Logan Wash Route (existing)	E	Ownership problem. Unreasonable length. Winter maintenance problem.
Access Road to Pacific Project	Roan Creek-Clear Creek Corridor	R	
	Big Salt Wash-Echo Lake Corridor (BLM, 1983b)	E	Unreasonable length and cost.
Water Pipeline Corridor	Diversion near DeBeque: Roan Creek-Clear Creek Corridor	R	
	Diversion near Loma: Big Salt Wash-Echo Lake Corridor (BLM, 1983b)	E	Unreasonable length and cost.
Water Intake and Diversion System	Pacific Intake	R	
	GCC Intake	R	
Water Storage and Supply	Private Reservoirs on the Colorado River and its Tributaries	R	
	Federal Reservoirs on the Colorado River and its Tributaries	R	
	Getty-Cities Service-Chevron Reservoir in the Roan Creek Area	R	
Electric Transmission Line Corridor	Roan Creek-Clear Creek Corridor	R	
	Davis Point to Project Area via LaSal Corridor-Buck Gulch Corridor (BLM, 1983b)	R	
Product Pipeline Corridor	Buck Gulch Corridor to SOPS Pipeline	R	
	Roan Creek-Clear Creek-Sheep Gulch Corridor to SOPS Pipeline	R	
	Buck Gulch Corridor to LaSal Pipeline	R	
	Roan Creek-Sheep Gulch Corridor to LaSal Pipeline (BLM, 1983b)	R	
Materials Transport	Truck via Roan Creek-Clear Creek Corridor	R	
	Railroad via Roan Creek-Clear Creek Corridor	R	

stand under their own weight. Similarly, the walls must be strong enough to avoid caving. Sorting of shale to maintain average feed grade would be difficult in this method; thus, oil values would need to be fairly uniform.

This method would involve development of multiple sublevel drifts, one below another, into the orebody. Blast holes would be drilled in a ring pattern from the sublevel drifts. After blasting, the ore would fall into drawholes which would connect to a transfer drift located below the sublevel drifts. Broken ore would be removed from the bottom of the drawholes and transported from the mine area via the mine haulage system.

Vertical crater retreat (VCR)

The VCR method would use two levels of development drifts: an overcut drift, and an undercut drift. Vertical blast holes would then be drilled to connect the two drifts. Spherical explosive charges capable of fragmenting equally in all directions would then be placed on top of plugs in the bottom of the blast holes. The charges would then be blasted in successive lifts causing a uniform layer of broken ore to drop into the undercut drift. Broken ore would be removed between each blast. The process would be repeated until the entire ore column had been removed.

Long wall

The long-wall method is a form of continuous mining developed for relatively thin mining sections. This method uses a mining machine with cutting heads which slice ore from a mining face about 500 feet long. Broken ore is removed from the face area by a conveyor haulage system.

Long-wall mining is a highly mechanized, high volume production method. Movable shields which support the roof in the vicinity of the mining face provide a high degree of safety for mining personnel. Stresses within the orebody are relieved rapidly as the roof caves behind the advancing mining face. However, the mining equipment requires large capital expenditures. Extensive preproduction development work is required prior to long-wall mining. General subsidence will shortly follow initial production unless backfilling is used.

4.1.2.3 Main plant site locations

The proposed action is to locate the main plant in Deer Park Gulch and Scott Gulch. Two alternative locations were considered as reasonable options for plant sites:

- Entire plant in Deer Park Gulch.
- Entire plant on the mesa top.

Entire plant in Deer Park Gulch

Deer Park Gulch is the largest available lower elevation surface area suitable for locating the surface plant. The mine portal and retorting locations would be identical to those of the proposed action. The oil and gas processing units would be positioned between these two areas (see Figure 4.1-20). With

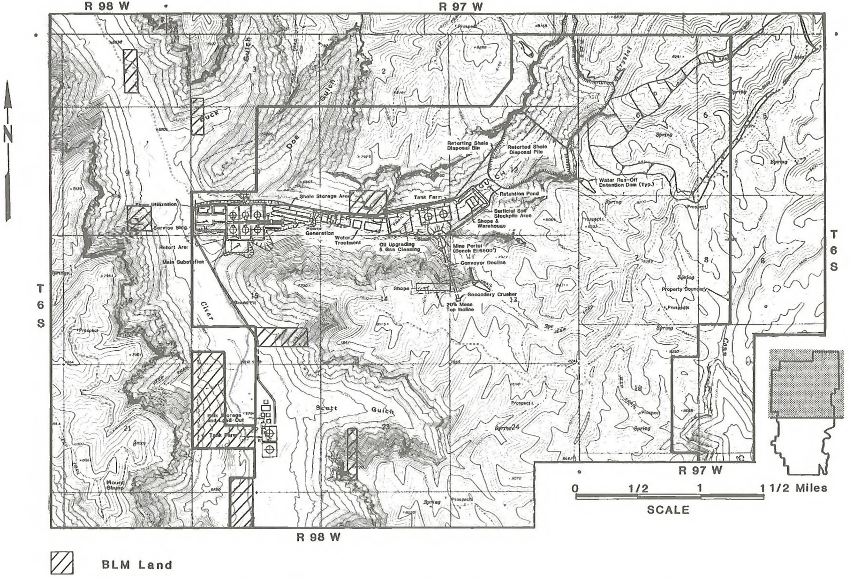


Figure 4.1-20. Deer Park Gulch plant site alternative

additional process units consuming land area in Deer Park Gulch, the amount of retorted shale disposal area available in upper Deer Park Gulch would be reduced; therefore, additional disposal on the mesa top would be required. A limited utilities and offsite area would be required along Clear Creek, south of Deer Park Gulch.

Entire plant on the mesa top

In this alternative, mined shale would be brought to the surface by way of an incline from the mining zone to the mesa. The raw shale would be conveyed on the surface to the mesa-top processing plant. Surface facilities would be located on the mesa top, just east of Scott Gulch, at an elevation of 7960 feet (see Figure 4.1-21). The plant layout would be a rectangular arrangement, with essentially all facilities situated within a 4000- by 4000-foot area. Retorted shale disposal would be located in the upper end of Deer Park Gulch, similar to the location for the proposed action. Alternatively, the shale could be disposed of on the mesa top. Certain minor facilities (tankage, bulk storage, and the explosives area) would remain in the valley area along Clear Creek. Corridors would be required to transport workers and materials to the mesa-top site, and to transport products from the mesa top to their destination.

4.1.2.4 Retorting and upgrading

Retort technologies

The proposed action is to use a combination of Superior and TOSCO II fines retorts. Several different retorting technologies were also considered:

- Superior retorts only.
- Union retorts.
- Paraho retorts.
- Other.

Superior retorts only. In this alternative, the Superior Retorting Process would still be the primary retorting system; however, fines retorts would not be included. Instead, shale fines would be agglomerated (either briquetted or compacted) and processed as coarse shale in the Superior Retorting Process, or would be disposed with the retorted shale.

Union retorts. The Union B process employs an indirect-heating, coarse-shale retort. Feed shale would enter at the bottom of the retort and would be forced upward by a rock pump. Hot gases would flow countercurrent to the flow of shale, and would provide the heat of retorting. The Union B retort would produce raw shale oil and a high-Btu product gas. It is probable that some type of fines utilization system (fines retort or agglomeration) would be included in a facility with Union B retorts.

Paraho retorts. The Paraho retort is a vertical kiln. Shale sized to less than 3 inches and greater than 0.375 inch would be fed into the top and would flow downward, regulated by a moving grate at the bottom of the retort. Gases generated by retorting and combustion within the retort would be recycled to provide the heat of retorting.

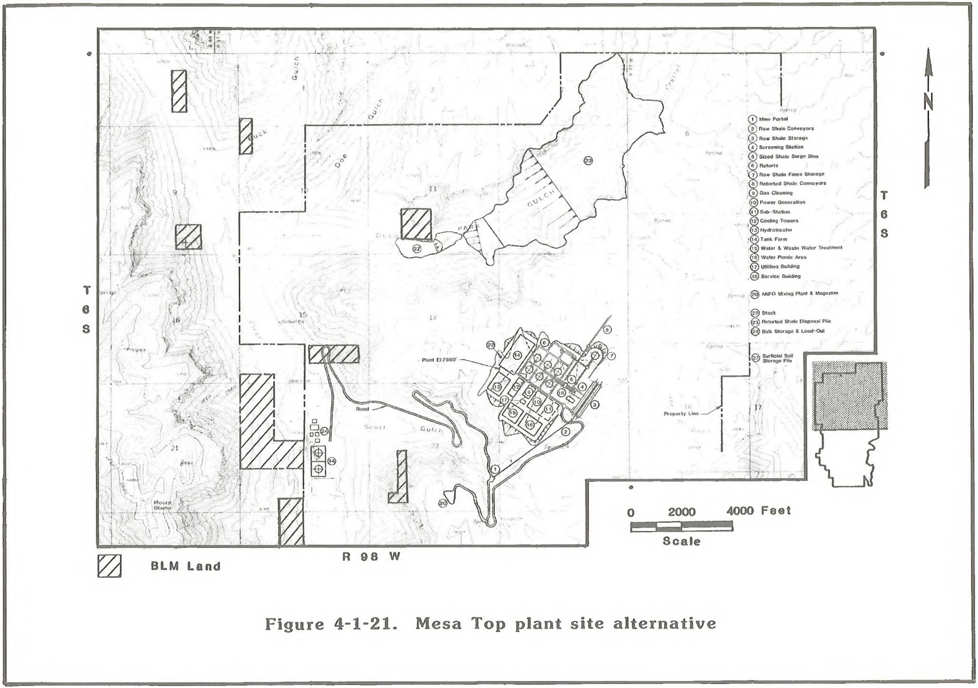


Figure 4-1-21. Mesa Top plant site alternative

The Paraho process is direct heated, producing oil and low-Btu product gas. Shale fines, not usable in the Paraho retort, would probably also be processed in a fines utilization system to recover their energy content.

Other. There are various other retort technologies available, at different stages of development, that could be suitable for specific applications. Among these are Petrosix; Paraho indirect; Lurgi, a fines retort; and Chevron STB, a fluidized process that also retorts fines.

Upgrading plant site locations

The proposed location for the oil upgrading facility (the hydrotreater and associated support system) is Scott Gulch. The alternative of using a merchant hydrotreater was also considered.

The hydrotreating plant could readily be separated from the retort facility, with a raw shale oil pipeline connecting the two facilities. If a merchant hydrotreater was used, the hydrotreating facilities would be located at some yet unspecified site. This site would be in the region, perhaps situated closer to the common-carrier line or other shale oil hydrotreating facilities. The concept could involve several shale oil producers sharing the same hydrotreating facilities.

Upgrading technology

The proposed action is to use a two-stage fixed-bed hydrotreating technology. In two-stage systems, hydrotreating occurs in reactors operating at two different pressures. Initial oil hydrotreating reactors operate at pressures much less severe than those for the final reactors.

Raw shale oil is sent through a solids removal system and then is pumped to the pressure required by the first stage of hydrotreating. The oil passes through a guard bed reactor to remove metals which contaminate downstream catalysts. After metals removal, the oil is hydrotreated to remove sulfur. Some hydrogen also reacts with hydrocarbons in the oil.

Oil from this initial stage of hydrotreating is pumped to the higher operating pressure of the second stage hydrotreater. This final upgrading step produces an oil with a nitrogen content tolerable for further processing in conventional refineries.

Reasonable alternatives to the proposed action are (1) single-stage fixed-bed hydrotreating and (2) ebullated bed hydrotreating. These alternatives also produce an oil with a nitrogen content tolerable for further processing in conventional refineries.

Single-stage fixed-bed hydrotreating. In single-stage systems, metals removal occurs at the same severe pressure as the hydrotreating step.

Raw shale oil is sent through a solids removal system and then is pressurized to the level required for hydrotreating. The oil passes through a guard bed reactor to remove metals which contaminate downstream catalysts. After metals removal, the oil is hydrotreated to remove sulfur and nitrogen. Some hydrogen also reacts with hydrocarbons in the oil. This produces an oil with a nitrogen content tolerable for further processing in conventional refineries.

Ebullated bed technology. Raw shale oil is pressurized to the level required in the ebullating bed reactor. In this reactor, metals and solids are removed and some hydrogenation reactions take place. The oil is sent to a fractionation system and then to final hydrotreating in a fixed bed reactor system.

4.1.2.5 Waste disposal

Hazardous solid waste disposal methods

The general categories of hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA) include oily sludges generated in wastewater treatment and spent catalysts from gas cleanup and hydrotreating. Four methods of handling these materials were considered for each of the two categories of hazardous waste. The proposed action for all hazardous solid wastes is onsite disposal in a landfill. The following alternatives are described below:

- Oily sludges
  - Offsite disposal
  - Reprocessing
  - Onsite land treatment.

- Spent catalysts
  - Offsite landfill
  - Offsite regeneration
  - Offsite metals reclamation.

Oily sludges. The following is a discussion of the alternative means for disposing of oily sludges.

- Offsite disposal - Based on one-way haul distances of 280 to 500 miles, it is estimated that annual offsite disposal costs could be up to 50 percent greater than those for an onsite landfill. If a hazardous waste facility were approved at a nearby location, these costs could be substantially reduced. Because of the close proximity of several shale oil projects in the region, a regional disposal site servicing these projects could prove feasible; however, no definite plans for such a facility have been developed at this time. Offsite disposal increases the potential for traffic accidents involving the spill or release of hazardous wastes.

- Reprocessing - Several options which exist for reprocessing oily sludges would eliminate separate handling of solids while providing for recovery of the oily fraction. The options available are filtration of oily sludges and direct blending of sludge with the crude shale oil. Incineration of oily sludges, possibly in combination with biosolids, is a third option which could be designed to provide supplemental steam production for turbine drives.

- Onsite land treatment - This option was considered, but was determined not to be feasible at this time because of uncertainty in regard to the chemical constituents in the oily sludge and the processing of these constituents. Metals concentrations in these sludges and the maximum allowable loadings for these metals have not been established. Further consideration of this option will be possible when this information is available.

Spent catalysts. The following is a discussion of the alternative means of handling spent catalysts.

- Offsite disposal - Same as described for offsite disposal of oily sludge.
- Offsite catalyst regeneration - Catalysts would be transported to a commercial regeneration facility, such as one currently in operation in Salt Lake City, Utah.
- Offsite metals reclamation - No commercial process presently exists for removing high concentrations of arsenic from heavily contaminated hydrotreating catalyst. If the degree of metals contamination is sufficiently low, the treating catalyst could be acceptable for nickel and molybdenum reclamation. Otherwise, it would require disposal as a hazardous waste. If existing processors are used, the spent catalyst must be transported a distance of 500 to 1300 miles for reclamation. All of the spent catalysts that are candidates for reclamation are potentially pyrophoric. Thus, care would need to be taken in transporting these materials.

Nonhazardous solid waste disposal methods

Excluding retorted shale, nonhazardous solid wastes consist of garbage and scrap materials, and biological sludge from wastewater treatment. The proposed action is to use offsite contract disposal for garbage and scrap materials. The only alternative considered reasonable for disposal of garbage and scrap is an onsite landfill.

Biological sludges from wastewater treatment would be applied in liquid form to the retorted shale pile for cooling and compaction; they would be used as a soil conditioner to aid reclamation; or they would be disposed of in an onsite landfill. No proposed action for disposal of biological sludges has been selected at this time.

Retorted shale disposal locations

The proposed action is for retorted shale disposal in the upper (northeastern) end of Deer Park Gulch. Considering topography of the Pacific Project area and the proposed plant site, the following alternatives were considered:

- Mine backfilling disposal.
- Mesa-top/head-of-hollow disposal.

Mine backfilling disposal. Backfilling retorted shale in underground mined-out panels was considered (see Figure 4.1-22); however, mine design and development constraints would allow only half of the retorted shale volume to be disposed of in this manner. Therefore, an additional surface disposal area would be required.

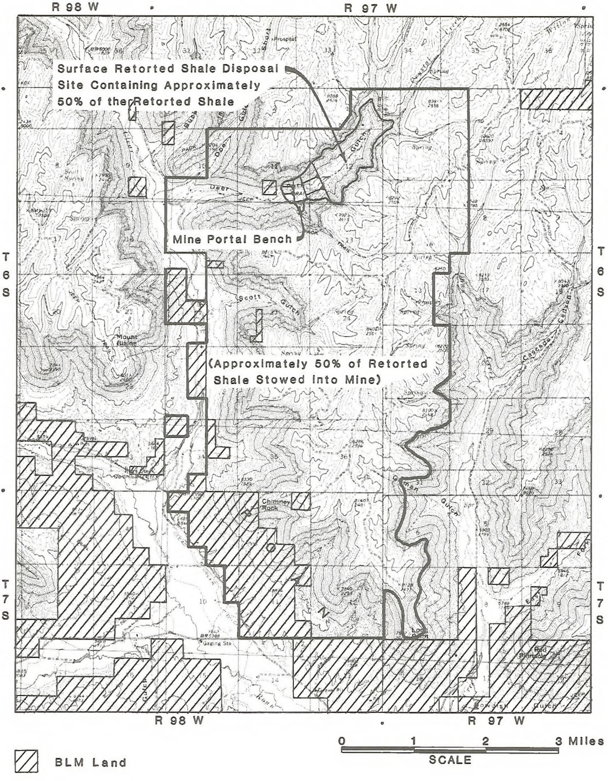


Figure 4.1-22. Mine backfill retorted shale disposal alternative

Mesa-top/head-of-hollow disposal. Because of topographic conditions, the most practical plan for mesa-top disposal in the project area would be to distribute the retorted shale to two separate piles, receiving 65 and 35 percent of the total volume, respectively (see Figure 4.1-23). Each pile would conform to existing ridge lines as much as possible for containment. The topography of the Pacific property mesa top would limit the average depth of each pile to approximately 340 feet. As a result of pile depth, over 1500 acres would be disturbed, which is more acreage than would be disturbed by disposal in Deer Park Gulch.

A series of parallel conveyors and maintenance access would be needed to sustain operations during the transport of retorted shale from the portal bench to the mesa top via the mine conveyor decline and the mesa access incline.

4.1.2.6 Mesa-top access road location

The proposed action is to construct a mesa-top access road from the Roan Creek Corridor via the Cliff Route. An alternate location (Conn Creek Route) for the mesa-top access road is shown in Figure 4.1-24. The Conn Creek Route would begin at the Conn Creek Road approximately 4 miles north of the Conn Creek Road/ Roan Creek Road intersection. The Conn Creek Route would begin at an elevation of approximately 6000 feet and extend to the mesa top. The road would cross portions of Sections 31 and 32, T6S, R92W, and Sections 6 and 7, T7S, R97W and would connect with an existing trail at an elevation of approximately 8000 feet. The road would have a length of approximately 5.5 miles and would have a grade of approximately 8 percent. The road would be constructed as described for the Cliff Route (proposed action). The road would be approximately 20 feet wide with ditches and culverts to provide adequate drainage. The road would create a surface disturbance of approximately 65 acres.

4.1.2.7 Water storage and diversion

Three alternative water systems are currently being considered to supply project water requirements: Federal reservoirs on the Colorado River or its tributaries (Ruedi and Green Mountain reservoirs), private reservoirs on the Colorado River or its tributaries (Azure, Iron Mountain, Threemile Creek, and Bearwallow reservoirs), and the Getty-Cities Service-Chevron (GCC) Reservoir being planned in the Roan Creek drainage. All three of the alternative storage systems would involve a direct diversion from the Colorado River near DeBeque.

The proposed action is to construct and operate the Pacific water intake and diversion facility (Pacific Intake). As an alternative, the Pacific Project could possibly share in the use of the GCC water intake and diversion system (GCC Intake). The GCC Intake is described and analyzed in the Clear Creek Shale Oil Project DEIS (BLM, 1983b) and is incorporated by reference herein. It is assumed that if the Pacific Project used the GCC Intake, additional pumping capacity (48 cubic feet per second) over that proposed by GCC would be added to the system. Both intake systems would divert water directly from the Colorado River near DeBeque.

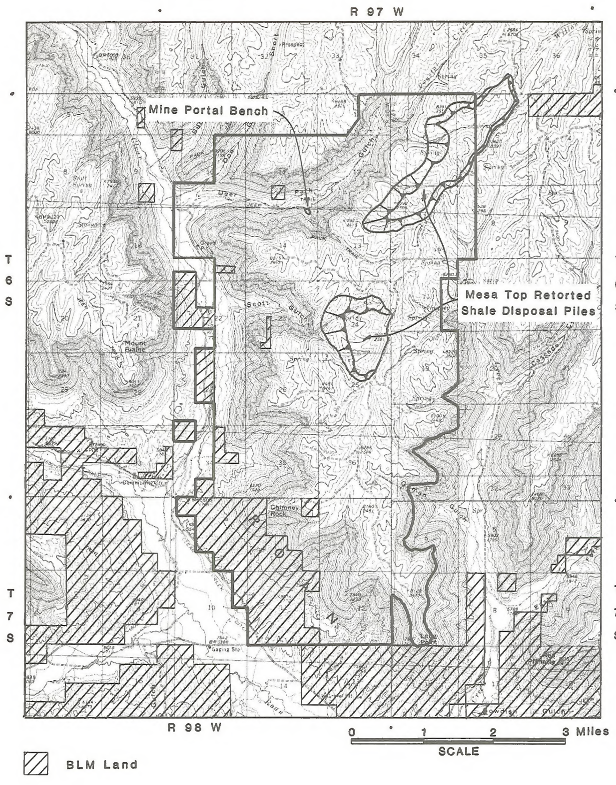


Figure 4.1-23. Mesa Top retorted shale disposal alternaitve

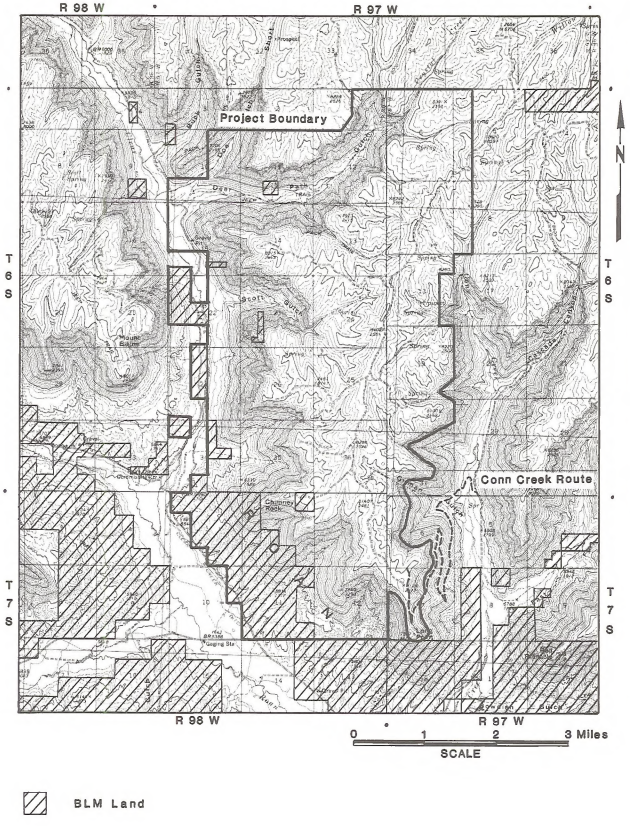


Figure 4.1-24. Mesa Top access road
Conn Creek route alternative

4.1.2.8 Support facilities and locations

Electric power supplies

The proposed action is to generate 240 to 290 MW onsite, supplemented by up to 50 MW of offsite power supplied via a connection with the existing 230-kV Cameo-to-Rifle transmission line.

An alternative is transmission of all power from an offsite electrical generation source.

With offsite power generation, retort product gas would not be combusted to generate power but would be used as a supplemental fuel, decreasing natural gas requirements by an estimated 2642 million Btu per hour when compared to the proposed action.

Electric transmission line corridor

Two alternatives are being considered: the Roan Creek corridor and the LaSal corridor. These are the same alternatives considered in the Clear Creek Shale Oil Project DEIS (BLM, 1983b), and that discussion/analysis is incorporated by reference herein. No proposed action has been selected at this time.

4.1.2.9 Materials transport alternative

The proposed action is to truck materials between a railroad spur at DeBeque and the project area. As an alternative, a railroad spur could be constructed to the project site. This alternative facility was analyzed for the Clear Creek Shale Oil Project (see BLM, 1983b). It is estimated that approximately one train per day would service the project.

4.1.2.10 No-Action alternative

The No-Action alternative could occur through either denial of the requested Federal actions or Pacific's decision to cancel or delay the project. In either case, the project would not proceed.

4.2 AFFECTED ENVIRONMENT

4.2.1 Climate and air quality

Baseline air quality and meteorology data were obtained from a five-station, monitoring network. Stations were located in Mid Deer Park Gulch, Lower Deer Park Gulch, Scott Gulch, Clear Creek, and on the Roan Plateau. A map depicting the locations of sampling stations is in the air quality technical report (Dames & Moore, 1984). The monitoring program began in November 1982, and was completed in October 1983. The DEIS reported data for the first 6 months of monitoring. The following has been revised to reflect results from the 12 months of data collection.

Wind speed and direction data were collected at 10- and 60-meter levels at the Mid Deer Park, Scott Gulch, and Mesa stations, and at 10 meters at the Lower Deer Park and Clear Creek stations. All valley stations reported a predominance of flow along the axes of the canyons. In addition, there are very pronounced diurnal variations in the winds: upslope during the daytime heating period and downslope during the nighttime cooling period. The flow in all cases conforms to typical mountain-valley wind patterns discussed previously in Section 2.1. Also, the 60-meter valley station wind roses are nearly identical to the 10-meter patterns, which indicates that the valley influence extends above the 60-meter level.

On the mesa, the prevailing wind is predominantly (13.47 percent of the time) from the south at the 10-meter level and from the south-southwest (16.58 percent of the time) at the 60-meter level above the ground surface. Surface frictional effects apparently cause the more southerly winds at 10 meters. There is little diurnal variation in the mesa wind direction data.

The results of atmospheric stability calculations indicate that the prevailing stability class on the Roan Plateau is neutral (Class D occurred 46.09 percent of the time), using the sigma-theta stability classification method. Atmospheric stability in the deep canyon locations reflect stable nighttime conditions (Class F, 36.31 percent) and unstable daytime conditions (Class A, 34.90 percent).

Precipitation was measured at the Mid Deer Park station. During the year of data collection (November 1982 to October 1983), the total precipitation measured at Mid Deer Park was 32.24 inches. Amounts measured during the same period at the Altenbern ranch (at the junction of Brush and Roan creeks) (21.23 inches) and Rifle (18.47 inches) were somewhat less for this period (CDM, 1984). The average humidity during the period was 47 percent, which is similar to long-term Grand Junction humidity records for similar periods.

Temperature data were collected at all five monitoring locations.

Total suspended particulates (TSP) were monitored for 12 months at the Mid Deer Park station and for 4 months at the Mesa station. The highest 24-hour concentrations measured during the first year of data collection were 45 $\mu g/m^3$ at Mid Deer Park and 43 $\mu g/m^3$ at the Mesa site. Annual geometric means for these two sites were 10 $\mu g/m^3$ at Mid Deer Park and 17 $\mu g/m^3$ at Mesa. The low concentrations are typical of remote areas. Trace metal concentrations for lead, mercury, and beryllium, and for fluorides were extremely low (CDM, 1984). No gaseous pollutants were measured at the project site; however, concentrations can be expected to be similar to background levels measured at the Chevron Clear Creek Shale Oil Project site (BLM, 1983b). Assumed background concentrations are listed in Table 4.3-4 (in Section 4.3).

4.2.2 Topography and geology

The Pacific property consists of an elongated, south-trending plateau fringed by the steep-walled valleys of Deer Park Gulch and Roan, Clear, and Conn creeks. Elevations range from 5600 feet along Clear Creek to 8500 feet on the plateau.

The surface of the plateau that occupies most of the Long Point area is underlain by tuffaceous siltstones and sandstones of the Uinta Formation. The sheer cliffs and the upper part of the steep slopes that rim the plateau consist of organic-rich marlstones of the Parachute Creek Member. The lower part of the steep slopes along Conn Creek is underlain by the Anvil Points Member. West of Long Point, the Anvil Points Member grades laterally into the clay shales of the Garden Gulch Member. The valley bottom and the badlands area immediately beneath the steep slopes are underlain by the varicolored claystone, siltstone and lenticular sandstone of the Shire Member of the Wasatch Formation.

Bedrock, in the valleys and the lower slopes near the plant site, is covered, in great part, by alluvium and alluvial fan deposits. The steeper slopes are partly covered with talus landslide material (Pacific, 1983a).

The Clear Creek Syncline axis bisects the ridge between Deer Park Gulch and Scott Gulch. Bedrock inclines toward the axis at the rate of 100 to 250 feet per mile. No faults have been mapped on the Pacific property; however, two faults with less than 100 feet of displacement have been mapped about 5 miles south of Long Point (Johnson, 1975). The Green River and Uinta formations are cut by many sets of high-angle fractures. The fractures are generally vertical, and dominant sets trend N30°W and N60°E (Pacific, 1983a). The property is located in seismic risk Zone 1.

An oil-shale sequence approximately 320 feet thick, averaging more than 15 gallons of oil per ton, and containing an estimated resource of 3.3 billion barrels of oil underlies the Pacific property. The following is a summary by zone of the estimated in-place shale oil resource.

R-6 Zone - The R-6 oil shale zone that underlies the Pacific property averages about 160 feet in thickness and about 8 gallons of oil per ton (Pitman, 1979). The zone in its entirety is not expected to be of economic importance. The R-6 Zone is estimated to contain a shale oil resource of about 173 million barrels.

Mahogany Zone - The Mahogany Zone averages about 90 feet in thickness and about 25 gallons per ton in grade. The Mahogany Zone is estimated to contain a shale oil resource of 1344 million barrels. The Mine Zone, the richest part of the Mahogany Zone, averages 60 feet in thickness and 28 gallons per ton in grade. It is estimated to contain 935 million barrels of oil.

R-8 Zone - The R-8 oil shale zone overlies the Mahogany Zone. This zone is approximately 183 feet thick, averages 15 gallons per ton, and is estimated to contain a total shale oil resource of 1756 million barrels.

Coal deposits underlie the Pacific property at a depth greater than 3000 feet. Oil and gas have not been produced on the property. However, both oil and gas have been produced elsewhere in northwest Colorado from the lateral equivalent of the sedimentary rocks that underlie the property. No other commercially recoverable minerals are known to occur in the project area.

4.2.3 Paleontology

A study of the Piceance Basin by Wallace (1983) included specific paleontological finds on the Pacific property. The field study by Wallace (1983) revealed a sparse distribution of gastropods and indeterminant plant remains from the Green River Formation outcrops in the Pacific Project area. The Uinta Formation has yielded no significant paleontological finds in the area of the Pacific property (Wallace, 1983). Nothing of paleontological significance was found in the Quaternary exposures. The Wasatch Formation contains crocodilian and garfish remains (Wallace, 1983), and is considered significant because of its potential as a quarry site for small mammals (rodents and insectivores).

4.2.4 Soils

Chemical and physical characteristics of the soils of the project area were evaluated for reclamation suitability and erodibility. A major objective of the evaluation was to delineate suitable topsoil sources for reclamation. Topsoil suitability was determined based on soil properties that include pH, salinity, saturation percentage, calcium-magnesium-sodium proportions, toxic element concentrations and soil depth. Other soil factors used to make this evaluation include depth, texture, coarse fragments, permeability, available water capacity, drainage, flood hazard, salinity, sodicity, erosion hazard, and steepness of slope.

The soil units and area that each occupies on the Pacific property, as well as their respective reclamation potential and erodibility, are indicated in Table 4.2-1. The table identifies 4585 acres comprising 38 percent of the study area as having soils with properties that are classed as good for their reclamation potential and suitable for use as topsoil. Soils classed as reasonably good for use in reclamation comprised 5385 acres (45 percent). These soils are less suitable for use as topsoil, but are valuable for use as subsoil. The remaining 17 percent of the soils are classed as having little value for reclamation.

Soil erodibility is a major environmental concern. The potential for water and wind erosion of soils in the project area under natural conditions was analyzed, and acreages of soils susceptible to high erodibility were compiled and recorded in Table 4.2-1. Water erodibility was determined to be high on 6517 acres, or 54 percent of the project area. High erodibility is generally characteristic of the entire region adjacent to the study area. Susceptibility of

Table 4.2-1. Acres of soil units by reclamation potential and erosion hazard

Soil unit	Reclamation potential: Good	Reclamation potential: Reasonably good	Reclamation potential: Little value	High water erosion potential	High wind erosion potential
Bitton variant		540			
Grobutte		1435		1659	
Guben variant		645		645	
Irigul	90				
Irigul-Parachute	85			85	85
Irigul-Parachute	1080				962
Northwater	36			36	36
Rhone-Parachute	1658			1880	
Torriorthent portion		474	711[a]		
Cryorthent-Cryoborroll portion		293	359[a]		
Cumulic-Haploborolls	118				
Starman portion		53	127[a]		
Silas	424				
Starman		166			
Starman-Irigul	923			923	
Winevada	171			171	
Nihill		1571		1002	
Moyerson variant portion		116	69[a]	116	
Glenberg portion		11			
Dominguez		58			
Lolo-Bitton variants		23			
Rubble land and rock outcrop			732		
Total Acreage (percent of study area)	4585 (38)	5385 (45)	1998 (17)	6517 (54)	1083 (9)

[a]Rock outcrop.

soils to wind erosion, on the other hand, is not a serious problem. The 1083 acres that are classed in the high wind erosion category, encompass only 9 percent of the study area.

4.2.5 Ground water

There are two basic aquifer systems underlying the Pacific Project area: the plateau aquifer system and the valley aquifer system (see Figure 4.2-1). The following descriptions of these systems are based primarily on CDM (1983g).

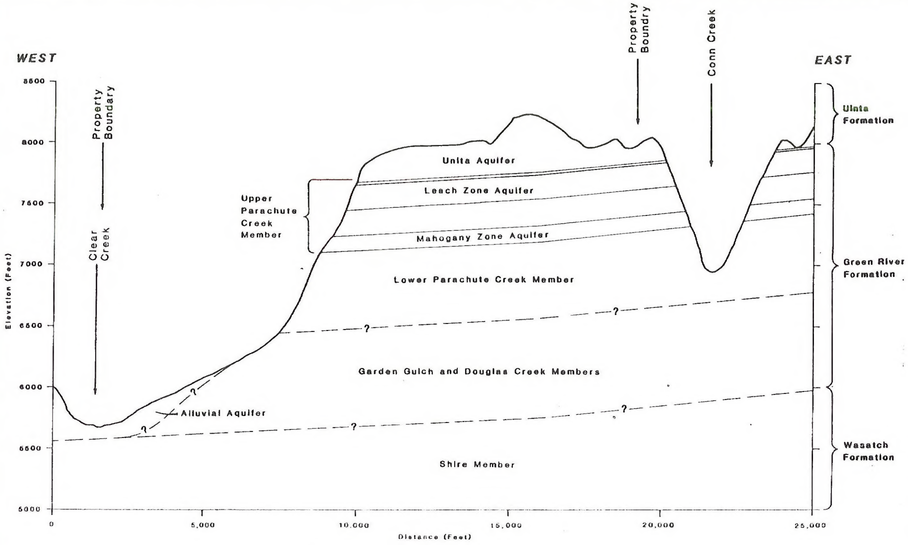


Figure 4.2-1. Schematic hydrogeological cross section of the Pacific Project site

4.2.5.1 Plateau aquifers

The aquifer system underlying the plateau sections of the Pacific property basically conforms to the two-aquifer system described for the Piceance Basin by Coffin et al. (1971). Water-bearing units were identified in the Uinta Formation, the Upper Parachute Creek Member, the Mahogany Zone, and the Lower Parachute Creek Member; however, the units within the Lower Parachute Creek Member were not monitored because the results of a drilling program (Pacific, 1983) indicated that there were no significant water-bearing zones below the Mahogany Zone. Each of the plateau aquifers is described below.

Uinta aquifer

The Uinta aquifer includes all of the saturated zones within the Uinta Formation. The aggregate saturated thickness of the aquifer ranges from 33 to 223 feet, with the thickest saturation located at the center of the property. Ground-water flow appears to be radial and controlled by the surface topography. Recharge to the aquifer is through infiltration of incident precipitation and snowmelt; discharge is through springs and seeps to surface drainages surrounding the plateau area. At least 11 springs are located on the Pacific property and emanate from zones within 50 feet of the Uinta-Green River Formation contact. Transmissivities range from 0.9 to 6.0 gpd/ft with relative hydraulic conductivities of 5.4×10^{-4} to 2.4×10^{-2} ft/day. The low values indicate that secondary permeabilities are not developed and that primary interstitial permeability is limited. Calculated storage coefficients for the aquifer range from 3.3×10^{-5} to 7.8×10^{-4}. The ground water is classified as calcium to calcium-sodium bicarbonate type and contains elevated concentrations of potassium, calcium, and barium. Total dissolved solids range from 220 to 1800 mg/l.

Upper Parachute Creek aquifer

This aquifer is located within a heavily fractured zone of the Upper Parachute Creek Member. This zone is approximately 100 to 150 feet below the contact between the Uinta and Parachute Creek members and is approximately 190 feet thick. This zone consists primarily of fractured and brecciated marlstones with abundant solution cavities. Average transmissivities and hydraulic conductivities vary from 58 to 250 gpd/ft and 4.0×10^{-2} to 1.7×10^{-1} ft/day, respectively. This large range of values is primarily the result of varying degrees of fracturing and dissolution. Calculated storage coefficients range from 2.1×10^{-4} to 1.3×10^{-4}. Ground-water flow is to the west with discharge to Clear Creek. The ground water is classified as sodium bicarbonate type and has significant concentrations of calcium and sulfate. Total dissolved solids range from 320 to 480 mg/l.

Mahogany Zone aquifer

This aquifer is located within the Mahogany Zone of the Parachute Creek Member and, regionally, is not a significant water-bearing zone. Monitoring of this aquifer on the Pacific property indicates that the unit is confined with a hydraulic head of up to 485 feet. The transmissivity of the aquifer is approximately 14.8 gpd/ft with an associated hydraulic conductivity of 1.6×10^{-2} ft/day. The storage coefficient for the aquifer is approximately 1.2×10^{-4}. Water quality is generally good with total dissolved solids values of less than 400 mg/l. The water is classified as sodium bicarbonate type.

Lower Parachute Creek aquifer

Although it is valuable as a ground-water source to the north in the center of the Piceance Basin, this aquifer is not a significant water-bearing unit in the Pacific property area (CDM, 1983; Weeks et al., 1974). Core holes and geotechnical holes on the Pacific property indicate that, because of the apparently low hydraulic conductivity, only limited ground water exists below the Mahogany Zone. Recharge to the Lower Parachute Creek aquifer occurs as a result of leakage from the overlying Mahogany Zone and direct infiltration within the outcrop areas. The principal areas of ground-water discharge from the Lower Parachute Creek aquifer is to the major valleys which are incised into the Roan Plateau. In most of these valleys, the discharge is masked by the alluvial deposits on the valley floor (Weeks et al., 1974).

4.2.5.2 Valley aquifers

Surface-water drainages, which border and dissect the Pacific property, contain ground water in the alluvial deposits that blanket the drainage bottoms. Bedrock below the alluvial deposits generally contains some ground water in weathered zones located in the upper sections of the formation. Recharge to the valley aquifers is by infiltration of incident precipitation and surface runoff, and from lateral inflow of ground water from the underlying aquifers within the Garden Gulch and Lower Parachute Creek members of the Green River Formation.

Deer Park Gulch aquifer

This alluvial aquifer consists of interbedded alluvial and colluvial deposits and attains a thickness of up to 130 feet. The upper 30 to 50 feet of the aquifer consist predominantly of silty clays and fine sands with intermittent zones of gravels and cobbles. Cobbles, gravels, and sand constitute the remainder of the aquifer. Colluvial deposits occur along the margins of the gulch. Transmissivities range from 35 to 5100 gpd/ft with hydraulic conductivities ranging from 0.78 to 30 ft/day.

Conn Creek and Clear Creek aquifers

These aquifers consist primarily of stratified stream deposits of sand, silt, clay, and gravel; however, some colluvial sediments occur along the valley margins. Transmissivities and hydraulic conductivities for the Clear Creek aquifer range from 273 to 359 gpd/ft and 1.7 to 2.30 ft/day, respectively; a storage coefficient of 2.1×10^{-5} was reported (CDM, 1983g). The Conn Creek aquifer has transmissivities between 13,900 and 14,200 gpd/ft with hydraulic conductivity between 48 and 49 ft/day. A storage coefficient value of 3.9×10^{-5} was estimated for the Conn Creek aquifer (CDM, 1983g).

Ground water from these alluvial aquifers is classified as calcium-sodium bicarbonate type and usually has total dissolved solid concentrations below 590 mg/l. Anomalous values for sulfate, iron, chloride, and aluminum have been reported.

Bedrock aquifers

The top 50 feet of the bedrock were monitored in Conn Creek, Clear Creek, and Deer Park Gulch by CDM (1983g). The formations monitored included the Garden Gulch Member in Deer Park Gulch and upper Clear Creek and the Wasatch Formation in lower Clear Creek and Conn Creek. Transmissivities for the Garden Gulch Member range from 2.0 to 1650 gpd/ft with associated hydraulic conductivities ranging from 4.8×10^{-3} to 4.4×10^{0} ft/day. A storage coefficient value of 1.1×10^{-3} was estimated by CDM (1983g). Transmissivity values for the Wasatch Formation range from 64 to 158 gpd/ft with associated hydrologic conductivities ranging from 1.8×10^{-1} to 3.0×10^{-2} ft/day. The reported storage coefficient is 1×10^{-5} (CDM, 1983g). The ground waters are classified as sodium to sodium-calcium bicarbonate and contain elevated concentrations of iron and aluminum.

4.2.5.3 Springs and seeps

Baseline studies (CDM, 1983g) identified a total of 13 springs on the Pacific property. Locations of these are indicated on Figure 4.2-2. The springs emanate from the Uinta Formation except for springs PP-9 and PP-10 which emanate from alluvial deposits. Table 4.2-2 is a summary of data on the springs.

Perennial and intermittent springs in the plateau area of the Pacific property create perennial, low base-flow stream reaches above the Roan Cliffs in Deer Park Gulch, Scott Gulch, and the Conn Creek drainage. These springs contribute little to surface runoff in the valley areas, but are thought to recharge alluvial aquifers. These spring flows have TDS levels generally less than 500 mg/l and are of the calcium-bicarbonate or mixed cation-bicarbonate type, with high calcium hardness. Overall, the springs have high quality with regard to drinking water parameters and trace elements.

4.2.6 Surface water

4.2.6.1 Surface-water quantity

The hydrologic characteristics of the watersheds, locations of stream gaging stations, periods for which streamflow records are available, and the method of flow measurement for streams in the vicinity of the Pacific property are shown in Table 4.2-3. The mean monthly flows of the streams listed in Table 4.2-3 are shown in Table 4.2-4. The estimated values of peak flow of various recurrence intervals and average annual runoff and sediment yields for the watershed of the streams are given in Table 4.2-5.

4.2.6.2 Surface-water quality

At the proposed diversion point at DeBeque, the Colorado River is a mixed water with no predominant cationic or anionic species (USGS, 1981). However, there is a roughly two-fold increase in total dissolved solids (TDS) during the low-flow period compared with the runoff period. Also, there is a shift in

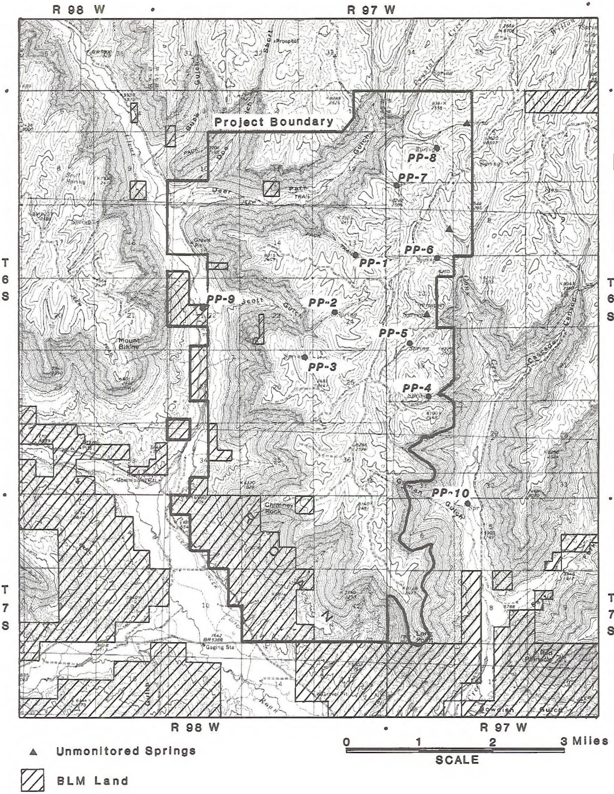


Figure 4.2-2. Locations of springs near Pacific Project

Table 4.2-2. Summarization of data on springs

Number	Elevation (feet)[a]	Hydrostratigraphic source	Water type	Discharge (cfs)		
				Spring	Summer	Fall
PP-1	7800	Uinta	Mixed Cation-Bicarbonate	1.0	0.3	1.5
PP-2	7750	Uinta	Mixed Cation-Bicarbonate	5.8	<0.1	Dry
PP-3	7740	Uinta	Mixed Cation-Bicarbonate	3.0	0.7	0.6
PP-4	7760	Uinta	Mixed Cation-Bicarbonate	2.0	<0.1	Dry
PP-5	7945	Uinta	Calcium-Bicarbonate	6.5	1.4	0.6
PP-6	8005	Uinta	Calcium-Bicarbonate	4.4	1.0	0.6
PP-7	7950	Uinta	Calcium-Bicarbonate	5.4	2.3	1.6
PP-8	8035	Uinta	Calcium-Bicarbonate	7.3	1.6	1.3
PP-9	5680	Alluvium	Magnesium-Bicarbonate	3.0[b]	Dry	Dry
PP-10	5940	Alluvium	NS[c]	2.5[b]	Dry	Dry

[a]Elevations obtained from topographic map. Accurate to ±10 feet.
[b]Flow visually estimated.
[c]NS = Not sampled; spring flow could not be segregated from surface runoff.

Source: CDM, 1983g.

Table 4.2-3. Surface-water streams in the project area

Stream	Watershed characteristics: Area (sq mi)	Watershed characteristics: Slope (ft/mi)	Gaging station: Location	Gaging station: Period of record	Gaging station: Method of measurement
Clear Creek	70.7	161.0	NE Sec. 9 T6S, R98W	5/82-9/82	Parshall flume and Cippolletti weir
Clear Creek	101.5	139.0	SE Sec. 22 T6S, R98W	1970-9/82	Parshall flume and Cippolletti weir
Upper Roan Creek	151.0	160.0	W 1/2 Sec. 32 T6S, R99W	1971-9/82	Water stage recorder
Lower Roan Creek	321.0	145.2	N 1/2 Sec. 15 T7S, R98W	10/74-Present	Water stage recorder
Doe Gulch	4.77	474.0	SW Sec. 10 T6S, R98W	7/81-9/82	Parshall flume and Cippolletti weir
Buck Gulch	4.33	439.0	NW Sec. 10 T6S, R98W	7/81-9/82	Parshall flume and Cippolletti weir
Deer Park Gulch	13.0	431.5	SW Sec. 11 T6S, R98W	7/81-9/82	Parshall flume and Cippolletti weir
Scott Gulch	2.72	940.6	NW Sec. 23 T6S, R98W	5/82-9/82	Crest-stage gage
Upper Conn Creek	16.96	391.4	NW Sec. 8 T7S, R97W	1973-9/82	Parshall flume and Cippolletti weir
Lower Conn Creek	37.37	318.5	NE Sec. 19 T7S, R97W	1971-9/82	Parshall flume and Cippolletti weir

Source: CDM, 1983i.

Table 4.2-4. Monthly average daily flows of streams (cubic feet per second)

Stream	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Clear Creek[a]	-	-	-	-	31	13	5.6	4.8	4.4	-	-	-
Clear Creek[b]	7.59	7.18	7.59	26.63	83.77	35.23	18.54	11.78	10.23	8.94	9.11	8.54
Upper Roan Creek	8.50	10.97	14.12	42.92	189.25	61.81	20.86	12.91	11.07	10.09	10.39	9.55
Lower Roan Creek	19.06	21.11	24.08	62.55	277.03	113.07	34.35	20.86	16.66	15.27	18.05	19.89
Doe Gulch[a]	0	0	0	0.2	0.6	0.2	0.03	0.001	0.003	0	0	0
Buck Gulch[a]	0	0	0	0.3	0.4	0.3	0.02	0.01	0	0	0	0
Deer Park Gulch[a]	0	0	0	1.4	2.5	1.2	0.3	0.1	0.1	0	0	0
Scott Gulch[a]	-	-	-	-	0	0	0	0	0	-	-	-
Upper Conn Creek[a]	0.5	0.5	0.53	0.5	2.5	1.0	0.9	1.1	1.3	0.8	0.8	0.7
Lower Conn Creek[a]	1.5	1.5	1.5	1.3	1.3	1.1	0.8	1.0	1.6	1.6	1.8	1.5

[a]Monthly values for water year 1982 only.
[b]Monthly averages for water years 1976-1982.

Source: CDM, 1983i.

Table 4.2-5. Estimated peak flows, runoff yields, and sediment yields

Stream	Peak flows (cfs)				Runoff yield[a]		Sediment yield
	10-yr	25-yr	50-yr	100-yr	acre-ft/yr	in/yr	tons/acre
Clear Creek	409	598	803	1,027	-	-	2.96
Clear Creek	562	1,063	1,628	2,410	9,484.0	1.75	3.18
Roan Creek	1,093	1,400	1,704	2,176	21,829.0	2.71	4.06
Roan Creek	1,783	2,648	3,589	4,604	-	-	3.35
Doe Gulch	47	61	71	86	60.46	0.24	6.64
Buck Gulch	43	57	64	79	63.04	0.27	6.51
Deer Park Gulch	87	134	179	227	293.4	0.42	5.85
Scott Gulch	42	54	62	72	-	-	10.92
Upper Conn Creek	190	240	283	323	663.8	0.73	4.77
Lower Conn Creek	420	540	628	721	992.7	0.50	5.76

[a]For water year 1982.

Source: CDM, 1983i.

makeup towards sodium chloride dominance during the low-flow periods. The pH varies between 7.5 and 9.0. Temperatures may rise as high as 25°C in July and August. Sodium adsorption ratio (SAR) is generally less than 5.0, with higher readings during low flows. Salt content and SAR generally increase in the downstream direction due to recharge from irrigation.

The perennial streams in the project area, Roan Creek, Clear Creek, and Conn Creek (having some intermittent reaches) are quite uniform spatially and temporally in their overall ionic make-up, being mixed cation-bicarbonate waters. Salt content is lowest in the Spring runoff period due to low TDS runoff from the Roan Plateau. Clear Creek is the only perennial stream with TDS as low as the drinking water standard of 500 mg/l; Roan and Conn creeks exhibit TDS values of up to 1000 mg/l. In addition, each stream shows high sulfate concentrations, with levels increasing in the downstream direction. Roan and Conn creeks exhibit sulfate levels equaling or exceeding the drinking water standards of 250 mg/l for sulfate during most low-flow period samples, while sulfate concentrations range from about 50 to 150 mg/l in Clear Creek. Sodium and SAR generally increase in the downstream direction for all the perennial streams, reflecting the presence of flood irrigation practices.

The Roan Creek basin has a high erosion rate with meandering downcut streambeds and unstable stream banks. Erosion and sediment yield is five times higher in the canyon areas than on the Roan Plateau. Overall sediment loadings for Roan Creek are 0.5 to 1.0 acre-foot per square mile of drainage area, while total sediment delivery from the Roan Creek basin is about 600,000 tons per year.

Water quality for the one intermittent stream in Deer Park Gulch and three ephemeral streams in Scott, Doe, and Buck gulches is characterized by TDS from 300 to 400 mg/l during the spring/summer flow period. Ionic make-up for all four gulches is consistent with the perennial streams, being of the mixed cation-bicarbonate type. However, whereas the pH of perennial streams varies from neutral to pH 9 (alkaline), the gulch stream flows are uniformly alkaline with pH values from 8 to 9.

Testing for pollution indicators on Deer Park Gulch and Clear Creek shows natural and traditional sources of certain pollutants. Both Deer Park Gulch and lower Clear Creek (just below Scott Gulch) contain high levels of strontium, 0.67 to 1.1 mg/l, respectively. The lack of a history of uranium mining in the area and the presence of only trace levels of uranium and radium activity in the samples tested indicates that these high strontium concentrations are a natural phenomenon. High coliform and fecal coliform levels in Deer Park Gulch and high thiosulfate (a complex sulfur compound indicative of organic pollution) in both Deer Park Gulch and lower Clear Creek are indicators of livestock grazing nearby on the valley floors. Neither station showed detectable levels of complex organic chemicals which would be indicative of man-made pollution.

4.2.7 Aquatic ecology

Streams that drain the Pacific property include Clear, Conn, and Roan creeks. Both Clear and Conn creeks are tributaries to Roan Creek, which is a tributary of the Colorado River located approximately 8 miles to the south.

No Federally listed threatened or endangered species have been reported to occur in Clear, Conn, or Roan creeks (CDM, 1983c). The present distributional range of two Federally listed threatened or endangered fish species has been reported to extend up the Colorado River to a point near the town of DeBeque.

Aquatic surveys on segments of the streams adjacent to the Pacific property were conducted in April 1981 and April and August 1982 (CDM, 1983c). Information presented is based primarily on these surveys. Unless noted, the description of the aquatic resources will be for stream segments adjacent to the Pacific property.

Fluctuating water levels from snowmelt and local rainfall influence water quality in the upper reach of Clear Creek. Throughout Clear Creek, turbidity is typically high during periods of high flow. Low densities and few taxa characterize the periphyton community in upper Clear Creek. Generally, abundance and diversity are higher in the lower reach of Clear Creek and probably reflect better conditions for periphyton growth. Macroinvertebrate densities and biomass are low in upper Clear Creek, reflecting poor habitat conditions. Better habitat conditions exist in lower Clear Creek, resulting in higher densities and biomass of macroinvertebrates.

Baseline surveys collected no fish in upper Clear Creek and only mottled sculpin (Cottus bairdi) in lower Clear Creek. The upper reach of Clear Creek does not contain trout spawning habitat; additionally, irrigation diversions currently prevent the upstream movement of fish. The lower reach of Clear Creek has areas that could provide habitat for trout production; however, periods of high turbidity and sedimentation are deleterious to the establishment of a substantial fishery. Rainbow trout (Salmo gairdneri) and cutthroat trout (S. clarki) occur occasionally in lower Clear Creek but irrigation diversions (up to 4 feet in height) severely hamper their immigration (CDM, 1983c).

At the lower end of Conn Creek, the entire stream is diverted for irrigation, which reduces the value of the aquatic community in the creek. Above the irrigation diversion, the periphyton in Conn Creek is characterized by high diversities but low densities and biomass. This indicates that conditions are good for macroinvertebrates, but their abundance is periodically reduced by adverse conditions. The absence of fish in Conn Creek during the aquatic surveys was attributed to the irrigation diversion and lack of habitat.

Roan Creek contains the most diverse aquatic community of the three streams. Periphyton densities were low in the upper reach of Roan Creek during 1982; whereas, in 1981 this reach had the highest density of periphyton. The ratio of periphyton to macroinvertebrate organisms was low in 1982 and macroinvertebrates may have exerted sufficient grazing pressure to reduce periphyton abundance. Periphyton densities in lower Roan Creek were intermediate. In April 1982, macroinvertebrate diversities were high in both reaches in Roan Creek and diversity remained high in the lower reach in August but was only moderate in the upper reach. In August 1982, organism numbers were high in upper Roan Creek and low in lower Roan Creek. Lower Roan Creek appears to be prone to high sediment loading, which probably contributes to lower macroinvertebrate numbers.

Only three fish species were collected in lower Roan Creek: longnose dace (Rhinichthys cataractae), speckled dace (R. osculus), and mountain sucker (Catostomus platyrhynchus). Rainbow and cutthroat trout are present in Roan

Creek upstream from the confluence of Clear and Kimble creeks. Roan Creek at this location is capable of supporting a trout population; however, most individuals are not of harvestable size. Carr Creek, an upstream tributary of Roan Creek, contains a known population of Colorado River cutthroat trout (CDM, 1983c).

During 1983, a study was conducted by Engineering-Science (1983) in the Colorado River near DeBeque, Colorado, to determine the species composition and relative abundance of ichthyoplankton in the river. A total of 16 species was collected with speckled dace (Rhinichythys osculus), fathead minnow (Pimephales promelas), roundtail chub (Gila robusta), flannelmouth sucker (Catostomus latipinnis), green sunfish (Lepomis cyanellus), bluehead sucker (Catostomus discobolus), and red shiner (Notropis lutrensis) comprising 88 percent of the total fish collected. No Federally listed threatened or endangered species or Colorado special status species were collected during the study (Engineering-Science, 1983). However, a survey conducted by Union Oil Company (1983) collected a larval fish near the town of Parachute that has been tentatively identified as a razorback sucker. Most of the Engineering-Science (1983) sampling effort involved shallow nursery areas and only limited sampling occurred in the main channel of the river. The sampling procedures were not designed to sample larval fish in the higher velocities in the main channel of the river. Larval fish studies on other rivers have shown that larval fish densities can be two to four times higher along the shoreline than in midchannel (Merriman and Thorpe, 1976; Hergaurader et al., 1982). With the high river flows in 1983, it appears that a high percentage of the larval fish used the shallow, flooded areas and low numbers occurred in the drift. Most of the species collected are prolific spawners.

4.2.8 Vegetation

The vegetation of the project site consists of 16 vegetation types which are geographically distributed in response to a variety of environmental factors (Pacific, 1983). The major types were sampled, and quantitative descriptions for the types are included in the Pacific Shale Project Vegetation Baseline Report (CDM, 1983h). Elevation differences, topography, soils, bedrock characteristics, available moisture, slope, and aspect are all important factors controlling the distribution and extent of the different vegetation types. The site can be divided into three primary topographic classes: 1) the Roan Plateau, 2) Escarpments and Slopes, and 3) the Roan Creek/Clear Creek drainage, including Deer Park and Scott gulches. The vegetation types which occur in these different topographic areas are listed in Table 4.2-6. All of the types are characteristic of the southern portion of the Piceance Basin. The patterns and distribution of the different types on the Pacific property are typical of other areas in the Roan Creek and Parachute Creek drainage systems.

Four special-status plant species occur on the Pacific property. Of these, three species, dragon milkvetch (Astragalus lutosus), Barneby's columbine (Aquilegia barnebyi), and sullivantia (Sullivantia hapemanii var. purpusii) have been considered for protection under the Federal Endangered Species Act (USF&WS, 1980); and one plant species, sun-loving meadowrue (Thalictrum heliophilum), is listed by the Colorado Natural Heritage Inventory (CNHI) program. These species have also been observed on adjacent properties (BLM and CNHI unpublished records,

Table 4.2-6. Vegetation types occurring on the Pacific Project area

Vegetation type	Major species	Area (ha)	Percent of project area
ROAN PLATEAU			
Aspen Woodland	*Populus tremuloides* *Symphoricarpos oreophilus*	27.5	0.4
Douglas-fir Woodland	*Pseudotsuga menziesii*	303.4	4.9
Plateau Drainage Sagebrush Shrubland	*Artemisia tridentata* *Symphoricarpos oreophilus*	326.4	5.3
Plateau Grassland	*Oryzopsis hymenoides* *Agropyron spicatum*	48.6	0.8
Plateau Mixed Shrubland	*Amelanchier utahensis* *Symphoricarpos oreophilus*	831.7	13.4
Plateau Sagebrush	*Artemisia tridentata* *Quercus gambelii*	1746.6	28.2
	Subtotal	3284.2	53.0
ESCARPMENTS AND SLOPES			
Barren Slopes	*Physaria acutifolia* *Machaeranthera pinnatifida*	442.3	7.1
Valley Dry-Slope Mixed Shrubland	*Atriplex confertifolia* *Eriogonum corymbosum*	1125.5	18.2
Valley Grassland	*Chrysothamnus viscidiflorus* *Eriogonum corymbosum*	19.9	0.3
Valley Moist-Slope Mixed Shrubland	*Amelanchier utahensis* *Symphoricarpos oreophilus*	289.7	4.7
	Subtotal	1877.4	30.3
ROAN CREEK VALLEY INCLUDING DEER PARK AND SCOTT GULCHES			
Gambel Oak Woodland	*Quercus gambelii* *Acer negundo*	2.1	<0.1
Greasewood Shrubland	*Sarcobatus vermiculatus* *Artemisia tridentata*	18.8	0.3
Juniper Woodland	*Juniperus osteosperma* *Pinus edulis*	409.5	6.6
Valley Riparian Woodland	*Acer negundo* *Robinia neomexicana*	46.2	0.7
Valley Sagebrush Shrubland	*Artemisia tridentata* *Amelanchier utahensis*	464.7	7.5
Pasture	*Bromus inermis* *Bromus tectorum*	93.3	1.5
Disturbed		0.6	<0.1
	Subtotal	1035.2	16.7
	TOTAL	6196.8	100.0

Chevron Shale Oil, 1981). Even though the species have no official threatened or endangered status, the BLM and CNHI still consider these species rare enough to merit special concern. No Federally listed threatened or endangered plant species have been observed in the Pacific Project area.

4.2.9 Wildlife

The major wildlife habitat types on the plateau are mixed shrub and aspen. Valley habitats are more diverse because of extreme topographic variation, and consist primarily of Douglas-fir (north-facing slopes), big sagebrush and juniper woodlands (valley bottoms), dry-slope mixed shrub (south and southwest-facing slopes), moist-slope mixed shrub (northwest-facing slopes), riparian woodland and pastureland (lower valley bottoms).

The Colorado Division of Wildlife (CDW, 1983) has designated portions of the bottomlands along Clear and Roan creeks, and some of the adjacent uplands and gulches as "critical habitat" for mule deer and elk. The areal extent of critical big game habitat on the Pacific property is 597 acres for mule deer and 687 acres for elk. Other important big game habitats on the property are riparian woodland, pastureland, and juniper woodlands interspersed with sagebrush.

Two additional sensitive wildlife habitats on the Pacific property have been identified. First, approximately 700 acres of the valley floor below Scott Gulch are considered as chukar brood habitat. This location is consistent with CDW (1983) chukar habitat mapping. Second, 16 golden eagle nest sites have been identified on the cliffs within the Pacific property. Four of these nest sites were active during baseline investigations (CDM, 1983d).

Mule deer are the most abundant large mammal on the Pacific property. During summer months, they tend to be widely distributed, occurring in a variety of habitats both on the plateau and in the valleys. During winter months, however, deer concentrate in lower elevation sagebrush, juniper, riparian, and agricultural habitats. Patterns of deer distribution and forage use indicate that the west-facing tributary gulches of Clear Creek are important sources of winter browse. Access to these areas, from the plateau and to the important winter forage on valley floors is via trail systems that avoid the precipitous cliffs.

Elk have also been observed on the Pacific property during spring and winter periods. Although elk are not present in large numbers, Deer Park Gulch provides critical winter range for elk (CDW, 1977).

Two Federally listed endangered species were observed in the vicinity of the Pacific property during baseline investigations, bald eagle (near the Colorado River in February 1983) and peregrine falcon (northwest quadrant of Scott Gulch, April 1982). A flock of greater sandhill cranes, a state-listed endangered species, was observed flying over the property in October 1982. None of the evidence obtained indicates that the Pacific property is important to these three species. The cliff habitats on the Pacific property provide potential nesting habitat for peregrine falcons, but no evidence of nesting was obtained.

Habitats with the most abundant small mammal prey base are the dry- and moist-slope mixed shrub, valley sagebrush, pastureland, and plateau mixed shrub.

Eleven species of raptors have been observed on the Pacific property. Most sightings were near the high cliffs or in proximity to valley sagebrush and pastureland habitats. Upland game birds identified during field investigations include the sage grouse, blue grouse, chukar, and mourning dove. Sage grouse are not abundant, and no leks have been found. Seventy-five songbird species are known to occur on the property. The only species of herpetofauna observed to occur in the area are the sagebrush lizard and western rattlesnake.

4.2.10 Cultural resources

Approximately 6140 acres of the Pacific property were intensively inspected for evidences of prehistoric and historic cultural resources. The lands inventoried included those that would be potentially affected by surface activities. Prior to the field survey, a literature search of previously recorded cultural resources was amended to include an ethnohistoric overview of Indian activity in the project area.

Four prehistoric and two historic archaeological sites were recorded; two prehistoric isolated artifact finds were also present. The prehistoric sites include two campsites of unknown age and two Late-Fremont/Protohistoric Ute sites. Site 5GF1101 was evaluated as being potentially significant in terms of National Register of Historic Places criteria. This prehistoric site indicates probable seasonal use for hunting and plant collecting. Sites 5GF1102 and 5GF1105 require subsurface testing before their eligibility for nomination to the National Register of Historic Places can be determined.

There are two historic sites located on the property: one structure, possibly associated with sheepherding or ranching activities; and a homestead, built around the turn of the century. Neither site is considered potentially eligible for the National Register of Historic Places.

Overall, the property exhibits a low cultural resource site density, because of a lack of major streams and suitable environmental zones for aboriginal use.

4.2.11 Visual resources

The following discussion of the visual resource baseline is presented according to the primary inventory components of the BLM's Visual Resource Management (VRM) system which involves the inventory of scenic quality (landscape quality) and visual sensitivity/distance zones (viewer conditions). These components are combined to determine VRM classes that identify the degree of visual modification allowed in any given area.

4.2.11.1 Scenic quality

The Pacific property is located in a setting of narrow gulches and creek valleys bounded by 1600- to 2000-foot cliffs leading up to the Roan Plateau, which has an average elevation of 8200 feet. Upper Clear Creek valley (beginning northward at Scott Gulch) and associated side gulches are rated as "A" (highest) scenic quality. This area contains a diverse mixture of scenic landscape features. The valley bottom is relatively narrow, and generally contains a mixture of riparian, irrigated agriculture, and shrub vegetation which gives way to the steep talus slopes of the Roan Cliffs. The nearly vertical cliffs are composed of tan, yellow, white, and occasionally red rock exposures. Vegetation is sparse; however, scattered pinyon-juniper vegetation adds variety and interest. The only cultural modifications in the upper Clear Creek area occur in the valley bottoms and are associated with small farm and ranch operations.

Lower Clear Creek valley and Conn Creek valley were rated "B" (moderate) scenic quality. The character and scale of these valleys are nearly identical to the upper Clear Creek valley units described above.

Roan Creek valley is of the same character as the valleys described above except in scale. This valley is noticeably wider and the valley bottom contains more agricultural fields and pastures. Upper Roan Creek valley, which extends southward for approximately 10 miles to the Colorado River valley, is rated "B" (moderate) scenic quality. Toward the Colorado River, the valley continues to widen and the cliffs become less pronounced. The lower end of this valley is rated "C" (lowest) scenic quality (BLM, 1982a).

The Roan Plateau is an elevated rolling landform broken by drainages. Vegetation in this area is primarily a mixed shrub-grassland association, except for some areas at the heads of the gulches which contain stands of conifers and aspen. This area is classified as a "C" (lowest) scenic quality rating.

4.2.11.2 Visual sensitivity/distance zones

Visual sensitivity and distance zones consider the number of viewers, viewer attitudes about scenic quality, and their distance relationship to the lands they view from important viewpoints. Sensitive viewpoints of the project area are from the Roan Creek road, I-70, and DeBeque. The Roan Plateau and the upper Clear Creek valley and associated side gulches cannot be seen from these key observation points, while the lower Clear Creek valley, the Roan Creek valley, and portions of Conn Creek valley can be seen from various combinations of these viewpoints and are rated moderate to high visual sensitivity.

4.2.11.3 Visual resource management (VRM) classes

There are five VRM Classes. Class I is for areas with existing special protective management designations such as wilderness and primitive areas, national natural landmarks, etc. VRM Class V is also a special designation applied to areas highly degraded, where rehabilitation is needed to bring it back to compatibility with the visual character of the surrounding lands. Through the inventory process, there are three VRM Classes (II, III, and IV) which are determined through various combinations of scenic quality and visual sensitivity/ distance zones. Each of these classes has management guidelines for the recommended degree of visual modification. These are briefly defined as follows:

- VRM Class II - Modifications (contrasts) may be seen but should not be evident or attract attention.

- VRM Class III - Contrasts may be evident and begin to attract attention but should remain subordinate to the existing characteristic landscape.

- VRM Class IV - Contrasts may be a dominant feature in terms of scale but should repeat the surrounding elements of form, line, color, and texture in the characteristic landscape.

The Roan Plateau was rated as VRM Class IV, because of low scenic quality and lack of visibility from key observation points. The Roan Cliffs and valley bottoms resulted in VRM Classes II, III, and IV. A VRM Class II designation was given to units in the upper Clear Creek area because of high scenic quality alone. Lower Clear Creek and the Conn Creek areas were designated VRM Class IV. Both were classified as "B" (medium) scenic quality with low sensitivity in a foreground distance zone. Below these valleys is the Roan Creek valley which is noticeably wider. It also rated "B" scenic quality, but because of moderate sensitivity was designated VRM Class III.

4.2.12 Noise

Baseline noise measurements were obtained on the Pacific property on September 9-10, 1982 and February 24-25, 1983. Three 10-minute averages were obtained during early morning, mid-morning, and mid-afternoon and recorded as L_{eq}. Table 4.2-7 shows the distribution of noise levels measured on the Pacific property near Clear Creek and at relatively remote sites on the property. Day/night noise levels were calculated from the L_{eq} values.

For comparison, typical street traffic noise at 100 feet has an L_{eq} of 70 dBA while normal conversation has an L_{eq} of 60 dBA; a typical suburban residential area has an L_{eq} of 53-57 dBA (Vesilind, 1975).

4.2.13 Land use and recreation

4.2.13.1 Land use

The Pacific property includes approximately 12,600 acres, of which approximately 10,180 acres are suitable for livestock grazing on rangeland that varies widely in productivity as a function of slope, aspect, and elevation. The remaining acreage consists primarily of steep slopes and cliffs, which are not suitable for grazing. Higher areas on the Roan Plateau provide good summer range (June through October), and the lower areas are used for the remainder of the year. Assuming an average total annual production of approximately 344 pounds per acre and a forage consumption rate of 50 percent, the property is capable of supporting an average stocking rate of approximately one animal unit month (AUM) per 5 acres (CDM, 1983e). On this basis, the site is capable of supporting approximately 2036 AUMs. A small portion of the site, located in the lower portion of Deer Park Gulch, is cultivated hay (100 acres).

Table 4.2-7. Distribution of noise (L_{eq}) and day/night noise levels (L_{dn}) within specific dBA ranges on the Pacific property

	Pacific property boundary near Clear Creek			Within property boundary		
	Number of L_{eq} observations			Number of L_{eq} observations		
dBA[a]	Day[b]	Night[c]	L_{dn} Average[d]	Day	Night	L_{dn} Average
>70	0	0	0	0	0	0
60-70	0	1	1	0	0	0
50-59	0	1	1	0	1	1
40-49	1	1	3	1	1	1
30-39	8	2	3	8	0	6
25-29	5	2	0	3	1	0
<25	2	1	0	4	5	0

[a]dBA is a measure of sound pressure level. The dB (decibel) is a unit on a logarithmic scale; thus, dB values are not additive. The A scale corresponds most closely to the frequency and loudness response of the human ear.

[b]0700-2200 hours.

[c]2200-0700 hours.

[d]L_{dn} is obtained by energy averaging the 24-hour noise levels with a 10-dB penalty applied to the nighttime noise levels.

The acreages for land uses on the Pacific property and for the land use study area (i.e., a 1-mile buffer around the property) are summarized in Table 4.2-8.

4.2.13.2 Recreation

The Pacific property lies in the Grand Junction Resource Area and is primarily located in a semiprimitive motorized class, as defined in the Recreational Opportunity System (ROS) system. Small portions of Deer Park and Scott gulches are in the roaded natural class. These classes are described in BLM (1983b). The roaded natural class is typified by a generally natural environment with moderate evidence of man. The Pacific property consists almost completely of private land; thus, recreational use is limited to that allowed by the owners.

Table 4.2-8. Areal extent of land use

Land use category	Land use on property[a] acreage (%)	Land use in study area[b] acreage (%)
Rangeland - R_1[c]	313.3 (2.5)	2,565.5 (6.9)
Rangeland - R_2[d]	415.8 (3.3)	1,527.5 (4.1)
Rangeland - R_3[e]	2,331.0 (18.5)	9,261.9 (25.0)
Rangeland - R_4[f]	7,122.4 (56.5)	16,160.0 (43.6)
Agriculture	100.8 (0.8)	1,729.5 (4.7)
Roads and utility corridors	1.7[g] (<0.1)	90.6[e] (0.2)
Pipeline	34.4 (0.3)	71.7 (0.2)
Miscellaneous land[h]	2,280.6 (18.1)	5,673.2 (15.3)
Total	12,600.0 (100.0)	37,079.9 (100.0)

[a]Pacific property only.

[b]Pacific property plus 1-mile buffer around the property.

[c]R_1 Rangeland is relatively flat and accessible land, consisting of bottomlands and riparian areas; offers good potential for grazing cattle and sheep.

[d]R_2 Rangeland is sloping land, consisting of alluvial fans and slopewash; somewhat steep slopes make this land slightly less suitable for grazing and is hence a less productive area.

[e]R_3 Rangeland has steep side slopes and offers limited grazing potential.

[f]R_4 Rangeland occurs on the plateau and in upland areas; offers good grazing opportunity and is relatively productive.

[g]Acreage includes only major facilities. Others (e.g., ranch roads) are not included.

[h]This land use classification consists mainly of cliffs, associated rock faces, and steeply sloping areas; land use in these areas is limited to wildlife habitat.

4.2.14 Socioeconomics

Technically, the Pacific workers would be employed and earn their income for their onsite activities. However, it would only be when the company or these workers interact in the study area communities, either directly or through the behavior of their household members, that significant socioeconomic effects would be generated. The major socioeconomic consequences of the projects are expected, therefore, to take place at the regional level. The socioeconomic environment which would be changed is basically the same for all major projects in this immediate area. In order to avoid redundancy, the regional environment, which applies equally to the Mobil and Pacific projects, is described in detail in Section 2.14.

At the present time, Pacific owns, manages, and supervises the Pacific property. The lower-lying areas are suitable for grazing and are leased for this purpose. There are also about 440 acres which are leased out for farming and are currently being used for hay production.

There are six leases on the Pacific property for farming and grazing. All of the employment and agricultural income produced on the Pacific property at this time is in the agricultural sector. These operations may produce annual employment for 6 to 10 workers. The average annual wage for workers in the agricultural sector of Garfield County in 1980 was $6256. Therefore, the total annual income produced by wages and salaries for those on Pacific property would likely be between $38,000 and $63,000.

There are no permanent residents or occupied dwelling units on the Pacific property. Because there is no resident population, no public facilities or services are required.

All property taxes on the Pacific property are paid by Pacific. Individual leaseholders pay sales and use taxes, as required.

The leaseholders belong to the Garfield County agriculturalists group (see Section 2.14.7.1). Since the current use of the property is farming and ranching, there is no change to the social structure as a result of the Pacific ownership.

4.3 ENVIRONMENTAL CONSEQUENCES

The projected environmental consequences of the proposed action and alternatives are discussed below, including the impact on the affected environment (4.3.1, 4.3.2, and 4.3.3), unavoidable adverse impacts (4.3.4), irreversible and irretrievable commitments of resources (4.3.5), relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity (4.3.6), and suggested mitigation measures (4.3.7). The impacts of alternatives would be relatively the same except as differences are discussed below and in Section 4.4.

An evaluation of the environmental impact throughout the life of the proposed action is presented in this section, including activities occurring during construction, operation, and abandonment.

4.3.1 Impacts of service corridor

The impacts of the 14-mile-long service corridor from DeBeque are not addressed in this EIS because the environmental impacts are identical to the Roan Creek corridor impacts discussed in the CCSOP DEIS (BLM, 1983b) which is incorporated by reference in this document, and summarized in Table 4.3-1. The corridor proposed by Pacific will move to the east to avoid the proposed GCC reservoir. The impacts will remain the same as listed. Specific impact analysis will be done during the rights-of-way process as outlined in Section 1.3 on page 1-13.

Table 4.3-1. Summary of potential impacts and recommended mitigation for access road, railroad, and power transmission line corridors

Project phase	Major impact/concern	Mitigation measures
Construction and Operation	Surface and Ground Water	
	Water quality	*Proper erosion and sedimentation control plan.
		*Vegetative buffer zones between roads and streams; keep all roads in corridor control clean of all garbage and foreign debris with disposal of such in an acceptable manner.
	Wildlife	
	Decrease in wildlife habitat quantity and quality	Use brush blades to minimize disturbance to herbaceous understory and low brush in power transmission line areas.
		Avoid removal of vegetation in riparian/wetland areas through use of siting alternatives.
		Establish brush piles throughout reclaimed areas to increase availability of cover for small animals.
		Avoid river, reservoir, and wetland areas through siting.
		*In consultation with CDW and USF&WS, develop in-house wildlife monitoring program to include such studies as habitat condition and trend, big game population distribution and movements, nesting raptor distribution and status, where needed and appropriate recognizing funding limitations.
		*Avoid all Category 1 habitats through construction siting, where possible.
		*Acres of Category 2 habitats/ranges may be destroyed through development of the corridor. The USF&WS mitigation policy directs that mitigation of such impacts be accomplished such that no loss of relative habitat value occurs. In-kind loss of habitats are to be minimized. No required mitigation acreages are presented; however, Operator recognizes that acquired and enhanced, or enhanced lands may be needed to offset project impacts and may differ from the amount of actual impacted acreage.
		*Acres of Category 3 habitats/ranges may be destroyed through development of the corridor. The USF&WS mitigation policy directs that mitigation of such impacts be accomplished such that no loss of relative habitat value occurs. In-kind loss of habitats are to be minimized. No required mitigation acreages are presented; however, Operator recognizes that acquired and enhanced, or enhanced lands may be needed to offset project impacts and may differ from the amount of actual impacted acreage.
		*Fencing should be minimized and should not exclude wildlife except from hazardous areas including consideration for grazing and personnel safety. Fences should be designed in consultation with CDW and USF&WS.
	Avifauna mortality resulting from electrocution and project-related activities	*Powerlines should be constucted to prevent electrocutions of migratory birds.
		*No activity should occur within an appropriate buffer zone around any occupied or active raptor nest except as provided by USF&WS and CDW.
		*Appropriate baseline inventories would be conducted over two field seasons to update nesting locations and relative abundance of raptors in vicinity of corridors prior to any construction. Survey procedures would be developed in consultation with CDW and USF&WS.
		*"Take" or "transplanting" of protected (according to regulations) raptor nests shall occur according to specifically permitted action by USF&WS and CDW.
	Wildlife mortality resulting from collisions with vehicles	*Enforce 30-mph speed limits at key big game crossing areas (as identified through monitoring studies).

Table 4.3-1 (continued)

Project phase	Major impact/concern	Mitigation measures
Construction and Operation (continued)		*Employ appropriate means to minimize big game road or rail casualties, if kill frequency exceeds 10/mi/yr (may include fencing and construction of big game passageways).
		*Construction activities should be scheduled as much as feasible to avoid critical big game habitats during key periods of time.
		*Reseed roadway shoulders and borrow ditches with unpalatable vegetation.
	Displacement of wildlife resulting from increased access to and human activity in sensitive habitats	*Construction activities should be scheduled as much as feasible to avoid critical big game habitats during key periods of time.
		*No public access to critical wildlife habitats under Operator control without consultation with CDW and USF&WS.
		*Avoid construction where possible on or near key wildlife use areas (nesting, fawning, calving areas).
		*Timing of construction and blasting where possible to avoid breeding/nesting seasons.
		*Equip machinery to suppress noise.
	Decrease in wildlife habitat quality and quantity	Where preservation is impossible, reestablish permanent ponds and marshes.
		*Revegetate all disturbed lands, where possible, except those adjacent to roadways, with vegetation mixtures favorable to wildlife.
		*Reclamation for wildlife would be a priority to the final decommissioning of the corridors.
	<u>Miscellaneous</u>	
	Potential landslides, slumping, or other mass wasting processes	*Avoid areas susceptible to such activity.
	<u>Soils</u>	
	Toxic overburden, subsoil, or soils	Bury in the core of roadfill slopes.
	<u>Vegetation</u>	
	Removal of vegetation with low vegetation potential	Avoid through siting, where possible, Douglas fir and riparisn vegetation.
	Impacts to vegetation resource values	Consolidate project activities within corridors to minimize surface disturbance.
		Avoid through siting, where possible, disturbance of relatively productive irrigated agricultural lands.
	Loss of threatened and endangered plant populations and habitat	*Search for rare plant populations prior to development of final alignments and avoid rare plant habitats, where possible.
		Transplant specimens of threatened cacti (that cannot otherwise be avoided) to suitable protected habitats.
		Compensate for the loss of rare plant habitat by securing other threatened habitat for permanent protection and by controlling access to populations which may be subject to illegal commercial exploitation.

*Operator-committed mitigation.

Source: BLM (1983b).

4.3.2 Impacts of product pipeline

Potential impacts of alternative product pipelines were analyzed in the CCSOP DEIS (BLM, 1983b), which is incorporated by reference in this document. These potential impacts are summarized in Table 4.3-2.

4.3.3 Project-specific impacts

The following subsections discuss project-specific impacts of the Pacific Project in the same discipline-oriented sequence of topics as presented in Section 4.2. This analysis has evaluated the magnitude, intensity, duration, and incidence of changes in the environment that would be caused by the project, and has also duly considered each of the impact issues raised during the scoping process.

4.3.3.1 Climate and air quality

Pacific Project air emissions would include particulate matter (PM), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), and hydrocarbons (HC). Emissions would occur during construction, mining, retorting, upgrading, power generation, and retorted shale disposal. An increase in regional population would also contribute to increased air emissions.

In order to determine the air quality impact of the Pacific Project, a number of analytical steps were undertaken. These include: (1) determination of point and area source emissions from the proposed activities; (2) determination of meteorological parameters (based on site-specific data) suitable for dispersion modeling; (3) application of air quality modeling for project-specific and cumulative impacts to nearby and more distant, sensitive Class I and Category I areas; (4) comparison of maximum predicted concentrations with appropriate regulatory standards (i.e., NAAQS, PSD increments, etc.); (5) determination of Air Quality Related Values (AQRV) at sensitive areas and evaluation of impacts; and (6) analysis of appropriate alternative and mitigative actions. This section describes the results of these analyses.

Construction

Various construction activities would extend over a 13-year period until the full production capacity of the plant is reached. However, major construction activities, including development of a service corridor from DeBeque to the project site, development of the mesa top access road, site preparation, the mine portal bench, the mine access incline, an underground crusher station, shafts, detention ponds, and diversion ditches would be more intensive during the initial 4 to 5 years of the project. The service corridor, approximately 18 miles in length, would be wide enough to accommodate the relocated and reconstructed County Highway No. 204, a 230-kV transmission line, and several underground utility pipelines. The principal pollutant from all of the construction activities would be fugitive dust from heavy equipment, and from ripping, drilling, blasting, and ground clearing. During the 13 years prior to full production, construction activities would not be continuous at any particular point and would

Table 4.3-2. Summary of potential impacts and recommended mitigation for Roan Creek pipeline

Project phase	Major impact/concern	Mitigation measures
Construction and Operation	Surface and Ground Water	
	Drainageway contamination	*Prevent spillage of oils, fuels, or other hazardous materials from construction vehicles.
	Protection of water quality and aquatic life	*Construction methods modified to minimize turbidity.
		*Install pipeline valves on both sides of drainages or use best possible pipeline rupture technology.
	Debris collecting in drainages from debris left in watershed	Debris removed promptly from any floodplain surface.
	Wildlife	
	Decrease in wildlife habitat quantity and quality	*Avoid removal of vegetation in riparian/wetland areas through use of siting alternatives.
		*Revegetate all disturbed lands, where possible, except those adjacent to roadways, with vegetation mixtures favorable to wildlife.
		Establish brush piles throughout reclaimed areas to increase availability of cover for small animals.
		Avoid wetland areas through siting alternatives.
		*Avoid all Category 1 habitats through construction siting, where possible.
		*Acres of Category 2 habitats/ranges may be destroyed by development of the pipeline. The USF&WS mitigation policy directs that mitigation of such impacts be accomplished such that no net loss of in-kind wildlife/habitat value is related. Although no commitment to required mitigation acreages is presented here, Operator recognizes that, based on available information, some acres may need to be acquired and enhanced or enhanced to offset project impacts. New enhancement technologies in effect at the time of project development may change the amount of required mitigation acres.
		*Acres of Category 3 habitats/ranges may be destroyed through development of the pipeline. The USF&WS mitigation policy directs that mitigation of such impacts be accomplished such that no loss of relative habitat value occurs. In-kind loss of habitats are to be minimized. No required mitigation acreages are presented; however, Operator recognizes that acquired and enhanced, or enhanced lands may be needed to offset project impacts and may differ from the amount of actual impacted acreage.
	Displacement of wildlife from increased human access to and activity in sensitive habitats	*Equip machinery to suppress noise.
		*Construction activities should be scheduled as much as feasible to avoid critical big game habitats during key periods of time.
		*Timing of construction and blasting to avoid breeding/nesting seasons.
		*Avoid construction of project facilities on or near key wildlife use areas (nesting, fawning, calving areas).
	Soils	
	Bank erosion during pipeline installation	Protect all areas of the bank where possible during construction; after construction, protect by replanting vegetation recommended by local land use managers of Federal and state agencies.
	Vegetation	
	Loss of threatened and endangered plant populations	Conduct searches of alternative alignments and route accordingly.

Table 4.3-2 (continued)

Project phase	Major impact/concern	Mitigation measures
Construction and Operation (continued)	Miscellaneous	
	Dumping of excess backfill	*Excavated material not used as backfill will not be placed in the floodplain or wetland areas.
	Spills	*Develop emergency cleanup program (under SPCC requirements).

*Operator-committed mitigation.

Source: BLM (1983b).

be spread over all project areas as well as the utility corridor. Occasional, localized high levels of particulate matter could be anticipated which may be controlled by appropriate mitigative activities such as water sprays.

Project emissions from operation

Pacific has identified approximately 100 separate emission sources based on mining, processing, and plant facility design. Best Available Control Technology (BACT) would be used throughout the plant to reduce emissions to acceptable levels. Among the types of control equipment to be used as BACT for TSP are baghouses (mining, crushing, and raw shale handling activities), wet scrubbers (grinding and load-in and load-out activities), venturi scrubbers with cyclones (fines retorts), and enclosures with wet suppression (retorted shale conveyors). BACT used to control SO_2 emissions would include low sulfur fuel (combustion sources), flue gas desulfurization, and hydrotreater off-gas scrubbing with a sulfur recovery unit. Other BACT to be used in the plant includes low NO_x burners and ammonia injection (where applicable), combustion controls, and floating-roof tanks with secondary seals. The bases for all emissions determinations were provided by Pacific and were extensively reviewed and determined to be reasonable by the BLM. Principal references and sources of data include: PEDCo (1976), MRI (1979), Colorado Air Pollution Control Division (1981), and EPA (1981b).

A summary of emissions by operating activities and facilities is provided in Table 4.3-3. These emission amounts are reduced from those presented in the DEIS as Pacific has found additional areas where air pollution controls can be added. The emissions data and the projected ground-level ambient concentrations are for full production of the 100,000-bpd plant. Emissions would steadily increase during the operational phase, from plant completion to full production, and the increase would be proportional to production rates.

In the case of some specialized oil shale process-related equipment, such as the TOSCO retorts, emission estimates were based on existing PSD permit applications for other oil shale facilities. Emission rates were further reviewed and found to be generally consistent with values established for similar activities of other proposed oil shale operations of comparable size and scope. The applicant has specified that emissions would be within limitations established for BACT, NSPS, and by the State of Colorado.

There are no existing oil shale processing facilities comparable in size to the proposed Pacific Project. The effectiveness of emission control technology has not been firmly established, except for smaller prototype activities. Consequently, some emissions identified in this evaluation, especially for shale oil retorting operations, are estimates based upon related industrial experience and design projections. At this time, accurate comparable information on air emissions are not available for all retort methods. Thus, the following discussion assumes that the project would be developed with the proposed retort method.

The emissions that could possibly result from malfunctioning air pollution control equipment cannot be quantified. However, during process upsets the emitting facility would be shut down, minimizing uncontrolled releases. Also, air permit regulations will likely forbid extended operation of the process with control equipment inoperative.

Table 4.3-3. Estimated Pacific Project emissions (g/s) for various mining and processing operations

	SO_2	TSP	NO_x	CO	HC
Raw shale handling (crushing, conveyors, transfers, storage, etc.)	0.01	5.33	0.79	6.86	0.03
Retorting	0.04	0.04	10.11	2.45	7.31
Upgrading	0.85	0.42	114.77	16.69	9.38
Storage tanks, valves, flanges, etc.	--	--	--	--	1.69
Auxiliary boilers	<0.01	<0.01	0.11	0.05	<0.01
Power generation/sulfur recovery unit/thermal oxidizer[a]	58.89	5.68	81.23	25.35	0.90
Mine ventilation	2.99	7.89	42.16	20.27	2.70
Retorted shale handling and disposal	--	4.05	--	--	--
Total	62.78	23.41	249.17	71.67	22.01

[a]All emissions are from a single stack. Retort off gases would be used as fuel for power; H_2S from upgrade process would go to the sulfur recovery unit.

The current level of design does not allow for precise estimates of potentially toxic or hazardous emissions. However, available design information suggests that emissions of asbestos, mercury, vinyl chloride, benzene, radionuclides, and inorganic arsenic will be minimal. Based on estimates from other oil shale projects, emissions of beryllium could exceed the significant rate (0.0004 ton/year) specified in the PSD regulations.

Recent studies have shown that exposure of untreated shale oil wastewaters to the atmosphere can result in the emission of large quantities of aromatic nitrogen-containing compounds, ketones, nitriles, and phenols (Hawthorne, 1984). Since some compounds within these chemical classes are known to be carcinogenic, this could pose a risk to worker and public health. Hawthorne (1984) showed that emissions of organic pollutants from untreated wastewaters exposed to air might amount to the following for a 100,000 bpd facility:

Compound	Emissions (gm/sec)
Nitrogen-heterocycles	145 - 158
Ketones	6 - 30
Nitriles	7 - 11
Phenols	4 - 8
Total organics	177 - 264

"By contrast, wastewaters stored in closed systems emit approximately three orders of magnitude lower amounts of organic compounds into the static air above the wastewater" (Hawthorne, 1984). Containment, followed by treatment of the wastewaters as proposed in the project design is an effective control for volatile organic emissions.

Meteorological data

Meteorological data necessary for computer modeling and impact assessment were obtained from an onsite monitoring program (CDM, 1984) as discussed in Section 4.2.1. Parameters included wind speed and direction and atmospheric stability at five site locations collected over a 1-year period.

Modeling methodology

The Complex I Model was selected for evaluation of projected point source impacts up to 25 km from the source. In addition, the Industrial Source Complex (ISC) Model was employed for area and volume source impacts. For receptors farther than 25 km, the TAPAS Model was used. For special situations such as persistent inversion conditions in the Deer Park Gulch, Scott Gulch, and Clear Creek drainage systems, box-model applications were also employed; these characterize impacts from drainage down canyons and gulches close to the source operations, as well as secondary impacts from several towns and locations along the Colorado River valley. These models are described by CDM (1983a) and Dames & Moore (1984).

The receptor locations used for modeling with the Complex I and ISC models are shown in Figure 4.3-1 for SO_2, CO, and NO_2. Receptors for TSP modeling are shown in Figure 4.3-2. Box model locations are shown in Figure 4.3-3.

Modeling results

Since the DEIS was published, local impacts from the Pacific Project were remodeled using revised emission values and a full year of onsite meteorological data. Other models (e.g., long-range and visibility) were not rerun because the values in the DEIS are believed to be conservative (Dames & Moore, 1984).

Table 4.3-4 shows maximum short-term and annual ambient concentrations predicted by the Complex I and ISC models for particulate and gaseous pollutants in the Pacific Project vicinity. This table was revised since the DEIS to reflect new modeling results using an entire year of meteorological data. Figure 4.3-3 shows locations of predicted maximum pollutant concentrations with respect to the Pacific Project boundaries. All predicted pollutant levels were below the NAAQS. The PSD Class II increment for particulate matter was predicted to be exceeded.

The highest predicted PSD increment consumption was the Class II 24-hour particulate matter concentration; this maximum 24-hour average particulate matter concentration was on the higher topography along the west face of Clear Creek valley. A concentration of 48.1 $\mu g/m^3$ was predicted immediately downwind of particulate sources in Deer Park Gulch; this value is approximately 130 percent of the allowable Class II increment and 62 percent of the secondary NAAQS. The predicted annual particulate matter concentration was 20.4 $\mu g/m^3$, or 107 percent of the annual Class II increment; this concentration was located along the higher Clear Creek valley walls about 1 km west of the project boundary. Both the

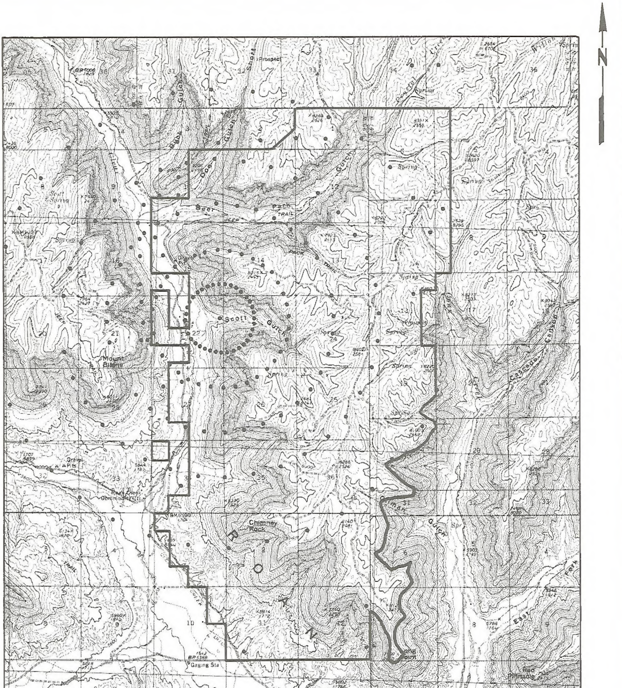


Figure 4.3-1. Receptor locations for Complex I/ISC modeling of sulfur dioxide, nitrogen oxide, and carbon monoxide emissions

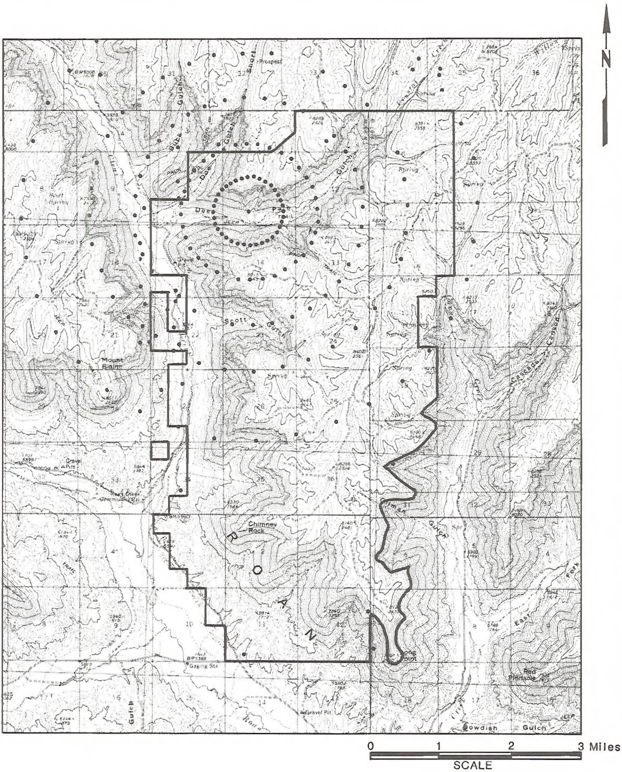
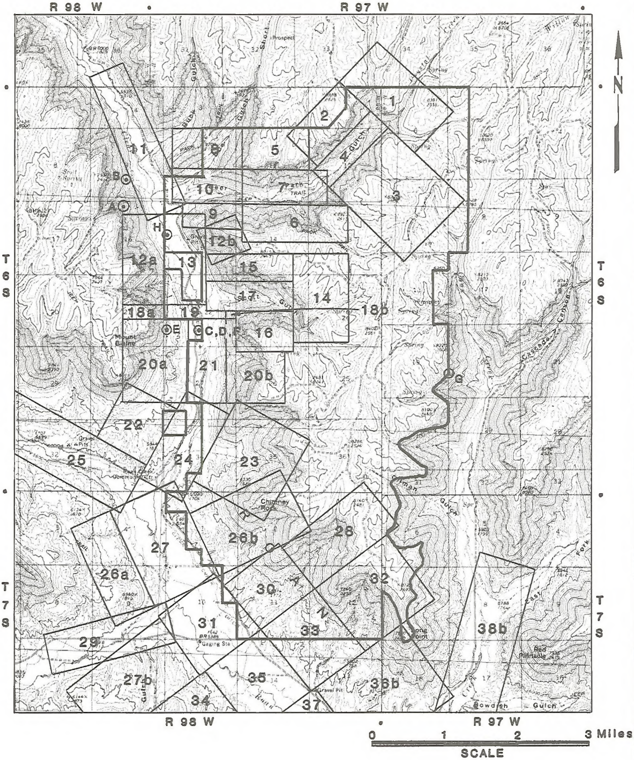


Figure 4.3-2. Receptor locations for Complex I/ISC modeling of particulate matter emissions



COMPLEX I/ISC

A	TSP Annual Avg.:	20.4		E	SO_2 3-hr Avg.:	438.3
B	TSP 24-hr Avg.:	48.1		F	NO_x Annual Avg.:	91.8
C	SO_2 Annual Avg.:	17.9		G	CO 8-hr Avg.:	444.1
D	SO_2 24-hr Avg.:	82.0		H	CK 1-hr Avg.:	2458.2

Box Model	24-hr Concentrations SO_2	TSP
Box 13	4	42
Box 21	94	30
Box 24	77	25
Box 27	53	17
Box 31	41	14

Figure 4.3-3. Location of maximum concentrations near Pacific property for Complex I/ISC, and box models (concentrations in $\mu g/m^3$)

Table 4.3-4. Maximum predicted ambient concentrations ($\mu g/m^3$) resulting from Pacific Project operations

Pollutant	Averaging time	Concentration[a]	Percent Class II increment	Assumed background concentration	Percent NAAQS[b]	Location
SO_2	Annual	17.9	89	1	24	1.5 km, 230°
	24-hour	82.0	90	14	26	1.5 km, 230°
	3-hour	438.3	86	17	35	1.8 km, 245°
Particulate matter	Annual	20.4	107	10[c]	41	3.2 km, 310°
	24-hour	48.1	130	45[c]	62	3.5 km, 315°
NO_x	Annual	91.8	--	4	96[d]	1.5 km, 230°
CO	1-hour	2458.2	--	3000	14	2.3 km, 310°
	8-hour	444.1	--	2500	29	5.0 km, 110°

[a]Predicted concentration from project operations.
[b]Based on assumed background plus concentration from project.
[c]Measured onsite.
[d]As NO_2.

24-hour and annual concentrations predicted by Complex I/ISC are above the allowable PSD Class II increments. This indicates the need for either additional control technology to reduce emissions or more sophisticated modeling to more realistically treat airflow in a constrained valley. Down-valley wind flow measured in Deer Park Gulch produced the highest predicted concentrations; the model extrapolated impaction on the opposite wall of Clear Creek. A model that allows turning flow in complex terrain may not predict as high a concentration as Complex I/ISC.

The maximum 3-hour SO_2 concentration predicted was 438.3 $\mu g/m^3$; the maximum 24-hour SO_2 concentration was 82.0 $\mu g/m^3$; the maximum annual SO_2 concentration was 17.9 $\mu g/m^3$. These are 86, 90, and 89 percent of the allowable Class II increments, respectively. The predicted maximum 3-hour, 24-hour, and annual SO_2 values all occurred in the Clear Creek valley along the western site boundary, downwind from power generation and sulfur recovery emission sources.

The maximum annual NO_x concentration predicted, including the background concentration, was about 96 $\mu g/m^3$, which is 96 percent of the NO_2 NAAQS of 100 $\mu g/m^3$. In this assessment, it was conservatively assumed that all nitrogen oxides emitted are immediately converted to NO_2. The maximum NO_2 concentrations occurred at the same location as maximum SO_2 concentrations. Maximum predicted CO concentrations including background concentrations were 14 and 29 percent of the 1-hour and 8-hour NAAQS, respectively. The 8-hour concentration occurred on the mesa top along the east boundary, adjacent to the mine ventilation exhaust outlets. The 1-hour concentration occurred in Clear Creek valley along the west boundary.

Concentrations of PM and SO_2 in Deer Park Gulch, Scott Gulch, and Clear Creek valley were also modeled using a box model (Ventilated Valley Diffusion Model; CDM, 1983f and Sohio, 1984). Six separate worst-case meteorological scenarios were considered based on site-specific data (Pacific, 1983a, 1983b). Table 4.3-5 shows results of this modeling for successive rectangular boxes extending 18 km from the plant site to the Roan Creek valley, or about three-quarters of the distance to DeBeque. Maximum offsite particulate concentrations were predicted to occur in the Clear Creek valley just down valley from Deer Park Gulch (Box 13, see Figure 4.3-3). The maximum offsite SO_2 concentration (Box 21) was 94 $\mu g/m^3$ or 103 percent of the Class II 24-hour increment. With the assumed background of 14 $\mu g/m^3$ (Table 4.3-2) added, the maximum 24-hour SO_2 concentration would be 108 $\mu g/m^3$, or 30 percent of the NAAQS. The maximum predicted particulate concentration was 42 $\mu g/m^3$ or 114 percent of the Class II increment. With the measured background of 45 $\mu g/m^3$, this would become 87 $\mu g/m^3$, or 58 percent of the secondary NAAQS.

The box modeling report (CDM, 1983f) states that, although the results show concentrations consuming the 24-hour PM and SO_2 Class II PSD increments, both the model and the source inputs are conservative. The meteorological settings were treated in a manner which assumed totally stable layers from the valley floor up to the effective height of the plume rise. Upper air studies performed by CDM in these areas have shown that during such conditions, the air becomes less stable and more neutral above 100 meters. Thus, the most realistic condition should be a box height somewhere above the plume height modeled in Cases 1 through 4 but below the rim of the valley as modeled in Cases 5 and 6. However, Union Oil Company conducted tracer tests in 1982 in Parachute Creek valley, a valley similar to where Pacific is proposing to locate. These tracer tests showed that a box model with a height equal to the tracer release height (plume height) conformed quite well with observed tracer gas concentrations. In addition, Union's tracer test showed that box models have a tendency to under-predict concentrations in boxes closest to the source. Therefore, one could expect Cases 1 through 4 to be the most realistic and that concentrations in boxes 21 and 24 might be under-predicted.

One may, nevertheless, conclude that the box-model results indicate a potential to exceed Class II increments under extreme worst-case meteorological conditions. Such conditions would occur infrequently. The NAAQS are not predicted to be exceeded even under worst-case conditions. One should also note that the confining topography places considerable constraints and limitations on the Pacific Project to ensure that applicable ambient air quality standards are met.

Using the box model, maximum 24-hour concentrations 18 km south of the plant site (Box 41 in Table 4.3-3) were predicted to be 24 $\mu g/m^3$ for SO_2 and 8 $\mu g/m^3$ for particulate matter, or 26 and 22 percent, respectively, of the PSD incremental allowances. Concentrations at DeBeque are expected to be well below these levels. Complex I worst-case modeling for DeBeque indicated a maximum SO_2 concentration of only 0.66 $\mu g/m^3$, and a maximum particulate concentration of 1.1 $\mu g/m^3$; modeling for other Colorado River valley communities (i.e. Grand Junction, Parachute, and Rifle) indicated still smaller values.

Hydrocarbon (HC) and nitrogen oxide (NO_x) emissions react photochemically in the atmosphere to form ozone. Although no photochemical model has been approved for routine regulatory application, the Clear Creek and White River oil shale projects have reported results from photochemical modeling in their PSD

Table 4.3-5. Summary of box-model results of maximum off-property 24-hour concentrations

	SO_2 (μg/m³)						Particulate matter (μg/m³)					
Box	Case 1	Case 2	Case 3	Case 4	Case 5	Case[a] 6	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
13	3	4	3	3	2	1	38	42	28	33	19	13
21	82	94	70	81	49	37	26	30	24	28	16	12
24	67	77	66	74	45	39	21	25	20	23	14	12
27	47	53	44	50	24	24	15	17	13	15	8	7
31	32	37	39	41	20	21	11	12	13	14	7	7
35	27	31	34	37	17	16	9	10	11	12	6	5
37	24	28	31	34	16	16	9	10	10	12	5	5
39	19	23	25	29	13	13	7	8	8	10	4	4
41	15	18	20	24	11	12	5	6	7	8	4	4

[a]Six separate meteorological conditions were examined for each pollutant type as follows:

Case 1 - A 14-hour persistent drainage flow during E stability conditions, with both gulch wind speeds of 1 m/s.

Case 2 - A 14-hour persistent drainage flow during F stability conditions, with both gulch wind speeds of 1 m/s.

Case 3 - A 12-hour calm period, followed by an 8-hour drainage flow during E stability conditions, with Deer Park Gulch wind speeds of 2 m/s and Scott Gulch wind speeds of 1.5 m/s.

Case 4 - A 12-hour calm period, followed by an 8-hour drainage flow during F stability conditions, with Deer Park Gulch wind speeds of 2 m/s and Scott Gulch wind speeds of 1.5 m/s.

Case 5 - A 14-hour persistent drainage flow with effective plume height equivalent to ridge height (speeds same as Case 1).

Case 6 - A 12-hour calm period followed by an 8-hour drainage flow with effective plume height equivalent to ridge height (speeds same as Case 3).

Source: CDM, 1983f and Sohio, 1984.

applications (Chevron, 1982; Phillips Petroleum, et al., 1981); in both studies, estimated ozone concentrations were below the NAAQS. The estimated HC emissions from the Pacific Project (175 pounds per hour) would be less than those from the White River project (350 pounds per hour), and well below Chevron's estimated 1100 pounds per hour. Estimates of ozone impacts from the Pacific Project facilities were calculated using the Empirical Kinetics Modeling Approach (EKMA) (EPA, 1981a). Results of this ozone impact analysis indicate that a wide range of values can be anticipated depending upon atmospheric conditions. Maximum 1-hour ozone concentrations for worst-case scenarios ranged from 57 $\mu g/m^3$ to 184 $\mu g/m^3$, compared to the NAAQS of 235 $\mu g/m^3$ (Dames & Moore, 1984).

Class I impacts

Predicted SO_2 and TSP concentrations in Class I areas because of the Pacific Project are shown in Table 4.3-6. The Complex I/ISC models and the Topographic Air Pollution Analysis System (TAPAS) model were employed for this evaluation and the table shows a range of values using the various modeling methods. As in the case of Class II impacts, ISC results for area and volume sources were added to Complex I point source results. TAPAS was used primarily for the Flat Tops Wilderness Area, which is the closest Class I area to the Pacific Project and is in the direction of the prevailing winds (Colorado National Monument, a Colorado Category I area, is actually closer, but it is in a direction opposite to the direction of prevailing winds). TAPAS was also used to predict impacts for the Mount Zirkel Wilderness Area, which is further downwind in the direction of prevailing winds. TAPAS was used for 24-hour assessments which generally represent the most constraining conditions. Complex I/ISC was used to model 3- and 24-hour SO_2 average concentrations, and for 24-hour average particulate concentrations.

Both the Complex I/ISC approach and the TAPAS approach presented some difficulties for this assessment. The Pacific Project facilities, as noted, would be located in the Deer Park Gulch-Scott Gulch areas that are strongly under the influence of drainage flow and local topographical and diurnal effects. Much of the time when the wind modeled on top of the mesa would take Pacific Project emissions toward the Flat Tops, the wind in the gulch areas would be under the influence of down-valley drainage flow and would move in the opposite direction. At other times when the modeled flow was up-valley, the mesa winds would not move with persistence toward the Flat Tops.

Nevertheless, it appears logical that, for some synoptic situations, the Pacific Project emissions would first move up-valley, and then in the direction of prevailing southwesterly flow toward the Flat Tops. For a conservative assessment, it was assumed that there would be some days when all of the flow would move up-valley and then continue under the influence of the worst-case meteorological scenario at the mesa top, toward the Flat Tops. The assumption was made that emissions would move from the Pacific Project mesa area directly to the Flat Tops. For the Complex I/ISC evaluation, 6 months of site-specific Mesa Top data were employed. (This analysis was not rerun for the FEIS using 12 months of data because the higher emissions rates used for the DEIS with 6 months of data caused the earlier analysis to be conservative.) Both modeling approaches projected concentrations at very small percentages of the Class I PSD incremental allowances and the NAAQS.

For the Flat Tops Wilderness Area, maximum 24-hour SO_2 concentrations ranged from 0.52 $\mu g/m^3$ (TAPAS) to 0.20 $\mu g/m^3$ (Complex I), or from 10 to 4 percent of the Class I increment. The 3-hour SO_2 Complex I value was 0.36 $\mu g/m^3$ or 1 percent of the increment. Particulate matter concentrations were approximately 2 percent of the allowable 24-hour increment for Complex I/ISC. Results were approximately 1 percent of the 24-hour increment.

Dinosaur National Monument impacts using Complex I/ISC, indicated both 3- and 24-hour SO_2 concentrations at less than 1 percent and at 2 percent of the respective increments. Particulate impacts were 4 percent for the 24-hour increment. The Mount Zirkel Wilderness Area assessment, using TAPAS, indicated a maximum 24-hour SO_2 concentration at 2 percent of the Class I increment; particulate matter was less than 1 percent of the 24-hour increment.

Table 4.3-6. Maximum predicted SO_2 and particulate (TSP) concentrations in Regional Class I areas ($\mu g/m^3$) as a result of the Pacific Project

FLAT TOPS WILDERNESS AREA

Pollutant	Averaging time	Complex I/ISC Concentration	Complex I/ISC Percent Class I increment	TAPAS Concentration	TAPAS Percent Class I increment
SO_2	24-hour	0.20	4	0.52	10
	3-hour	0.36	1	--	--
TSP	24-hour	0.38	4	0.23	1

COLORADO NATIONAL MONUMENT[a]

Pollutant	Averaging time	Complex I/ISC Concentration	Complex I/ISC Percent Class I increment
SO_2	24-hour	0.35	7
	3-hour	0.43	2
TSP	24-hour	0.45	4

DINOSAUR NATIONAL MONUMENT[a]

Pollutant	Averaging time	Complex I/ISC Concentration	Complex I/ISC Percent Class I increment
SO_2	24-hour	0.08	2
	3-hour	0.15	<1
TSP	24-hour	0.30	4

MOUNT ZIRKEL WILDERNESS AREA

Pollutant	Averaging time	Complex I/ISC Concentration	Complex I/ISC Percent Class I increment	TAPAS Concentration	TAPAS Percent Class I increment
SO_2	24-hour	0.03	<1	0.08	2
	3-hour	0.07	<1	--	--
TSP	24-hour	0.05	<1	0.06	<1

[a]Colorado National Monument and Dinosaur National Monument are State Category I areas; SO_2 increments are identical to those for PSD Class I areas.

Impacts from NO_x were evaluated using TAPAS for Flat Tops and Mount Zirkel Wilderness areas. Maximum 24-hour concentrations were 1.02 and 0.24 $\mu g/m^3$, respectively, at these Class I locations. Since the NO_2 annual NAAQS is 100 $\mu g/m^3$ and these results reflect single worst-case days for NO_x, it can be assumed that additional NO_2 impacts will be minimal.

The TAPAS Model also identified maximum concentrations in Class II areas. Predicted values showed no exceedance of standards. At the Grand Hogback, 40 km east-northeast of the Pacific Project site, maximum 24-hour SO_2, particulate matter, and NO_x concentrations were 0.66, 0.25, and 2.3 $\mu g/m^3$, respectively.

Complex I/ISC was used to model Pacific Project impacts at other Class I and certain sensitive Class II areas not shown in Table 4.3-6. These included Arches National Park, the Black Canyon of the Gunnison National Monument, the Maroon Bells and Raggeds wilderness areas, and the Grand Mesa. All predicted concentrations were a very small percentage of applicable PSD increments and NAAQS.

Visibility

A Level I visibility screening analysis (Latimer and Ireson, 1980) was performed to determine if significant impacts would occur at nearby Class I/Category I areas. The Level I analysis is a simple, straightforward calculation designed to identify those emission sources that have little potential of adversely affecting visibility. If a source passes a screening, it would not be likely to cause adverse visibility impairment, and further analysis of potential visibility impairment would not be necessary. The analysis indicated that potential significant impacts were unlikely at all Class I areas. However, a more detailed visibility analysis was required to predict potential visibility impacts at Colorado National Monument (Category I).

The Level I analyses indicated a possibility for a coherent plume to be visible from Colorado National Monument. The EPA visibility model PLUVUE was used to refine the analyses of plume perceptability at Colorado National Monument. The model was run for average summer meteorological conditions, since summer is the expected season of maximum impacts. Plume discoloration is greatest in the summer as NO_2 forms faster because of higher O_3 concentrations. Also, because the average visual range is higher in the summers, any reduction is more apparent. The PLUVUE Model results showed that the potential for a visible plume during daytime conditions was unlikely. The potential for visibility impairment from nighttime transport towards Colorado National Monument was shown to occur only during low wind speed, stable conditions. On the basis of Roan Plateau wind frequency distributions, a plume from the project may be perceivable from Colorado National Monument approximately 3 to 4 times a year during the hours immediately after sunrise.

Atmospheric deposition

Acid deposition is considered under the assessment of the AQRVs for Class I areas. Acid rain is a regional phenomenon generally associated with emissions generated by large industrial sources. Acid deposition has, however, been documented in a high altitude Rocky Mountain setting where no direct relationship can be made with major emission sources (Lewis and Grant, 1980). Additional studies and analyses have been done by Fox et al. (1982) and Turk and Adams (1983).

Deposition of sulfur from SO_2 emissions of the Pacific Project was calculated for Class I/Category I and other sensitive locations. This calculation used the SO_2 concentrations predicted by TAPAS and Complex I models and estimated deposition velocities to determine the total wet and dry sulfur deposition rate. Results were as follows:

Sensitive area	Total wet and dry sulfur deposition (kg/HA-yr)
Flat Tops Wilderness Area	0.04 - 0.12[a]
Colorado National Monument	0.08
Dinosaur National Monument	0.02
Mount Zirkel Wilderness Area	0.02

[a]Range using TAPAS and Complex I, respectively.

These rates indicate no significant acid deposition impacts are likely. As indicated previously (Section 3.3.1.1), wet sulfate deposition of less than 20 kg/HA-yr has not produced any recorded damage in the most vulnerable areas (Roberts, 1983). Wet sulfate deposition of 20 kg/HA-yr approximates total wet and dry sulfur deposition of 13 kg/HA-yr. At a recent conference on acidification of the environment, some participants suggested that the threshold for acidification is as low as 5 kg/HA-yr of sulfur deposition (Swedish Ministry of Agriculture, 1982). The sulfur deposition rates calculated above represent a small percentage of this postulated threshold impact value.

Secondary impacts

This section presents the estimated air quality impacts from secondary growth emission sources associated with the construction and operation of the proposed Pacific Project. Secondary growth impacts were focused on four representative locations in the Colorado River valley: Rifle, DeBeque, Parachute, and Grand Junction. Project air emissions were based on population growth projections presented in the socioeconomics baseline (Section 2.14), and emission inventories established in a 1982 report on air quality impacts of oil shale and related growth in western Colorado (PEDCo, 1982). Project growth emissions were modeled using a box model (Dames & Moore, 1984) to simulate the worst-case meteorological condition of a severe inversion (mixing depth 100 m) combined with very light winds (1 m/sec).

Results are provided in Table 4.3-7 and indicate modest increases of NO_x and particulate matter at Rifle above the No-Action scenario. Secondary growth pollutant increases at Parachute, DeBeque, and Grand Junction were predicted to be small to negligible. Since these concentrations are predicted from emission rates and do not include background, these results are useful only as a tool for understanding how air quality might change in a relative sense. Actual concentrations may be higher, particularly for TSP as it includes the measurement of reentrained dust as well as direct emissions.

Table 4.3-7. Secondary pollutant impacts at representative Colorado River valley locations (24-hour average concentrations expressed in $\mu g/m^3$)

Town	1980[a]	No action[b]	With Pacific
Rifle			
SO_2	2	3	4
NO_x	14	28	37
TSP	49	62	71
DeBeque			
SO_2	2	2	2
NO_x	16	16	17
TSP	34	35	36
Parachute			
SO_2	1	2	2
NO_x	20	29	29
TSP	92	102	102
Grand Junction			
SO_2	11	14	14
NO_x	103	132	136
TSP	122	152	156

[a]Highest predicted 24-hour concentration based on 1980 emissions data.

[b]Based on population increases through 1999 for Rifle, DeBeque, and Parachute, and through 2009 for Grand Junction.

Impacts on climate

Very localized wind patterns may be affected by alteration of the topography or by building construction. Land clearing could alter the reflection and evapotranspiration of the ground, resulting in temperature and humidity changes. It is also possible that warm retorted shale placed in the narrow canyons may affect drainage flows, resulting in very localized eddies in these areas. These potential impacts would be very localized and temporary and would be mitigated through vegetation reclamation and the eventual decommissioning of the industrial facility. No impacts to regional climate are anticipated from any of the proposed actions or alternatives.

Facility abandonment

Fugitive dust can be anticipated from cleared areas and retorted shale disposal areas. These impacts can be mitigated significantly by reclamation.

4.3.3.2 Topography, geology, and mineral resources

Construction

During construction of the retorting facilities in Deer Park Gulch, the alluvial fan at the mouth of the gulch would be altered from its current configuration to a series of flat benches becoming progressively lower to the west. Also, most of a 10-acre, southwest-trending, elongated ridge of bedrock between the lower drainages of Deer Park and Doe gulches would be leveled during construction of the retorting facilities. Small portions of the lower valley walls of Deer Park and Doe gulches would be cut and leveled. Construction of the liquids processing area would be essentially confined to the alluvial fan in Scott Gulch. That part of the western-sloping fan between the elevations of 5800 and 5600 feet would be cut into a series of flat benches descending to the west. The mesa-top access road would create a linear trace across the cliff face.

The lower reach of Deer Park Gulch that is the proposed location for retort facilities is partially underlain by landslide material (Hail, 1978). The storage reservoir area in the NW¼, Section 10 in Doe Gulch is underlain by slopewash and talus deposits. The proposed locations for the tank farm and oil upgrading plant at the lower end of Scott Gulch are also areas of landslide material (Hail, 1978). The mine access road to the portal may cross talus slopes that may become unstable because of construction activities. Construction areas in Sections 22 and 27 on the east side of Clear Creek are underlain by fan material derived from flash floods and some talus and landslide material. Most of the northernmost construction camp area is underlain by slopewash and talus; however, the southern end is on the Shire Member of the Wasatch Formation. The southernmost construction camp area is almost entirely on the Shire Member. The administration building site on the east side of Clear Creek, west of the mouth of Scott Gulch is underlain by slopewash and talus, alluvial fan material deposited in flash floods, and landslide material. The parking areas in Section 3, on the east side of Clear Creek, are essentially underlain by talus and slopewash, and the visitors center in Section 34, on the west side of Clear Creek, is underlain by slump deposits. Blasting during road construction and mine bench preparation may tend to increase rockfall. Rockfall from the cliff face may occur during any time of the year, and would pose a risk of possible damage to the plant facilities in the valley. The area is especially susceptible to rockfall in the spring because of ice wedging.

Siting of the plant facilities in Deer Park, Doe, and Scott gulches; the reservoir, pipeline, and utilities corridors along Roan and Clear creeks; and water intake facilities along the Colorado River would impede or prevent the extraction of low-grade deposits of sand and gravel in these areas. High-grade deposits of sand and gravel elsewhere along the Colorado River, would be mined and partially depleted for project construction and related development activities.

The Pacific property is located in seismic risk Zone 1, and may be subject to minor effects from distant earthquakes. Shocks associated with these earthquakes might increase the danger of rockfall in the plant facilities area.

Operation

Shale oil production during the life of the project would result in the disposal of 684 million tons of retorted shale in Deer Park Gulch. This would change the topographic configuration of the eastern third of the gulch below the oil shale cliffs from that of a narrow, steep-sided box canyon with relief ranging from 1300 to 1600 feet to a wide, shallow valley with 200 to 400 feet of relief. An additional 1-mile length of the valley would be impacted to a lesser degree by the disposal of retorted shale. In this area, the surface of the disposal pile would be stair-stepped down from 7800 feet to the terminus of the pile on the valley floor at an elevation of about 6200 feet. Retorted shale disposal in Deer Park Gulch would cover approximately 4 miles of cliff face at the upper end of the box canyon, which includes some tabular, erosional rock outliers in the lower part of the Parachute Creek Member below the Mahogany Zone.

The Pacific Project would produce 107,000 barrels per day of oil and generate 90 percent of its own electrical requirement. It would be a net energy producer. However, energy demands through the life of the project would require the mining of some additional coal in the region to generate additional power for the project; some additional oil and gas would also be required to balance the electricity needs of the project.

Pillars left in the mine for roof support would commit 38 percent of the oil shale in the Mine Zone (which would be equivalent to about 355 million barrels of shale oil) which would not be recoverable by mining. An additional 400 million barrels of lower grade shale oil in the Mahogany Zone in beds above and below the Mine Zone would not be recovered. However, the total of 1344 million barrels in the Mahagony Zone of the Pacific property is only a small part of the 135 billion barrels contained in 25-gallon per ton shale of the Mahogany Zone throughout the Piceance Basin (Keighin, 1975).

Abandonment

A total of about 8.7 million cubic yards of soils would be cut from the surface of Deer Park, Doe, and Scott gulches; 4.4 million cubic yards would be used for fill during site preparation. Upon completion of the Pacific Project, the disturbed area would be recontoured to blend with the surrounding topography. This surface would be similar to the original surface, but at a lower contour level.

An alternating pattern of pillars and 60-foot-high voids in the 8400-acre mined-out area would discourage, if not prevent, oil and gas exploration. After completion of mining operations, some support pillars could eventually fail, causing the overburden to collapse into the mined void, resulting in differential surface subsidence in a checkerboard pattern. The hazardous and nonhazardous solid waste disposal facilities and product oil pipeline should have minimal impact on the geology and mineral resources of the project area.

4.3.3.3 Paleontology

It is expected that the Pacific Project would adversely impact paleontological resources in the region. Any disturbance of potentially fossiliferous strata (the Wasatch, Green River, or Uinta formation), however, could result in a chance discovery and recovery of paleontological values that would be unknown otherwise.

<u>Construction</u>

Impacts to paleontological resources during construction would occur as a result of excavation, grading, and other site preparations, as well as through fossil collecting by construction personnel. Such impacts are expected to be of minor consequence, inasmuch as minimal acreage would be involved and most construction would be confined to nearly level surfaces where fossiliferous exposures have been significantly weathered or masked with a veneer of Quaternary sediments.

<u>Operation</u>

Impacts during operation would occur when fossiliferous formations are directly involved, as in the shale mining and processing operation, and would result in the destruction of fossils. The waste disposal facility and water impoundment may tend to protect the undisturbed fossil resources by making them inaccessible. Once installed, support facilities would have only a minor impact, with the possible exception of access roads, which could permit exploitation of those fossils previously protected by isolation.

<u>Abandonment</u>

Upon termination of the project, adverse impacts on paleontological resources would cease except as disturbance or destruction is perpetuated by public access resulting from project-related roads or exposure of strata that are paleontologically sensitive.

4.3.3.4 Soils

About 1314 acres (12 percent) of the Pacific Project area would be subjected to various surface uses and impacts. The associated project components and their approximate acreages are listed in Table 4.3-8.

<u>Construction</u>

Generally, the impact on soils to be stripped and stockpiled would be significant and include the destruction of soil horizons, changes in soil temperature and moisture characteristics, loss or dilution of soil organic matter, and erosion. These impacts, through ecosystem interactions, indirectly affect soil nutrients and microflora; water availability and quality; vegetative growth, cover, and succession; and wildlife habitat and livestock forage.

Soils on lands to be used for administration and service buildings, the retort area, raw shale storage, shops, warehouses, intraplant corridor, the main

Table 4.3-8. Approximate soil disturbance acreages, Pacific Project

Project component	Acreage
Administration and service buildings, retort area, raw shale storage, shops and warehouse, intraplant corridor, main substation, shale oil upgrading, tank farm, construction area, explosive area, access roads, construction camp, visitors center, and parking area	585
Retention pond and terminal reservoir	53
Retorted shale disposal area	676
Total land disturbed	1314[a]

[a]Disturbed acreage for other project components are treated in BLM (1983b).

substation, shale oil upgrading, the tank farm, the construction laydown area, the explosives area, the construction camp, the visitors center, and parking area would encompass an estimated 585 acres. Impacts to soil horizons on these sites would be significant but short-term as a result of disturbance and mixing during stripping and stockpiling. Similarly, or as a result of inundation, soils of the 53 acres that would be occupied by the retention pond and terminal reservoir would be significantly impacted.

Operation

During operation, additional impacts on soils would be negligible except that retorted shale disposal throughout the life of the project would significantly impact the soils on a total of 676 acres.

Abandonment

Upon abandonment, stockpiled soils would be redistributed over affected areas to recreate a soil cover similar to that which originally existed. Since the volume of topsoil required to reclaim some areas (e.g., the retorted shale disposal area) may exceed that originally stockpiled from those areas, some of the topsoil may have to come from other affected areas where greater volumes were stockpiled than needed for reclamation. It is reasonable to predict that with the passage of time, the growth of vegetation and development of soil horizons in the soil cover would result in development of a stable plant growth medium on most reclaimed surfaces. Pacific's revised plans to accomplish greater slope stability and to reduce soil loss involve construction of level benches at intervals of 25 feet. This effectively reduces the slope length to 25 feet. Based on application of the Universal Soil Loss Equation (SCS and EPA, 1977), the theoretical rate of erosion on the reclaimed 2:1 embankment slope of the retorted shale disposal area would be 11.6 tons per acre per year. This rate of erosion was calculated using the following equation factors:

R, factor for rainfall	30
K, erodibility	0.37
LS slope length, 25 feet slope percent 50	8.75
C, cover 25 percent grass cover and 25 percent canopy of tall forbs and short shrubs	0.12

$30 \times 0.37 \times 8.75 \times 0.12 = 11.6$

This relatively low rate of soil loss could be sustained with a bench maintenance program involving repair of any breaks in the berms, and removal of deposition that would reduce the effective holding capacity of the benches.

4.3.3.5 Ground water

Construction

Potential impacts on the ground-water regime would occur from construction activities, especially from activities which involve the excavation and removal of talus, bedrock, and alluvial materials. These activities would include construction of roads, preparation of the plant site and mine benches, and intra-plant and product pipelines and retention ponds. Discharge and recharge areas may also be affected by construction activities; however, the impact would be insignificant in context with the overall ground-water system.

Other potential impacts include degradation of ground-water quality by accidental fuel and oil spills, or by infiltration of surface runoff from construction areas; and disruption of discharge and recharge areas by construction. The generation, storage, and disposal of both liquid and solid wastes may also potentially impact both surface- and ground-water quality. The magnitude of the potential impacts will depend on the location, extent, and nature of the release or spill.

Imperceptible changes in ground-water levels, flows, and quality would be expected in the immediate vicinity of the surface-water diversion on the Colorado River because of temporary diversion of the river by coffer dams and construction of the intake structure and pumping facility; however, after completion of the diversion structure, the ground-water system should approach preconstruction conditions.

Operation

Mining. Ground-water impacts from dewatering/depressurization during the mining operations are expected to be minor because the Mahogany Zone is essentially isolated or only weakly interconnected with the overlying and underlying aquifers. If, however, interaquifer communication does exist, the impacts on the ground-water system because of mining could occur over several square miles. Dewatering, for example, could cause cessation of surface flow in springs and seeps in adjacent and overlying areas. Dewatering during mining and mine drainage could affect both the quantity and quality of springs and seeps in adjacent areas.

Raw shale handling. No major impacts on ground water are anticipated from stockpiling of crushed oil shale or other oil shale handling procedures. However, a potential exists for infiltration of precipitation into the pile.

Retorting and upgrading. No adverse impacts on the ground-water regime are expected to occur as a result of retorting and upgrading operations.

Waste disposal. Retorted shale would be disposed of in the upper portion of Deer Park Gulch. The planned elevation of the top of the disposal pile would approach 7725 feet. As shown on Figure 4.3-4, the top of the disposal pile in the upper reaches of Deer Park Gulch would be above the top of the Mahogany Zone and at approximately the same elevation as the base of the leach zone.

Diversion ditches would be constructed to divert surface runoff and ground-water inflow from the Uinta aquifer and the upper part of the Upper Parachute Creek aquifer around the pile. The bottom and sides of the disposal area would be lined with up to 10 feet of compacted retorted shale to minimize the potential for seepage into and out of the pile. As discussed in Section 4.2.5, Deer Park Gulch is an area of local ground-water discharge for both the Upper and Lower Parachute Creek aquifers. Without a rockfill underdrain, it is predicted that construction of the liner and placement of the retorted shale would impact the shallow ground-water system within the valley bottom alluvium and would also affect natural discharge from the Upper and Lower Parachute Creek aquifers. The principal impact of placement of this physical barrier on ground-water discharge from the Parachute Creek aquifers would be the elimination of evapotranspiration which is presently the primary mechanism for discharge. As a result of elimination of natural ground-water discharge, ground-water levels within both the Upper and Lower Parachute Creek aquifers would tend to rise above the pre-development levels. This in turn would result in an increase in the potential for ground-water inflow to the retorted shale pile and saturation of its base, which in turn could affect the stability of the pile. The magnitude of the associated increase in ground-water levels within the Upper and Lower Parachute Creek aquifers and the potential rates of ground-water inflow to the retorted shale pile through the liner are addressed in a report by In Situ Inc. (1984) commissioned by the Pacific Project.

If it is determined that ground-water discharge in the area of the proposed retorted shale pile is a potential problem, Pacific proposes to construct a rockfill underdrain or other appropriate facilities beneath the bottom liner of the retorted shale disposal pile. This underdrainage system would intercept ground-water discharge and prevent the ground-water table from rising into the retorted shale pile.

The quality of ground water which comes in contact with the retorted shale would be degraded resulting in an increase in the potential for contamination of both surface and ground water downstream of the retorted shale disposal area.

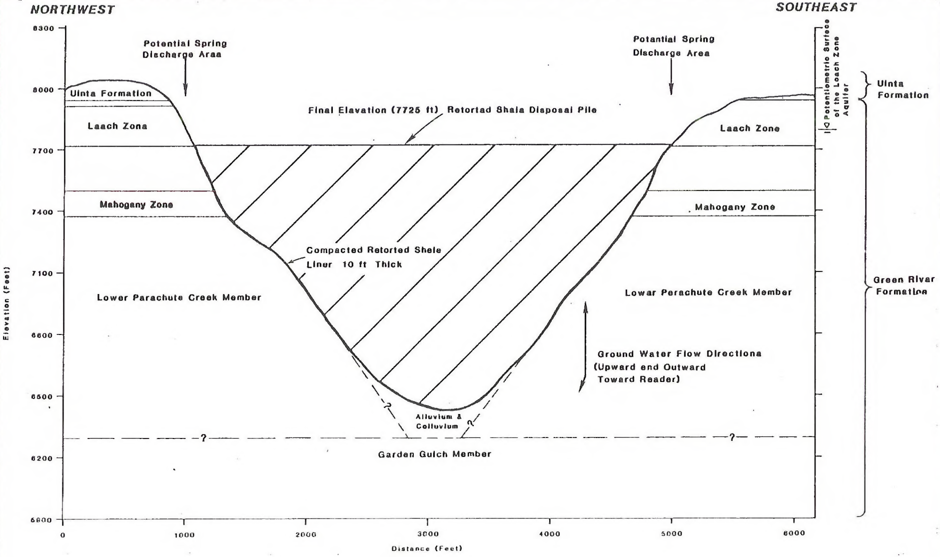


Figure 4.3-4. Schematic hydrogeological cross section of the upper Deer Park Gulch retorted shale disposal area

Support facilities. No major ground-water impacts are expected to occur as a result of the proposed water supply diversion from the Colorado River. The water supply pipeline from DeBeque to the project site would not impact the ground-water regime.

Operation of support facilities and utilities would not result in ground-water impacts unless contaminants were accidentally spilled and these migrated into the ground-water system causing degradation of ground-water quality.

Paved access roads and parking areas would interfere with natural ground-water recharge and discharge rates. Deer Park and Scott gulches, for example, are located within areas of natural ground-water discharge. Because of the low rates, ground-water discharge is not manifested in visible springs and seepages in these gulches, but occurs primarily as evapotranspiration.

Abandonment

The potential ground-water impacts during abandonment include degradation of ground-water quality as a result of infiltration of contaminated surface-water runoff. Closure of the mine itself should not impact the ground-water system. However, if subsidence occurs within the mine workings and the overlying strata, intercommunication between the local surface and the mine could impact springs and surface water on the mesa top. Mine abandonment could eventually result in new springs and seeps in the area along the Mahogany Zone outcrop and near the mine portal and ventilation shafts, once the mined zone is restabilized. The mine waters could be poorer in quality than the original aquifer waters because of the dissolution of soluble minerals in the mine walls; thus, the weepholes in the portal entrance plug could transfer lower quality mine drainage water to Clear Creek via the proposed concrete-lined ditch.

4.3.3.6 Surface water

Construction

Water quantity. A total area of approximately 638 acres would be disturbed during the construction phase of the project, which constitutes less than 1 percent of the Clear Creek drainage basin. For a temporary period of about 1 year, the erosion potential of this disturbed area would be higher than the current level, but the net increase in the sediment load of Clear Creek is expected to be less than 3 percent. Deer Park and Scott gulches both contain ephemeral streams, and the areas to be disturbed in these watersheds represent less than 3 and 10 percent of the respective drainage areas. Therefore, temporary minor increases in their sediment loads would be experienced only if intense storm events occurred during the period of construction. The resulting impact on the sediment load of Roan Creek would be insignificant. The retorted shale pile would occupy an additional area of 676 acres. A small portion of this area would be disturbed during the construction phase; however, the major disturbance in this area would occur during the operational phase of the project. Construction of the low rock-filled gabion structure near DeBeque would increase the maximum sediment load of the Colorado River by less than 0.5 percent for a short period of time (less than 6 months).

The drainage courses of the lower reaches of Deer Park and Scott gulches would be permanently altered. The average annual runoff and peak flows of the streams in these gulches would be reduced by about 10 percent. The resulting impact on the average and peak flows of Clear and Roan creeks would be insignificant. The diversion on the Colorado River would not cause any significant reduction in flow area under the various flooding conditions. Therefore, there would be minimal impact on the sedimentation, erosion, or flood flows of the Colorado River. The proposed withdrawal from the Colorado River is approximately 3 percent of the minimum recorded streamflow at DeBeque and is duly appropriated. Users of junior water rights may not have water available which is currently being used.

Water quality. The total disturbed area of 2 square miles represents 2, 0.6, and 0.03 percent of the drainage areas of Clear Creek, Roan Creek, and the Colorado River, respectively. With the proposed runoff collection, diversion, and zero discharge system covering the entire project area, the impacts of project operation on the sediment loads of these streams are estimated to be insignificant. The sediment loads of the rerouted streams in Deer Park and Scott gulches would be reduced because the sediment yield from approximately 10 percent of their watersheds would be contained and the rerouted channels would be designed with erosion control and energy dissipation measures.

The onsite retention and detention dams and containment berms would be designed with reasonable factors of safety. Simultaneous failure of all three structures is very improbable. In the unlikely event of the failure of one of these structures, streamflows of Clear and Roan creeks and the Colorado River may be temporarily increased for a day or so.

Increases in salinity (TDS) in Clear and Roan creeks would be expected because of surface-water runoff contact with freshly exposed, oxidized minerals in disturbed areas and subsequent discharge to natural drainages. This effect would be more pronounced where stream channels are disturbed (road and pipe stream crossings and dams), although sheet flows from all disturbed areas will contribute to a general TDS increase during construction until diversions are in place. Even areas which are disturbed only during construction, such as utility corridors and construction staging areas, would contribute higher TDS loads than similar undisturbed terrain, even after revegetation, and could require a long time to return to pre-disturbance conditions in terms of salinity contribution to runoff.

All construction activities would involve increases in erosion rates, which would cause increased suspended sediment loadings in project area streams. At the peak of construction activities, construction area erosion would increase the annual average sediment loading of Clear Creek below Scott Gulch by less than 4.8 percent. Planned runoff control and sedimentation structures would significantly reduce this impact. These effects would be short term in most cases, and most severe where construction takes place in the streambed.

Operation

Water quantity. The major change in flow during operation would be the average 32 (range 0 to 48) cubic-feet-per-second (cfs) diversion from the Colorado River at DeBeque, although there would be additional minor changes in flow associated with onsite retention or detention of runoff. Downstream users of junior water rights may not have water available which is currently being used.

Water quality. For all proposed users of upper Colorado River basin water (including the Pacific Project) in which a zero discharge policy is applied, the major project impacts on lower-basin salinity would be two-fold:

- Depletions in the Colorado River causing increases in salt loading in the lower basin because of diversions of low-salinity water from the upper basin; and

- Reductions in both flow and salt loading because of retention of contaminated area runoff.

The net change in TDS at Imperial Dam, as a result of project flow depletions and retention of runoff, is estimated to be an increase of 1.166 mg/l, mainly because of the Colorado River diversion of approximately 32 cfs at DeBeque. This increase would represent 0.13 percent of the salinity standard for Imperial Dam (CRBSCF, 1981).

A sanitary landfill could be operated onsite for biological sludge from process wastewater treatment if the sludge is not disposed of in the retorted shale pile or used as a soil conditioner. The process wastewater biological sludge would contain heavy metals, and could contain complex organics. Leakage from the facility, if any, could impact Clear Creek and its associated alluvial aquifer.

The retorted shale disposal pile in Deer Park Gulch would have the potential of polluting down-gradient ground and surface waters. However, leachates and runoff containing high TDS, fluoride, boron, molybdenum, zinc, and other heavy metals, would be minimal because of the design of the disposal area containment. Controlled compaction of the embankment and the bottom liner would keep leachates from moving out of the pile while compaction of the remainder of the pile, control of moisture additions, and the high-positive net evaporation rate would keep leachates from forming and migrating in the pile. These factors make the probability of ground-water pollution low. Runoff would similarly be routed off of and away from the retorted shale pile, minimizing the risk of contact with uncontaminated surface water.

Operation of an onsite hazardous waste disposal or temporary storage facility would present risks of ground-water pollution, mainly from heavy metals. While the siting, design, and monitoring of the disposal or storage facility would be tightly controlled by Federal regulations, a residual risk would remain as a result of the potential for the leaching heavy metals into the alluvium and also into Clear Creek. This risk would be minimized by the saline nature of the soils of the area, which would strongly attenuate heavy metals migration in the soils system.

Spill risks

Spill risks described in Section 4.3.3.5 would also apply to project area surface waters. Materials that pose this risk include raw and upgraded shale oil, vehicle lubricating oil and transmission fluid, gasoline and diesel fuels, ammonium nitrate blasting material, and ammonia and sulfur by-products. Risks of spills or other uncontrolled releases would exist whenever and wherever these materials are stored, transported by truck, rail, or pipeline, or transferred from one storage or transport facility to another. Risks of surface-water quality degradation would also exist in situations where the above materials are transported to or away from the project facilities. Surface-water quality impacts associated with spills from truck accidents would be most severe over a short term on aquatic habitat and water users downstream of the spill site.

A third type of uncontrolled release risk would involve storage tank leaks that are undetected for a long period of time. Nearly all the fuels, by-products, and oils discussed above would be stored in project area tankage during handling and use. Undetected leaks could cause impacts of varying magnitude on surface water down-gradient of the storage areas, depending on the size and location of the release.

Abandonment

During reclamation, the disturbed areas would be recontoured and vegetated in accordance with permitting stipulations of the Colorado Mined Land Reclamation Board. The lower portions of Deer Park Gulch and Scott Gulch would be partially filled by the retorted shale and sediment accumulation in retention and detention dams. Therefore, the overall relief, slopes, and erosion potential of these areas would be reduced. Consequently, the sediment loads of the streams in Deer Park and Scott gulches, and Clear and Roan creeks would also be reduced. The times of concentration of the Deer Park Gulch and Scott Gulch watersheds (defined as the time taken by runoff from the remotest portions of the watershed to reach the point of interest) would be reduced, resulting in lower flood peaks. The impact on the peak flows of Clear and Roan creeks and the Colorado River would be insignificant. Long-term impacts associated with the retorted shale embankment faces are discussed below.

The hydrologic regimes and drainage courses of Deer Park and Scott gulches would be altered, but there would be no change in the hydrologic regimes of Clear and Roan creeks.

As no retention or detention dam, or surface-water impoundment would be left in place, there would be no chance of flooding because of dam breaks. Since water use by the plant would cease, the appropriated 21,000 acre-feet per year of Colorado River water would be available for other beneficial uses.

Water quality. The major impacts on Colorado River Basin salinity because of diversions and runoff retention would cease upon abandonment. The remaining minor impact on salinity would be associated with the lagging return of reclaimed disturbed areas to their pre-disturbance condition. Runoff which had been retained would flow across disturbed areas, picking up slightly higher concentrations of total dissolved solids (TDS) than under natural, undisturbed conditions, and enter surface waters.

The average annual runoff contribution after abandonment from previously retained areas would be only about 0.43 percent of the historical annual discharge of Clear Creek below the mouth of Deer Park Gulch; moreover, salt loadings from these areas would only constitute about 0.33 percent of Clear Creek salt loading. Thus, slight increases in the runoff of total dissolved solids (TDS) would have no noticeable effect on Clear Creek or downstream surface waters.

Without maintenance, impacts by TDS, as well as other pollutants, after abandonment of the retorted shale pile in Deer Park Gulch could potentially be more severe. Without appropriate maintenance, erosion on the 27-degree embankment slopes (2 horizontal to 1 vertical) could be excessive as discussed in Section 4.3.3.4. If the topsoil cover on this embankment becomes eroded, retorted shale would be exposed to all runoff and snowmelt events. Both dissolution of soluble minerals into runoff water and transport of shale solids down into natural stream channels would contribute to increases in TDS, heavy metals, boron, and fluoride concentrations in Clear Creek.

4.3.3.7 Aquatic ecology

Construction

Major project facilities. Potential impacts associated with the construction of the major project facilities include a primary impact associated with increased total suspended solids (TSS) in streams and rivers, and a secondary impact associated with the increased harvest of the fishery resource. During construction of the main plant systems, approximately 585 acres (Table 4.3-6) would be disturbed and increased soil erosion on these areas has been projected to increase sediment loading of Clear and Roan creeks by less than 1 percent (see Section 4.3.3.6). This projected increase in TSS would not have a detectable impact on aquatic resources of the area.

Peak construction of the project would result in 3613 people moving into the region (see Section 4.3.3.14), which is projected to create an additional 31,440 fishing trips in the region (Section 4.3.3.13). The fishing resource of the region is presently being harvested at or above its production capacity (Sealing, 1983). It is the goal of the Colorado Division of Wildlife (CDW) to provide 2.3 fish per fishing trip. Therefore, under present conditions, the fishery resource would not be capable of supplying the 72,000 fish that would be required to meet the goal of the CDW. Because of a 42.5 percent mortality of stocked fish, 125,700 trout would need to be stocked in the region to prevent the fishery resource from being overharvested. Another concern involves stream-residing Colorado River cutthroat trout, which can be readily overharvested (Binns, 1977). Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch, which contain Colorado River cutthroat trout, have a high possibility of being overexploited.

Support facilities. Potential impacts of construction of the support facilities include increased TSS levels in streams and destruction of aquatic habitat. A total of approximately 729 acres would be disturbed by the retention pond and terminal reservoir and the retorted shale disposal area; these areas are projected to increase TSS levels in Clear and Roan creeks by less than 1 percent. This increase would not impact aquatic organisms in either creek or the Colorado River.

Destruction of aquatic habitat would occur during the construction of the intake structure on the Colorado River. Activities would include construction of temporary cofferdams across the river, installation of rock gabions, and construction of intake and approach pads. The cofferdams and rock gabions would create temporary impacts limited to the construction period. The intake structure would eliminate approximately 100 feet of shoreline, and the approach would cover approximately 2000 square feet of stream bottom. Both impacts would persist for the duration of the project. In relation to the total habitat in the Colorado River, these disturbances should not cause detectable impacts on the aquatic community in the Colorado River.

Operation

It is proposed that 21,000 acre-feet would be diverted annually from the Colorado River or its tributaries. Depending on the diversion schedule, flow reductions could result in downstream habitat reductions. The maximum withdrawal rate would be approximately 48 cubic feet per second, which represents 1.8 and 5.4 percent of the average and minimum flows of the Colorado River, respectively (USGS, 1981). Table 4.3-9 shows the average depletions that would occur by month based on 1962 to 1981 flows. No Federally listed threatened or endangered fish species (USF&WS, 1980a; 1982) are known to occur in this reach of the Colorado River. However, flow depletions in the Colorado River could cause reductions in downstream habitat of the Colorado squawfish (Ptychocheilus lucius) and the humpback sucker (Gila cypha), both of which are endangered (CDM, 1983c; CDM and Bio/West, Inc., 1983). Releases from an upstream Federal or private reservoir during low-flow periods could increase aquatic habitat in the Colorado River between the release point and the project intake structure.

With all water supply alternatives, an intake structure would be required and entrainment and impingement of aquatic organisms would occur. If Pacific constructs a separate intake structure for its project, intake velocities would be 0.5 foot per second or less. However, if the GCC intake is used, intake velocities could approach 2.0 feet per second. Adult razorback suckers, a species under review for classification as threatened or endangered (USF&WS, 1982), have been collected in recent years in this reach of the Colorado River (Valdez et al., 1982); however, the fact that only adult razorback suckers have been collected suggests their spawning areas are located downstream. Sampling conducted during 1983 resulted in the collection of a larval fish near the town of Parachute that has been tentatively identified as a razorback sucker (Union Oil Company, 1983). An occasional brown trout is the only game fish reported to occur in the reach of the Colorado River adjacent to the intake (CDM, 1983c). Therefore, minnows and suckers are the predominant species that would be subject to entrainment and impingement impacts.

Highest entrainment rates would be expected in July and August, when larval fish densities would be highest. Impingement rates are normally highest in late fall and winter when young-of-the-year (YOY) fish are moving from rearing areas to wintering areas. Based on flows in recent years, water withdrawal during the peak entrainment period would normally not exceed 1.5 percent, and at maximum, not exceed 2.5 percent of the Colorado River flow (USGS, 1979-1982). With an intake velocity of 0.5 foot per second, most YOY fish could avoid the intake if they desire; however, with an intake velocity of 2.0 feet per second, most YOY fish would not be able to avoid being carried into the intake.

Fish that are too large to be entrained are subject to impingement by the intake. With intake velocities of 0.5 foot per second or less, most YOY and larger fish can avoid the intake. However, many could inadvertently enter the intake. Based on the level of entrainment and impingement, and the type of fish that would be impacted, the aquatic community of the Colorado River should not be altered by water withdrawal at a velocity of 0.5 foot per second. With intake

Table 4.3-9. Average depletion by month for the Pacific Project (cfs)

Month	1962	1963	1964	1965	1966	1967	1968	1969-1976	1977	1978	1979	1980-1981
Oct	33.3	33.3	12.5	0	33.3	19.0	33.3	33.3	33.3	46.4	46.4	33.3
Nov	34.4	34.4	48.0	48.0	34.3	48.0	34.4	34.4	34.4	48.0	48.0	34.4
Dec	33.3	33.3	41.0	46.4	33.3	46.4	33.3	33.3	33.3	42.2	40.4	33.3
Jan	33.3	33.3	33.3	46.4	33.3	46.4	33.3	33.3	33.3	33.3	33.3	33.3
Feb	36.9	36.9	36.9	48.0	36.9	46.1	36.9	36.9	36.9	36.9	36.9	36.9
Mar	33.3	33.3	33.3	46.4	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
Apr	34.4	34.4	30.3	38.8	34.4	34.4	28.6	34.4	33.4	9.1	34.4	34.4
May	33.3	33.3	37.3	33.3	33.3	33.3	39.0	33.3	34.3	46.4	33.3	33.3
Jun	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	46.2	34.4	34.4
Jul	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	27.6	33.3	33.3	33.3
Aug	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	37.4	33.3	33.3	33.3
Sep	34.4	34.4	0	34.4	0	34.4	34.4	34.4	0	0	34.4	34.4

Source: CDM and Bio/West, Inc. (1983).

velocities of 2.0 feet per second, most YOY and many larger fish would be carried into the intake. With a withdrawal rate of 48 cfs, entrainment and impingement could cause a moderate impact on the fish populations of the river.

Despite the application of air emission control technologies, retorting and upgrading facilities and the electrical generating station would release minor amounts of SO_2 and NO_x that, when mixed with atmospheric moisture, could form acids which would return to earth as acid precipitation. The susceptibility of a lake to acidification is related to its pH and buffering capacity, and lakes with less than 200 μeq/l of alkalinity are most sensitive to acidification (Turk and Adams, 1982). In their studies on montane lakes in the Flat Tops Wilderness Area east of the Pacific Project area, Turk and Adams (1982) found that lakes with less than 200 μeq/l of alkalinity were generally above 11,000 feet in elevation. Under worst-case conditions, annual acid deposition from the Pacific Project is estimated to be less than 0.12 kg per hectare (Section 4.3.3.1). At this deposition rate, even the most sensitive aquatic ecosystems would not likely be adversely impacted (Environment Reporter, 1983).

The operation work force of the project would peak at approximately 3365 workers in the fourteenth year of the project and would remain at about that level for the duration of the 25-year project. Population-induced growth by the operation work force would create an additional 57,150 fishing trips annually. If the goal of 2.3 fish per fishing trip is met, an additional 131,000 fish would be harvested. As stated previously, the fish resource of the region is already being harvested at capacity. To prevent the fishery resource from being overharvested, a total of about 228,200 trout would need to be stocked annually in the region. Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch, which contain Colorado River cutthroat trout, can be expected to be overexploited, unless protected by regulation.

Accidental spills could occur during the truck or rail transport of chemicals, or by the rupture of the products pipeline. Chemicals that would be transported by truck, rail, and pipeline are discussed in Section 4.3.3.6. The severity of an impact on aquatic organisms would depend on quantity entering the stream, toxicity of the chemical, and the dilution rate within the stream. In the unlikely event that a major spill occurred, severe impacts on aquatic organisms could occur.

Abandonment

It is not expected that abandonment activities would have an adverse impact on the aquatic resources of the area. The termination of air emissions and water withdrawals could have a beneficial effect on the aquatic resources of the area.

4.3.3.8 Vegetation

Construction

Significant impacts on vegetation would occur during the construction phase of the project. During this period, approximately 638 acres would be cleared for facilities. Most of the construction activity would occur in Deer Park Gulch and

Scott Gulch, and would impact the vegetation types characteristic of the valley bottoms and side slopes. Table 4.3-10 is a summary of the project facilities and vegetation disturbances.

During construction, approximately 422 acres of limited-importance plant communities would be disturbed. This acreage represents 66 percent of the total disturbance. Limited-importance communities include those that are abundant on the project site, are of limited importance to wildlife, have limited productivity, are relatively easy to reclaim, and are widespread and abundant on a regional basis. On the Pacific property, these communities include: valley moist slope-mixed shrubland (VMM), greasewood shrubland (GWS), juniper woodland (JW), plateau drainage sagebrush shrubland (PDS), plateau grassland (PG), plateau-mixed shrubland (PMS), plateau sagebrush shrubland (PSS), valley grassland (VG), valley sagebrush shrubland (VSS), disturbed areas (D), and pasture (P).

The loss of the limited-importance plant communities would not be important when viewed on either a local or regional basis. The types that would experience the greatest percentage loss on the site are greasewood shrubland, pasture, valley grassland, valley moist slope-mixed shrubland, and valley sagebrush shrubland (see Table 4.3-10). These types are common locally and their loss would not represent an important impact.

Construction activities would also disturb approximately 212 acres of important plant communities (34 percent of the disturbed area). Important plant communities include those that are important to wildlife, have high levels of productivity, are of limited regional extent, or are difficult to reclaim. These communities include the following types: Douglas-fir woodland (DW), valley riparian woodland (VR), gambel oak woodland (GW), and valley dry slope-mixed shrubland (VDM).

The greatest impact associated with the important plant communities would be the loss of 31 percent of the valley riparian woodland habitat within the project site (see Table 4.3-9). This type provides important wildlife habitat and is also one of the most productive types within the area.

During the construction phase, impacts on special-status species could occur in Deer Park Gulch in conjunction with the construction of shops, warehouses, a raw shale storage area, and the construction of the mesa-top access road. The facility in Deer Park Gulch would impact approximately 15 percent of the known available habitat for dragon milkvetch (Astragalus lutosus) in Deer Park Gulch. Even though dragon milkvetch is currently considered to be a special-status species, the potential loss in Deer Park Gulch would only be moderately important. Dragon milkvetch is known to occur on numerous sites throughout the Piceance Basin, and also occurs on several other sites on the Pacific property. It is possible that with careful construction practices, the existing population could be avoided. The construction of the access road could influence populations of dragon milkvetch and Barneby's columbine (Aquilegia barnebyi). Populations of these species occur in the immediate vicinity of the proposed access road, and could be impacted, depending on the exact alignment of the road. Impacts to these two species would only be moderately important because both of these species are known to occur in numerous localities throughout the Piceance

Table 4.3-10. Summary of major construction-related surface disturbances that would be in limited-importance plant communities, important plant communities, and special-status species habitats[a]

	Vegetation types[b]																
	Limited-importance plant communities											Important plant communities				Special-status species habitats	
	GWS	JW	P	PDS	PG	PMS	PSS	VG	VMM	VSS	D	DW	GW	VR	VDM	BS	Total[c]
Construction facilities																	
Administration and service building, retort area, shale storage, shops, and warehouse		4.0 (1.6)	43.4 (17.6)					11.5 (4.6)	15.0 (6.1)	66.0 (26.7)	1.8 (0.7)		1.1 (0.4)	13.5 (5.5)	90.8 (36.7)		247.1
Retention pond - Deer Park Gulch									4.8 (16.3)	14.6 (49.5)				2.0 (6.8)	8.0 (27.1)	0.1 (0.3)	29.5
Construction area, explosives area	1.1 (2.2)									36.7 (74.1)				6.8 (13.7)	4.9 (9.9)		49.5
Tank farm		23.9 (40.0)									17.7 (29.6)			3.0 (5.0)	11.9 (19.4)	3.2 (5.4)	59.7
Main substation, oil upgrading, runoff detention pond	12.0 (8.1)		19.6 (13.3)						14.5 (9.8)	59.2 (40.2)					42.0 (28.5)		147.3
Intraplant corridor										14.6 (54.9)					12.0 (45.1)		26.6
Mesa-top access road		13.2 (24.0)			0.6 (1.1)	1.9 (3.5)	17.8 (32.4)	1.2 (2.2)		3.0 (5.5)					16.5 (30.0)	0.7 (1.3)	54.9
Terminal reservoir										23.7 (100.0)							23.7

[a]Values given in acres; values in parentheses represent percent of total acreage for each facility. Retorted shale disposal is considered to be an operational impact and is not included in this table.

[b]Abbreviations for the vegetation types are given in the text.

[c]Totals do not include impacts associated with service corridors, product pipelines, water intake structures, reservoirs, mine ventilation shafts.

Basin. In summary, construction activities would disturb approximately 4 acres of potential habitat for special-status species; this represents less than 1 percent of the total construction area.

Impacts on vegetation resulting from air pollution during the construction phase are expected to be negligible. The primary pollutant would be fugitive dust, which would not likely be harmful to the vegetation bordering the areas of construction.

Operation

The largest disturbance to existing vegetation associated with operation of the facility would be the disposal of retorted shale. Over the life of the project, the total disposal site disturbance would be 676 acres. Of this total, 309 acres (46 percent) would be in limited-importance plant communities, and 214 acres (32 percent) would be in important plant communities. Of the important plant communities, the loss of the riparian woodland type would be the most important because of its limited occurrence on both a local and regional basis.

In total, the loss of potential special-status species habitat would be approximately 153 acres (22 percent of the disturbance) during operation of the facility. This disturbance would occur in the barren slope type in the upper portions of Deer Park Gulch. The retorted shale disposal site would cover approximately 90 percent of the total known habitat and total known population of sun-loving meadowrue (*Thalictrum heliophilum*) on the Pacific property. Sun-loving meadowrue is a newly discovered and described species that has not yet been evaluated relative to its distribution. Because of the limited knowledge about this species, the loss of the population in Deer Park Gulch could represent a significant impact, depending upon actual construction practices in this area.

During operation, a variety of air pollutants would be produced from the retorting and upgrading processes. Emissions from these sources would be controlled in order to meet established air quality standards. As long as these standards are met, there is not likely to be any impact on the vegetation resulting from sulfur dioxide, nitrogen oxides, or particulates.

Abandonment

The greatest impacts from abandonment would be associated with the new landforms created by the project. The retorted shale embankment would support vegetation different from the types which currently grow in Deer Park Gulch.

4.3.3.9 Wildlife

Construction and operation of the Pacific Project would result in major impacts to wildlife. Habitat loss in lower valley areas, notably Deer Park and Scott gulches, would eliminate critical elk and mule deer winter range. Also, major impacts to wildlife would occur because of the regional influx of people that are either directly or indirectly associated with the project.

Plant site and retorted shale disposal

Both Deer Park Gulch and Scott Gulch are winter range for mule deer; Scott Gulch is within an area of critical winter range for this species (CDM, 1983d). The Colorado Division of Wildlife (CDW) has estimated that 687 acres of Deer Park Gulch are also within elk critical habitat. The proposed plant facilities, including the retorted shale disposal pile, would eliminate this critical elk winter range resource. Additionally, the loss of valley habitats, particularly riparian woodland and pastureland, would represent a loss of important habitats for chukar and many nongame bird and mammal species. Apart from the reduction of habitat in these gulches, noise and visual disturbances would degrade the quality of raptor nesting habitat among the nearby headwall cliffs. Golden eagles were nesting among the cliffs in both Deer Park and Scott gulches during the baseline period. Likely, the nesting sites in Deer Park Gulch would be impacted by the retorted shale disposal and attendant transport facilities to the headwall cliffs.

Roads, pipelines, powerlines, other corridors

The electric transmission line corridor alternatives are the Roan Creek corridor and the LaSal corridor. These are identical to the CCSOP alternatives and impacts to wildlife have been addressed in the EIS for that project (BLM, 1983b). In general, multipurpose corridors cause the least impacts to wildlife as habitat disturbances are spatially restricted.

Water storage and water conveyance

Alternative water storage facilities are a Federal reservoir, a private reservoir, and the GCC Reservoir. Impacts to wildlife from the GCC Reservoir are described in BLM (1983b). The other alternatives are existing reservoirs for which there would be no additional impacts to wildlife.

4.3.3.10 Cultural resources

The indicators of significance used in the analysis of cultural resources have been adapted from Federal Regulations (36 CFR 60.4) that set forth minimal criteria for determining whether or not a cultural resource is "significant," (that is, important enough to merit management consideration by projects that affect it). These criteria include:

- Sites associated with significant cultural events.
- Sites associated with significant persons.
- Sites that embody distinctive architectural or artistic features.
- Sites that have yielded or may be likely to yield information important in prehistory or history.

Eight cultural sites and isolated artifacts (two historic sites, four prehistoric sites, and two prehistoric isolates) were recorded in the project area during a Class III inventory. One of the prehistoric sites (5GF1101) was evaluated as being a significant cultural resource. Site 5GF1102 and 5GF1105 require subsurface testing before site significance can be determined. A Section 106/2b consultation was made with the BLM and SHPO, resulting in these determinations.

The proposed construction and operation activities would directly alter, damage, or destroy one insignificant historic site. None of the three significant prehistoric sites nor the rest of the insignificant resources would be directly impacted. Significant indirect adverse impacts could occur, however, as a result of construction and maintenance of the proposed project. These indirect impacts could include:

- Increased exposure of cultural resource sites as a result of construction and maintenance activities, such as additional access routes in the project area.

- Increased uncontrolled collection of the cultural resources (e.g., artifacts) by nonprofessional hobbyists, as recreational activity.

4.3.3.11 Visual resources

Proposed project components which have been addressed in the CCSOP DEIS (BLM, 1983b), or are existing or approved, or which were determined to be not visible from any sensitive viewpoint were not assessed further.

Construction

Visual resource impacts that would exceed the VRM Class guidelines would result from construction of the mesa-top access road. Major landform and moderate vegetation disturbances would result from construction of the road up the Cliff Route on the steep face (75 percent slope) of the Roan Cliffs. Extensive talus slopes would be created in this visually prominent location. This particular portion of the Roan Cliffs is visible both from the Roan Creek Road and I-70. Although I-70 carries high volumes of often scenery-conscious, recreation-oriented viewers, the situation is ameloriated to a certain extent by the fact that I-70 is 10 to 12 miles from the project area. It is anticipated that viewers would be attracted toward closer features of interest, such as the Colorado River, and more prominent portions of the Roan Cliffs. Visibility was, therefore, rated as low, resulting in insignificant impacts as seen from I-70. However, visibility is high from the Roan Creek Road which is oriented toward the project area intermittently over a distance of several miles and passes directly below the proposed site. The Roan Cliffs were rated as Visual Resource Management (VRM) Class II through the inventory. VRM Class II guidelines recommend that visual modifications "may be visible, but should not be evident." The strong degree of visual contrast (which would be seen by travelers in up to 200 cars per day on Roan Creek Road) would exceed these guidelines and be a significant adverse impact. Constructing the road up the Conn Creek Route would create less of a visual impact.

The construction camp would result in strong landform and vegetation contrasts in a VRM Class III area. This camp would be at least partially visible from the Roan Creek Road and would be a significant visual impact.

The electric transmission line would produce strong structure contrasts up the Roan Creek valley, a highly visible VRM Class III area, and would result in significant visual impacts.

The visitors center would provide the public with an understanding of the oil shale operations. Through such understanding, a greater public acceptance is likely. The visitor center is, therefore, seen as a positive ameliorating aspect of the project.

Other proposed facilities would either create only low landform, vegetation, and/or structure contrasts during construction or would be modified by low visibility conditions.

Operation

Visual impacts of project facilities would remain significant and adverse throughout the operational life of the project. No additional visual impacts from operations would be significant.

Abandonment

Significant impacts of the mesa-top access road on the face of the Roan Cliffs would remain for an indefinite period after abandonment. All other visual impacts would eventually be reduced through revegetation to insignificant levels.

4.3.3.12 Noise

Two sets of noise standards apply to the analysis of noise impacts: (1) noise standards enforced under the Occupational Safety and Health Act (OSHA) of 1971, presented in Table 4.3-11; and (2) the Colorado Civil Revised Statute 25-12-101, which sets noise limits at a distance of 25 feet from the property line on which the noise-producing activity occurs (Table 4.3-12). Any noise above the limits shown in Tables 4.3-11 and 4.3-12 constitutes a public nuisance under these Federal and state standards.

Noise source emissions

Three basic types of activities were considered in the noise assessment: roadway traffic, construction activities, and process equipment. Because sound pressure levels are additive logarithmically (e.g., two sounds of equal magnitude will increase the overall sound level by 3 decibels), only major noise sources were considered, because lesser sources would be masked and would not contribute to the overall noise level.

The Pacific Project is designed to meet good engineering practice standards, and it was assumed that all construction and operations would be in compliance with the Federal Occupational Safety and Health Administration and Mine Safety and Health Administration regulations for noise exposure. Very short-term noise sources (blasting) were not included in the assessment, as these effects will be considered in detail under the mine permit guidelines of the Colorado Mined Land Reclamation Board. It should be noted, however, that operations of many noise

Table 4.3-11. Permissible OSHA noise exposure limits[a,b]

Duration per day in hours	Sound level dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25	115

[a]Table G-16 in 29 CFR 1910.95.
[b]The OSHA standard limit also provides for a maximum sound level for impact of impulsive noise (e.g., blasting) of 140 dBA.

Table 4.3-12. Colorado noise limits

Zone	7:00 a.m. to next 7:00 p.m. dBA	7:00 p.m. to next 7:00 a.m. dBA
Residential	55	50
Commercial	60	55
Light industrial	70	65
Industrial	80	75[a]

[a]Because the noise-production activities on the property would be operating both day and night, it is the 75-dBA standard at the property line that must be met during construction and operation of the facility.

sources at one location (such as at a retort or power plant) were included as one 90-dBA source.

A modified version of the Federal Department of Transportation's STAMINA I computer model was used to estimate noise levels at grid receptors located across the area during both the construction and operations phases.

Construction. During the construction phase, it was assumed that five earthmoving machines (scrapers and dozers at 90 dBA each), four heavy-duty trucks, and two light-duty trucks would be operating simultaneously at the retort site in Deer Park Gulch and a like number in Scott Gulch. In addition, three earth movers, two heavy-duty trucks, and two light-duty trucks would be working on the roads in upper Deer Park Gulch, in Clear Creek valley between the retort and the upgrade facilities, and below the upgrade facility in Clear Creek valley.

Figure 4.3-5 shows the distribution of noise impacts resulting from the construction activity. From this figure, it can be seen that the 75-dBA noise isoline would extend beyond the property boundary in the Clear Creek valley during the construction of the roadway (most of which is off the property) and the power plant.

Operation. Figure 4.3-6 shows the distribution of noise during the busiest hour of the day, when the plant would be in operation. It was assumed that a train was moving in the vicinity of the upgrade facility at the same time that 400 cars and 3 buses were entering or leaving the plant vicinity. Buses and cars would generally be stopping at the parking lot about 3 miles away and employees would be transported to the plant site by shuttle bus. Thus, the assumed noise sources are considered to be a worst case; noise levels should be less than those calculated. The assumed noise sources, combined with the reflective character of the deep narrow canyon would result in a calculated maximum noise level exceeding 100 dBA in the vicinity of the roadway near the tank farm. High noise levels were also calculated near the emergency flare stack.

Secondary noise impacts would result from the population growth in the DeBeque and lower Clear Creek area, and from increased traffic in the Clear Creek corridor. Estimates of noise from traffic and trains in the Clear Creek corridor were estimated in the CCSOP DEIS to be from 55 to 77 dBA (BLM, 1983b), and this analysis is incorporated by reference in this document. Doubling these traffic estimates would increase the ambient noise at 50 feet by approximately 3 dBA.

Noise impacts from construction and increased traffic in the DeBeque area are expected to have only a minor adverse impact.

4.3.3.13 Land use and recreation

Project site land use

Construction. Onsite impacts from project components would involve the conversion of approximately 1200 acres of rangeland and approximately 100 acres of cultivated land in lower Scott Gulch to industrial uses. Assuming that grazing continues on lands not needed for industrial uses, this would result in the loss of approximately 240 AUMs and between 100 and 300 tons of hay production per year. Although conversion of this amount of rangeland could be considered significant to the individual leaseholders involved, it would not be a significant loss when viewed from a regional perspective. However, cultivated land is a high value resource in the region (as discussed in Section 2.13); thus, its conversion would be a significant impact.

Most project components (including the river pumping plant, terminal reservoir, retorted shale disposal site, the mesa-top access road, and onsite waste disposal site) are located on rangeland or vacant lands. The following components are exceptions and are further explained below.

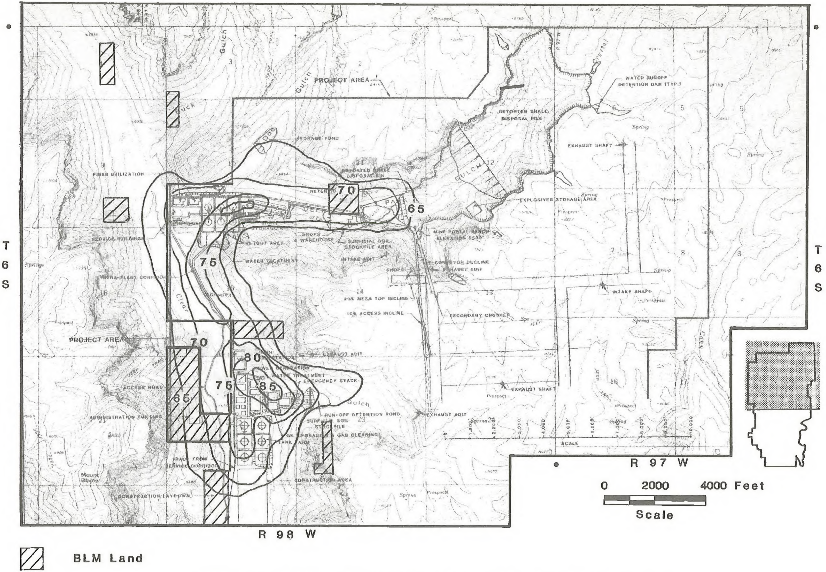


Figure 4.3-5. Construction noise level contours

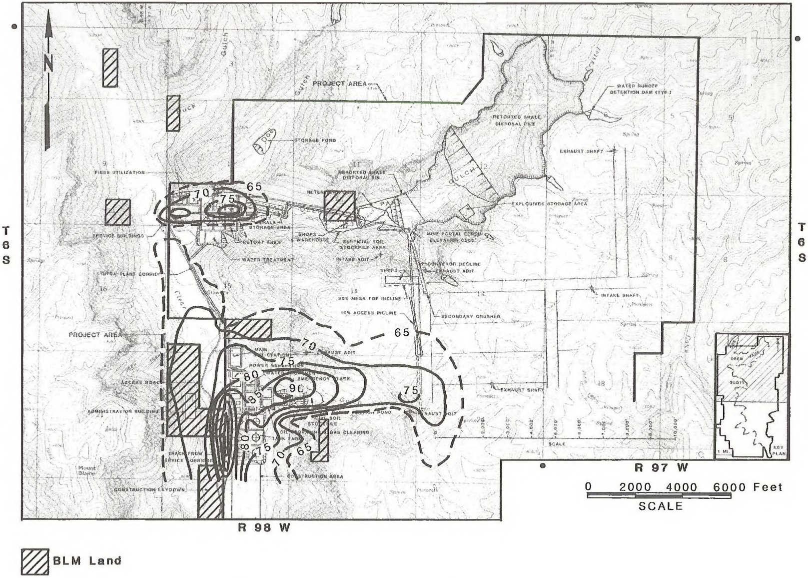


Figure 4.3-6. Operation noise level contours

- Deer Park Gulch/Scott Gulch plant site (including Scott Gulch hydrotreating site) - The proposed plant site, including the Scott Gulch facilities, would encompass approximately 344 acres. Of these, approximately 100 cultivated acres (85 acres in Deer Park Gulch, and 15 acres in Scott Gulch) would be significantly impacted.

- Water supply - The proposed use of Federal reservoirs (Ruedi and Green Mountain) would have no direct land use impact.

- Corridors - Land use impacts associated with the product pipeline corridors and electric transmission line corridor are presented in the CCSOP DEIS. The natural gas pipeline corridor and its effects on land use are discussed, in part, in BLM (1983b) and, in part, in the Colony FEIS (BLM, 1976); these are incorporated by reference in this document.

Operation. Impacts on land use during operation would be essentially the same as those during the construction phase.

Abandonment. Abandonment of the project would allow other land uses to be established; however, it is not possible at this time to forecast the nature of these future uses.

Project region land use

Increased population associated with project construction and operation would induce secondary land use changes in the region. Estimated changes are shown in Table 4.3-13. By the year 2009, the project-related population would result in the conversion of an estimated 1347 acres from existing uses. Most of these land use conversions would occur in Garfield County, 874 acres compared to 473 acres in Mesa County. Although a sufficient amount of developable land is available, these land use conversions may require the conversion of cultivated lands to nonagricultural uses. As noted in the Section 2.13.1, preservation of highly productive agricultural lands is an important priority in both the Mesa County and Garfield County land use plans. A significant impact would, therefore, result if the projected land use requirements are met through conversion of cultivated lands.

Recreation

Construction. The hydrotreating site and other Scott Gulch facilities would convert the area from the roaded natural and semiprimitive motorized Recreation Opportunity Spectrum (ROS) classes to the semiurban class, as these facilities would be a substantial modification of the natural environment. As well, the Deer Park Gulch plant site and retorted shale disposal area would change from the roaded natural and semiprimitive motorized classes to a semiurban class.

These recreational opportunity class changes would not be significant impacts because the property is, for the most part, privately owned and, thus, existing recreational use is limited to that allowed by the owners.

Operation. Impacts on recreation during operation would be essentially the same as those during the construction phase.

Table 4.3-13. Estimated land use requirements associated with increased project-related population (in acres)

	Garfield County	Mesa County	Total (Mesa and Garfield)
Residential[a]	708	342	1050
Commercial[b]	14	6	20
Industrial[c]	100	44	144
Public facilities[d]	466	201	667
Total	1288	593	1881

[a]Assumes housing type mix as follows: 55 percent single family, 30 percent multifamily, and 15 percent mobile home. Standard used for land requirements were: single family (3.5 units per acre), multifamily (20 units per acre), mobile homes (6 units per acre).

[b]Based on a standard of 1.5 acres per 1000 population.

[c]Based on a standard of 11 acres per 1000 population.

[d]Based on a standard of 12 acres per 1000 population for community facilities and a standard of 25 percent of total developed area for streets.

Abandonment. Abandonment of the project could allow other recreational uses to be established; however, it is not possible at this time to forecast the nature of these future uses.

Population increases associated with project construction and operation would increase use levels at recreation areas within the project region. Most of the increased use in dispersed activities (hunting, back-country camping, etc.) would occur on Federal lands, which account for the majority (98.5 percent) of the accessible recreational acreage within Mesa and Garfield counties. Use levels would also increase in nondispersed recreation activities (such as softball, tennis, etc.), which require facilities provided by local governments. These impacts are described in Section 4.3.3.14.

Table 4.3-14 presents estimates for increased use levels associated with the project-related population increase.

Project-related population increases and associated increases in recreational use are elements of an overall pattern of projected growth that would substantially influence the oil shale region.

As noted, most of the projected increased use would occur on Federal lands. However, it is difficult to allocate these uses to specific locations. Visitation to BLM Recreation Management Areas (RMAs) would increase, and would have the most significant impact on areas that are currently near or above carrying capacity, such as Grand Valley and Ruby Canyon/Black Ridge. Overall, with the possible exception of fisheries and a few developed areas that are already heavily used, it is expected that increased use of Grand Mesa, White River, and Uncompahgre national forests would not exceed carrying capacities as a result of

Table 4.3-14. Estimated increased activity days in selected activities resulting from project-related population increases, Mesa and Garfield counties[a]

	Camping (developed)	Camping (Back-country)	Fishing	Hunting	Downhill skiing	Snow-mobiling	Four-wheeling
1980[b]	423,300	526,300	904,900	551,300	316,200	157,100	1,015,200
1988[c]	4,920	18,270	31,440	19,140	10,980	4,760	26,445
1999[d]	12,305	32,540	55,980	34,090	19,550	8,465	47,112
2001[e]	12,560	33,220	57,150	34,800	19,960	8,640	48,008

[a]Increased activity days are estimated by applying participation percentage and participation rate factors from 1981 Colorado SCORP to estimated project-related population increases. (See Section 4.3.3.14 for population projections.)

[b]1980 use levels taken from Parachute Project Baseline Report.

[c]Year 4 - peak construction employment.

[d]Year 15 - overall peak employment.

[e]Year 17 - operation employment only.

project-related increased use levels. This conclusion is based on the fact that developed sites in national forests currently have a surplus capacity of approximately 166,000 activity days. Given a projected peak increased use of 12,560 activity days (Table 4.3-14), it is apparent that adequate capacity exists, even if all the projected increased use occurs in national forest lands.

Back-country camping use levels, which occur, to a large degree, in wilderness areas, would also increase and contribute to a potential decline in the quality of the wilderness experience. It is significant to note, however, that projected project-related increases are small relative to the existing level of use; the peak project-related increase in back-country camping is 33,220 activity days; this compares to an estimated 1980 use level of 526,300 in the two-county project region. It is likely that the majority of this increased visitation would occur in the Flat Tops Wilderness Area, and to a lesser extent, in other regional wilderness areas and Wilderness Study Areas (WSAs).

Because the "carrying capacities" of back-country areas are dependent upon several variables, such as individual tolerances of crowding, it is difficult to assess the effect project-related increased use would have on the quality of back-country experiences in the region and the amount of available carrying capacity that would be used. U.S. Forest Service officials estimate that current carrying capacities would be reached in the region's wilderness areas by the year 2000.

Fishing activity days are projected to increase by 57,150 during the peak period of employment. As described in Section 4.3.3.7, the fishery resource in the project region is already used at or above carrying capacity. The projected increased use, therefore, would result in degradation of the quality of fishing in the two-county project region, unless new reservoirs are developed, or other measures are taken to improve available habitats and increase productivity.

Hunting activity days are projected to increase by 34,800 during the period of project operation. This increase would be relatively minor when compared to existing use levels, but it can be assumed that the Division of Wildlife would manage the future allowable number of hunters to be compatible with wildlife production and available habitat. These increased activity levels may, therefore, force changes in management policies, such as restricting the number of licenses or the length of seasons within management units in the two-county region.

Effects on other uses, such as downhill skiing, snowmobiling, four-wheeling, and motorcycling, are expected to be minor because of the large number of available and proposed areas and facilities for these activities.

4.3.3.14 Socioeconomics

This section describes the social and economic impacts associated with the construction and operation of the 100,000-bpd Pacific Project. The process for determining the impacts is as follows: first, social and economic projections are made for the study area "Without" the Pacific Project. This set of projections is referred to as the "No-Action" alternative. Then projections are made for the same area "With" the Pacific Project. The differences between the with and Without project cases are defined as the project impacts. Projections are made for employment, demographic, economic, housing, education, public facilities and services, fiscal, and social impacts. The quantified projections are based on the Planning and Assessment System (PAS), which was developed by Mountain West Research - Southwest, Inc. Assumptions are based on information derived through the Cumulative Impacts Task Force (CITF) (see MWR, 1982). Projections of the fiscal balances and capital expenditure needs are made with the FISPLAN model, using PAS data inputs. The period covered is from the present to the year 2009. For purposes of this EIS, the estimated start of construction is 1985. The important assumptions are identified in the text at the points where the analyses are undertaken. Estimates of employment, local purchases, assessed valuation, and severance taxes have been provided by Pacific. It should be noted that the various computer-generated tables in this section may contain rounding errors such that totals may differ slightly from the sum of components.

Direct project employment, wages, and local purchases

Table 4.3-15 shows the estimated employment and wages for construction, operation, and local purchases. Construction employment would rise sharply to a first peak in 1988 at 2135 workers, would decline the next year, and would peak again in 1991 at 2130 workers. This would be followed by a pattern of decline that would last for more than a decade. Construction income (figured at $34,400 per worker per year in constant 1982 dollars) would follow the same pattern of increase and decline. Construction purchases would follow a somewhat different pattern and would depend on the type of construction being done at any one time. The peak year for construction purchases from the local area would be 1995, when purchases would amount to almost $36 million.

Operations employment would begin in 1987 and would rise annually to 3365 at full production in 1998. This level would be maintained for the remainder of the projection period. Direct basic income would follow the same pattern of increase. Average wages for operations workers are estimated to be $32,612 per year in constant 1982 dollars, and at full operation, this would produce almost $110 million of basic income annually for the study area. Annual local purchases during operations would rise with the increase in production until they reach $67.8 million in 1999, a level that would be maintained thereafter.

The peak year for total employment and wages paid would be 1999, when 3435 workers would be employed onsite. This work force would be made up of 70 construction and 3365 operation workers. Total wages paid in 1999 would be about $112 million in 1982 dollars. The peak in local purchases would be 1995, when almost $73 million would be spent on behalf of the project.

Residential allocation of work force

The allocation of direct-basic (onsite) employees to the local communities is based on information provided by Pacific and reviewed with local planning officials. This allocation for both the construction and operation periods is shown in Table 4.3-16. The allocation is necessarily speculative and depends importantly on Pacific having a single-status camp and encouraging its workers to live in areas (e.g., Battlement Mesa) best able to accommodate them. The construction work force is divided to identify local and nonlocal workers. These estimates show that about 62 percent of the local and 81 percent of the nonlocal construction work force would reside in Garfield County. Battlement Mesa is projected to house over 70 percent of the local construction workers from Garfield

Table 4.3-15. Pacific Project construction and operation employment and income - 1985-2009

Year	Construction	Operation	Total	Total wages[a]		Local purchases[a]	
				Construction	Operation	Construction	Operation
1985	230	--	230	7,912	--	700	--
1986	550	--	550	18,920	--	10,599	--
1987	1,655	160	1,815	56,932	5,218	25,801	--
1988	2,135	455	2,590	73,444	14,838	11,500	--
1989	885	900	1,785	30,444	29,351	7,399	--
1990	1,790	1,070	2,860	61,576	34,895	31,999	8,390
1991	2,130	1,220	3,350	73,272	39,787	21,900	13,389
1992	1,865	1,515	3,380	64,156	49,407	5,800	13,389
1993	1,325	1,825	3,150	45,580	59,517	5,800	17,389
1994	1,240	2,015	3,255	42,656	65,713	24,400	35,900
1995	1,240	2,075	3,315	42,656	67,670	35,900	37,059
1996	970	2,460	3,430	33,368	80,226	30,000	37,059
1997	295	2,965	3,260	10,148	96,695	16,800	54,089
1998	25	3,365	3,390	860	109,739	1,801	66,541
1999	70	3,365	3,435	2,408	109,739	--	67,830
2000	10	3,365	3,375	344	109,739	--	67,830
2001	--	3,365	3,365	--	109,739	--	67,830
2002	40	3,365	3,405	1,376	109,739	--	67,830
2003	55	3,365	3,420	1,892	109,739	--	67,830
2004	10	3,365	3,375	344	109,739	--	67,830
2005	--	3,365	3,365	--	109,739	--	67,830
2006	--	3,365	3,365	--	109,739	--	67,830
2007	--	3,365	3,365	--	109,739	--	67,830
2008	--	3,365	3,365	--	109,739	--	67,830
2009	--	3,365	3,365	--	109,739	--	67,830

[a]Thousands of 1982 dollars.

Source: Pacific (1983b).

Table 4.3-16. Residential allocation of Pacific Project work force

Place	Construction[a]		Operation
	Local	Nonlocal	Local
Garfield County (total)	0.620	0.806	0.620
Battlement Mesa	0.450	0.230	0.450
Parachute area	0.050	0.025	0.050
Rifle area	0.120	0.061	0.120
Pacific Construction Camp	--	0.490	--
Mesa County (total)	0.380	0.194	0.380
DeBeque	0.050	0.025	0.050
Grand Junction area	0.280	0.143	0.280
Palisade	0.030	0.016	0.030
Fruita	0.020	0.010	0.020

[a]Local and nonlocal personnel comprise 35 and 65 percent of the total construction employment, respectively.

Source: CITF (1983); Pacific (1983b); and Bureau of Economic Analysis (1983).

County, 45 percent of the total. The Pacific construction camp is expected to provide housing for about half of the nonlocal construction workers, with 23 percent going to Battlement Mesa, 6 percent going to Rifle, and the remaining 2.5 percent living around Parachute.

It is projected that 38 percent of the local construction work force would live in Mesa County, with the Grand Junction area accommodating the greatest number (28 percent of the total for both counties). Mesa County would house only 19 percent of nonlocal construction workers, and most of these (14 percent of the total) would live in the Grand Junction area.

It is projected that over 60 percent of the operations work force would opt to live in Garfield County, with Battlement Mesa providing about 45 percent of the total. Mesa County is expected to accommodate about 38 percent of these workers, with about 28 percent of the total selecting to live in the Grand Junction area.

Study area employment and income and population impacts

The Pacific Project is projected to produce employment and income both from its onsite construction and operations activities and from its purchases in the local area. This represents "basic" employment and income, because the demand comes from outside the study area. When the basic income is spent and respent in the local area, it creates additional jobs and income which are called nonbasic. The amount of nonbasic jobs and income that would be produced depends on several factors, including the ability of the local area to capture spending. The proportion of basic income that would actually be spent in the local area would depend on who the workers are and their obligations outside the study area. For local workers, the spending patterns are included in the PAS model. It is different for nonlocal workers, however. For example, construction workers with families living in other communities would be expected to spend less of their income in the study area than would workers with their families present or workers who were single.

Assumptions on family characteristics of nonlocal workers are those adopted by the CITF (i.e., 55 percent will be married with family present, 10 percent married with family absent, and 35 percent single). Income weights have been assigned to reflect the different spending patterns of these nonlocal workers and to estimate effective basic income. The weights estimate the effect of wages paid to nonlocal workers as compared to local workers who have a value of 1.0. The weights used are: 0.8 for the workers with family present; 0.35 for married workers with family absent; and 0.6 for single workers. This means that 80 percent, 35 percent, and 60 percent of the income of these respective categories of nonlocal workers were used to calculate the effects of their basic income on nonbasic employment and income in the study area.

In the economic hierarchy and market area definitions used by CITF, Garfield County is a second-order county and Mesa County is a fifth-order county, meaning that Mesa County serves as a trade and service center, providing a level of goods and services that is not available in Garfield County. Therefore, in the established market patterns, a certain proportion of the income to Garfield County residents would be spent in Mesa County, an activity that produces nonbasic employment and income in Mesa County. The amount and distribution of this economic activity to each sector of the county economy is accomplished by determining "gammas" (i.e., the ratio between total basic income and the nonbasic share assigned to each sector). The calculations and reiterations necessary to complete a presentation of the total county economy with the numerous variables involved is a key function of the PAS model.

One idea about the relationship between basic and nonbasic employment and income is that there would be a time lag between the production of basic income and the response by nonbasic elements of the economy. Although there has been much speculation about the appropriate timing of the nonbasic response, no empirically based theory has been developed. Through consultation with local leaders, a ratio of 75 percent/25 percent lag has been developed, where 75 percent of the nonbasic response would occur in the same period as the change in basic response, with the remaining 25 percent occurring in the next period. This lag structure has been incorporated into PAS model assumptions.

For this analysis, the nonbasic response to basic activity is assumed to remain constant over time. This means that the gammas (sector-specific multipliers for employment and income that are applied to effective basic income) remain constant for the projection period.

The level of purchases of materials and supplies from local businesses was provided by Pacific as was the distribution of these purchases by economic sector. CITF assumptions on the spatial distribution of these purchases were incorporated in the PAS projections.

The projections of employment and income for the No-Action alternative, without the Pacific Project, include the addition of a number of important assumptions about future basic employment and income in the study area. These assumptions are contained in the Basic Activity System (BAS) file for the PAS Model. The version of the BAS file used for this baseline projection was the CITF BAS file as of May 1, 1983. This list includes basic employment for Garfield and Mesa counties which is likely to occur over the next 20 years. It assigns future levels of growth to agriculture, manufacturing, and the basic components of trade, services, transportation, and communications. The BAS file also includes project-specific projections which were made for conventional oil and gas, coal, uranium, electric power generation, water projects, and other energy-related facilities such as transmission lines, pipelines, and railroads. In general, these estimates are conservative in that they deal only with existing projects or projects for which firm commitments have been made, useable project data are available, and development appears highly probable. The BAS file for the Pacific baseline projections included the changes in the basic employment by sector and the Union I Oil Shale Project as reviewed by the CITF. The Union I (10,000 bpd) project was the only oil shale project included in the No-Action projections.

Employment. Total employment projections are shown in Table 4.3-17 for the study area as a whole, and separately for Garfield and Mesa counties.

In 1999, study area employment is projected to be about 12 percent higher in the two-county area with the Pacific Project than without it at peak employment. It also means that unemployment would be less, up to 4.5 percent below the No-Action alternative. Although slight fluctuations in employment impacts are expected to occur after 1999 because of variations in Pacific's work force, this level of impact (which represents about an 11 to 12 percent increase over the existing conditions), would continue for the remainder of the projection period.

Garfield County would receive the majority of the employment impacts, about 52 percent from peak construction to 2009. In 1999, the impacts would increase the Garfield County employment to about 17,077, an increase of 3587 jobs or 26 percent more employment. For the remainder of the projection period, employment would continue at this same level, but the relative number of jobs would decrease slightly to 24 percent. These jobs would mostly effect the area of south-central Garfield County, where Rifle, Parachute, and Battlement Mesa are the major communities.

At peak employment, Mesa County's share of the employment impacts is projected to be 3335 jobs, about 48 percent of the 6923 total for the study area. Since Mesa County has a considerably larger work force to begin with, the Pacific Project employment would not make up nearly as large a proportion of total employment as would be the case for Garfield County. These 3335 jobs would be an increase of 7 percent from the No-Action alternative in 1999, a level of impact that would continue through 2009. The major location of these jobs would be the Grand Junction area, which serves as the market and trade center for the entire Western Slope.

Income. Labor income impacts are shown in Table 4.3-18. Generally, as would be expected, the income impacts would follow the pattern of the employment impacts. At the same time, there are some noteworthy differences that can be attributed to differential pay rates in the various economic sectors. For example, wage rates in the construction and mining sectors tend to be higher

Table 4.3-17. Summary of employment impacts by jurisdiction for Pacific

	GARFIELD COUNTY				TOTAL GARFIELD & MESA				MESA COUNTY							
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	11305	11305	0	0	47907	47907	0	0	36602	36602	0	0				
1981	13400	13400	0	0	52276	52276	0	0	38876	38876	0	0				
1982	14888	14888	0	0	54679	54679	0	0	39791	39791	0	0				
1983	14013	14013	0	0	53221	53221	0	0	39209	39209	0	0				
1984	12659	12659	0	0	51046	51046	0	0	38387	38387	0	0				
1985	12853	12626	227	1	51634	51289	345	0	38782	38663	118	0				
1986	13036	12464	572	4	52660	51718	942	1	39624	39254	370	0				
1987	14361	12512	1849	14	55575	52559	3015	5	41214	40047	1166	2				
1988	15304	12594	2709	21	57693	53364	4329	8	42389	40770	1619	4				
1989	14650	12682	1967	15	57354	54023	3330	6	42704	41341	1362	3				
1990	15744	12773	2971	23	59287	54018	5269	9	43544	41245	2298	5				
1991	16389	12846	3543	27	60130	53883	6246	11	43740	41037	2703	6				
1992	16513	12918	3595	27	60522	54439	6082	11	44009	41522	2487	6				
1993	16352	12993	3359	25	60745	54926	5818	10	44393	41933	2459	5				
1994	16525	13069	3455	26	61482	55230	6252	11	44957	42160	2796	6				
1995	16677	13148	3529	26	62087	55614	6473	11	45410	42466	2943	6				
1996	16848	13230	3617	27	62703	56026	6677	11	45856	42796	3059	7				
1997	16724	13313	3410	25	62993	56447	6546	11	46269	43133	3136	7				
1998	16923	13403	3520	26	63683	56874	6809	12	46760	43471	3289	7				
1999	17077	13490	3587	26	64239	57316	6923	12	47162	43826	3335	7				
2000	17118	13581	3536	26	64584	57733	6851	11	47467	44152	3314	7				
2001	17195	13671	3523	25	64802	57970	6832	11	47607	44299	3308	7				
2002	17328	13762	3565	25	65088	58194	6894	11	47761	44432	3329	7				
2003	17444	13857	3587	25	65353	58425	6928	11	47909	44568	3341	7				
2004	17502	13955	3546	25	65534	58664	6869	11	48032	44709	3323	7				
2005	17594	14058	3536	25	65770	58916	6854	11	48176	44858	3317	7				
2006	17703	14165	3538	25	66037	59179	6857	11	48334	45015	3319	7				
2007	17819	14277	3541	24	66319	59455	6864	11	48500	45178	3322	7				
2008	17939	14394	3545	24	66616	59744	6871	11	48676	45351	3325	7				
2009	18064	14515	3549	24	66925	60045	6879	11	48860	45530	3329	7				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-18. Summary of labor income impacts by jurisdiction for Pacific (1000s 1982 $$)

	GARFIELD COUNTY				TOTAL GARFIELD & MESA				MESA COUNTY							
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	167159	167159	0	0	746167	746167	0	0	579008	579008	0	0				
1981	230079	230079	0	0	864974	864974	0	0	634895	634895	0	0				
1982	256608	256608	0	0	902187	902187	0	0	645579	645579	0	0				
1983	238043	238043	0	0	871335	871335	0	0	633292	633292	0	0				
1984	210734	210734	0	0	829426	829426	0	0	618692	618692	0	0				
1985	215444	210532	4911	2	842450	834947	7503	0	627006	624415	2591	0				
1986	218277	206156	12121	5	861221	841496	19725	2	642944	635341	7603	1				
1987	246991	206781	40209	19	921895	857239	64656	7	674904	650458	24446	3				
1988	267601	208045	59555	28	966953	872179	94774	10	699353	664134	35219	5				
1989	254735	209399	45336	21	958607	883393	75213	8	703872	673994	29877	4				
1990	278842	210801	68041	32	999599	883507	116092	13	720756	672706	48050	7				
1991	292342	211825	80517	38	1018073	881189	136884	15	725731	669364	56367	8				
1992	295667	212830	82837	38	1027073	889871	137202	15	731406	677041	54365	8				
1993	293159	213882	79276	37	1030859	897496	133363	14	737701	683614	54087	7				
1994	297137	214946	82192	38	1044261	902404	141857	15	747124	687459	59665	8				
1995	299983	216037	83946	38	1054590	908531	146058	16	754608	692495	62113	9				
1996	304948	217179	87768	40	1068397	915069	153327	16	763450	697890	65559	9				
1997	304208	218338	85870	39	1075245	921751	153493	16	771037	703413	67623	9				
1998	309735	219585	90149	41	1090315	928522	161793	17	780581	708937	71644	10				
1999	312251	220785	91465	41	1099557	935539	164017	17	787307	714754	72552	10				
2000	312354	222057	90296	40	1104528	942197	162331	17	792174	720139	72035	10				
2001	313321	223284	90037	40	1105441	943446	161995	17	792120	720162	71957	10				
2002	315488	224535	90952	40	1110085	944703	165381	17	794597	720168	74429	10				
2003	317205	225825	91379	40	1114109	945988	168120	17	796905	720163	76741	10				
2004	317615	227166	90449	39	1114183	947324	166859	17	796568	720158	76410	10				
2005	318837	228567	90269	39	1115320	948720	166600	17	796484	720153	76331	10				
2006	320337	230035	90301	39	1116813	950183	166629	17	796476	720148	76328	10				
2007	321920	231567	90353	39	1118390	951710	166680	17	796471	720144	76327	10				
2008	323583	233172	90410	38	1120048	953312	166736	17	796466	720139	76326	10				
2009	325308	234839	90469	38	1121770	954975	166794	17	796462	720137	76325	10				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

than rates in the trade or service sector, and higher than the study area average for all sectors.

While the study area employment impacts were projected to be 12 percent over the No-Action alternative at peak employment, the income impacts at the same point would be expected to be 17 percent higher. Again, once the peak level is reached, the impacts would continue at that level over the remainder of the projection period, ranging from about $162 million to about $168 million. Not only would the income impact be higher because of the higher wage rates for the project workers, but the distribution of income impacts would be slightly different from employment impacts. The employment impact split between Garfield and Mesa counties at peak employment would be 52/48 for employment but it would be 56/44 for income impacts. This is because of the higher wage rates of the basic as compared to the nonbasic workers.

For Garfield County, the income impact in 1999 at peak employment would be $91 million, an increase of 41 percent over the No-Action projection. During the following decade, the impact declines slightly to about 38 percent more than the No Action figure. These rates of increase are substantially higher than those for employment, which ranged from 26 to 24 percent over the No-Action projections for the same time period.

In Mesa County, the income impacts would be significant but proportionately less than those shown for Garfield County. This is because Mesa County would receive much of the lower pay nonbasic employment, have a smaller proportion of the project-related jobs allocated to it, and, because of its much larger employment and income bases, record smaller percentage increases in response to the income impacts. Still, the income impacts of over $72 million would be large for the area. The annual income effects show a 10 percent impact for the county after 1999. As in the case of employment, the Grand Junction area would be the most affected by the income impacts because it is the area's market center.

Population

Population change is the result of births, deaths, and migration. Births and deaths produce natural increase (plus or minus), while migration produces positive or negative population change because of in- or out-migration. The rates of change in these demographic components were developed in conjunction with the CITF and local officials. Migration was divided into employment-related and nonemployment-related with the former being by far the most important. For the With Pacific alternative, employment-related population change is directly linked to the jobs generated by the project, both basic and nonbasic. The assumptions about the characteristics of the households associated with the workers are important in calculating the population impacts.

The estimated distribution of population to communities was accomplished by considering the residential characteristics of three categories of workers: direct basic, indirect basic, and nonbasic. Direct basic workers were allocated as shown in Table 4.3-16 by considering the location of the work site, transportation, community capabilities, and past experience as shown by survey data. Indirect basic employment would be created by project purchases, so the place of work for these people would depend on where purchases are made. Similarly, nonbasic jobs would exist in market centers where goods and services are purchased. The distribution of population effects for indirect basic and nonbasic workers is accomplished by a commuter matrix which identified their residential locations. Thus, population additions by county and community are based on increases in both basic and nonbasic employment. The population projections for the No-Action and the With Pacific alternatives are shown in Table 4.3-19. Included are figures for the entire study area, the counties, and the significant communities.

The population projections for the No-Action alternative anticipate little overall growth, about a quarter of 1 percent for the study area as a whole for the period 1983 to 2009. Garfield County shows a slight decline for the period (-0.1 percent average annual rate of change), most of it in the period 1983 to 1986 (a -2.1 percent average annual rate of change) following the shutdown of the recent oil shale activities. Battlement Mesa, Parachute, Rifle, and New Castle all show declines for the period 1983 to 2009, while Carbondale, Glenwood Springs, and Silt would expect slight increases. In Mesa County, the No-Action projections show a slight growth rate (0.4 percent average annual rate of change) with every community increasing except Collbran where the population decline is projected to be from 348 to 335 over the 26-year period.

The population growth rate With Pacific for the entire study area is projected to be twice that which would be experienced without the project. Population impacts would increase consistently throughout the projection period, reaching a maximum impact of 7 percent in the year 2009. This means that at the end of the projection period, the population would be 9842 higher with the project than without it, a significant increase even for an area of this size.

Of the 6433 people who would be added to the study area in 1999, over 70 percent, or 4628 would be in Garfield County. The distribution of the population is expected to be concentrated in the Battlement Mesa and Rifle communities. Battlement Mesa would receive about 50 percent of the county total, 2337, followed by Rifle's 845. These two communities would account for over 68 percent of the county total and almost 50 percent of the total for the study area.

By 2009, it can be expected that Garfield County would receive about 5906 more people with the project, 60 percent of the entire study area impacts. Battlement Mesa and Rifle would get about 3645 (37 percent) of the population impacts for the study area. This is over 60 percent of the Garfield County total. Of the remaining impacts (2261), 1161 would go to the communities of Glenwood Springs, Parachute, Carbondale, New Castle, and Silt. The other 1100 people would go to the communities in the eastern part of the county and to the unincorporated area.

Mesa County is projected to realize population impacts of about 1804 at peak employment in 1999, and around 3936 by the year 2009. These would be 28 percent of the total study area impacts for 1999 and about 40 percent in 2009. Since Mesa County has a much larger population base than Garfield County, these impacts would be a relatively modest proportion of the total population, 1 percent in 1999, and 4 percent in 2009. Grand Junction would receive 1420 people by 2009, a figure that is surpassed only by Battlement Mesa in Garfield County. However, the size of the city means that the population impacts would be only 2 percent in 1999 and 4 percent in 2009. These would be significant gains, but do not approach the rate of increase that would occur with the much smaller population base at Battlement Mesa.

Table 4.3-19. Summary of population impacts by jurisdiction for Pacific

Year	GARFIELD COUNTY				CARBONDALE				GLENWOOD SPRINGS				NEW CASTLE			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	22514	22514	0	0	1997	1997	0	0	4637	4637	0	0	563	563	0	0
1981	27052	27052	0	0	2103	2103	0	0	4858	4858	0	0	623	623	0	0
1982	29166	29166	0	0	2135	2135	0	0	4901	4901	0	0	671	671	0	0
1983	27535	27535	0	0	2164	2164	0	0	4923	4923	0	0	644	644	0	0
1984	26578	26578	0	0	2195	2195	0	0	4939	4939	0	0	634	634	0	0
1985	26310	25919	390	1	2195	2195	0	0	4936	4936	0	0	634	634	0	0
1986	26489	25806	683	2	2221	2221	0	0	4963	4963	0	0	637	637	0	0
1987	27614	25865	1749	6	2246	2246	0	0	4989	4987	1	0	641	586	55	9
1988	28771	26014	2756	10	2271	2270	1	0	5024	5011	12	0	647	589	58	9
1989	27874	26160	1713	6	2289	2289	0	0	5038	5032	6	0	650	591	58	9
1990	29559	26284	3274	12	2316	2309	6	0	5079	5048	31	0	656	594	62	10
1991	30536	26353	4183	15	2338	2322	15	0	5109	5062	46	0	662	595	66	11
1992	30707	26415	4291	16	2356	2334	22	1	5129	5074	55	1	666	597	69	11
1993	30461	26482	3979	15	2372	2345	26	1	5142	5084	58	1	669	598	70	11
1994	30650	26476	4173	15	2388	2349	38	1	5160	5090	69	1	672	599	73	12
1995	30765	26493	4272	16	2400	2356	43	1	5166	5095	71	1	674	599	74	12
1996	31013	26483	4529	17	2417	2361	56	2	5188	5098	90	1	678	600	78	13
1997	30783	26491	4292	16	2432	2368	63	2	5205	5099	105	2	681	600	81	13
1998	31040	26499	4541	17	2448	2375	73	3	5228	5099	129	2	685	600	85	14
1999	31156	26527	4628	17	2458	2382	75	3	5232	5099	133	2	686	600	86	14
2000	31178	26554	4623	17	2467	2389	77	3	5235	5098	136	2	687	600	87	14
2001	31239	26581	4658	17	2492	2396	96	4	5273	5097	176	3	693	600	92	15
2002	31340	26608	4731	17	2500	2403	97	4	5276	5097	179	3	694	600	93	15
2003	31417	26637	4780	17	2508	2409	99	4	5278	5096	181	3	695	600	94	15
2004	31467	26665	4801	18	2518	2415	102	4	5288	5096	191	3	697	601	96	16
2005	31635	26694	4941	18	2536	2421	114	4	5324	5096	227	4	706	601	105	17
2006	31859	26722	5137	19	2560	2427	133	5	5371	5096	275	5	717	601	116	19
2007	32104	26748	5356	20	2587	2433	153	6	5424	5095	328	6	729	601	128	21
2008	32379	26770	5609	21	2617	2438	178	7	5485	5094	391	7	743	601	142	23
2009	32693	26787	5906	22	2651	2443	208	8	5557	5092	465	9	759	601	158	26

Year	PARACHUTE				RIFLE				SILT				BATTLEMENT MESA AA			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	331	331	0	0	3215	3215	0	0	923	923	0	0	416	416	0	0
1981	902	902	0	0	5115	5115	0	0	1118	1118	0	0	1071	1071	0	0
1982	1189	1189	0	0	5552	5552	0	0	1178	1178	0	0	1877	1877	0	0
1983	926	926	0	0	5225	5225	0	0	1130	1130	0	0	937	937	0	0
1984	678	678	0	0	4827	4827	0	0	1105	1105	0	0	930	930	0	0
1985	686	680	6	0	4850	4840	10	0	1103	1103	0	0	1023	937	85	9
1986	687	671	16	2	4895	4850	44	0	1104	1104	0	0	927	705	221	31
1987	725	676	49	7	5046	4875	170	3	1111	1111	0	0	1356	705	650	92
1988	769	681	87	12	5267	4910	357	7	1119	1118	1	0	1913	705	1207	171
1989	736	685	50	7	5168	4941	226	4	1124	1123	0	0	1445	707	737	104
1990	806	690	116	16	5482	4970	512	10	1133	1129	4	0	2263	708	1555	219
1991	843	693	149	21	5677	4995	682	13	1142	1133	8	0	2745	702	2042	290
1992	851	697	154	22	5730	5017	712	14	1149	1137	11	1	2817	697	2119	303
1993	844	700	143	20	5715	5038	677	13	1153	1141	11	1	2675	695	1980	285
1994	854	703	151	21	5765	5055	710	14	1159	1145	14	1	2730	683	2047	299
1995	859	705	153	21	5790	5071	719	14	1163	1148	14	1	2750	676	2073	306
1996	873	708	165	23	5860	5084	776	15	1170	1151	19	1	2892	666	2226	334
1997	870	710	159	22	5861	5096	764	15	1175	1153	22	1	2802	659	2142	324
1998	885	712	172	24	5938	5107	831	16	1182	1155	27	2	2956	653	2302	352
1999	890	715	175	24	5963	5118	845	16	1185	1157	28	2	2990	653	2337	357
2000	892	717	174	24	5976	5128	847	16	1188	1159	29	2	2983	653	2330	356
2001	901	720	180	25	6033	5137	895	17	1198	1161	37	3	3013	654	2359	360
2002	906	722	183	25	6055	5148	907	17	1200	1162	37	3	3044	653	2390	365
2003	910	725	185	25	6074	5158	916	17	1203	1164	38	3	3065	654	2411	368
2004	913	728	185	25	6090	5169	921	17	1207	1166	41	3	3064	655	2408	367
2005	919	730	189	25	6129	5180	949	18	1220	1168	51	4	3075	656	2419	368
2006	928	733	194	26	6184	5190	993	19	1235	1170	64	5	3091	657	2434	370
2007	937	736	200	27	6243	5201	1042	20	1251	1172	79	6	3106	658	2449	372
2008	946	739	207	28	6310	5210	1099	21	1269	1174	95	8	3122	659	2463	373
2009	957	741	215	29	6386	5219	1167	22	1291	1175	115	9	3138	660	2478	375

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-19 (continued)

Year	MESA COUNTY				GRAND JUNCTION			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	81530	81530	0	0	28143	28143	0	0
1981	86101	86101	0	0	30045	30045	0	0
1982	87483	87483	0	0	30484	30484	0	0
1983	87944	87944	0	0	30693	30693	0	0
1984	88506	88506	0	0	30922	30922	0	0
1985	89401	89173	228	0	31296	31228	68	0
1986	90597	90262	335	0	31809	31693	116	0
1987	92006	91309	697	0	32373	32114	278	0
1988	93036	92179	856	0	32800	32450	350	1
1989	93443	92988	454	0	32734	32764	169	0
1990	94027	93276	751	0	33129	32827	302	0
1991	94255	93147	1107	1	33161	32686	474	1
1992	94700	93672	1028	1	33314	32874	439	1
1993	95012	94152	859	0	33406	33042	364	1
1994	95425	94587	837	0	33548	33194	354	1
1995	95826	94862	963	1	33688	33300	387	1
1996	96350	95215	1135	1	33868	33419	448	1
1997	96833	95527	1306	1	34034	33526	507	1
1998	97419	95806	1612	1	34241	33620	620	1
1999	97859	96054	1804	1	34396	33702	693	2
2000	98161	96277	1884	2	34496	33776	720	2
2001	98397	96488	1909	2	34574	33845	729	2
2002	98642	96693	1948	2	34658	33913	745	2
2003	98877	96898	1978	2	34736	33980	756	2
2004	99093	97105	1987	2	34806	34048	758	2
2005	99321	97316	2005	2	34883	34117	765	2
2006	99868	97528	2339	2	35067	34187	879	2
2007	100508	97741	2766	2	35282	34258	1023	3
2008	101245	97950	3295	3	35531	34328	1203	3
2009	102085	98149	3936	4	35814	34394	1420	4

Year	PALISADE				FRUITA			
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	1551	1551	0	0	2810	2810	0	0
1981	1781	1781	0	0	2991	2991	0	0
1982	1856	1856	0	0	3061	3061	0	0
1983	1808	1808	0	0	3079	3079	0	0
1984	1766	1766	0	0	3074	3074	0	0
1985	1785	1779	5	0	3098	3085	13	0
1986	1814	1799	14	0	3122	3103	19	0
1987	1861	1817	44	2	3178	3141	37	1
1988	1889	1832	57	3	3218	3172	46	1
1989	1871	1846	24	1	3227	3201	25	0
1990	1893	1844	49	2	3247	3206	41	1
1991	1896	1835	61	3	3251	3201	50	1
1992	1896	1841	55	3	3266	3220	46	1
1993	1888	1847	41	2	3276	3239	37	1
1994	1892	1852	39	2	3293	3256	36	1
1995	1896	1853	43	2	3310	3269	40	1
1996	1908	1857	51	2	3332	3285	47	1
1997	1913	1860	53	2	3351	3299	51	1
1998	1930	1862	67	3	3377	3313	64	1
1999	1942	1865	77	4	3396	3326	70	2
2000	1946	1867	79	4	3410	3338	72	2
2001	1949	1868	80	4	3423	3350	73	2
2002	1952	1870	82	4	3436	3361	74	2
2003	1955	1871	84	4	3449	3373	76	2
2004	1957	1873	83	4	3461	3385	76	2
2005	1959	1875	84	4	3474	3397	76	2
2006	1976	1877	99	5	3502	3410	91	2
2007	1997	1879	118	6	3533	3422	111	3
2008	2023	1881	142	7	3570	3434	135	3
2009	2054	1883	171	9	3611	3447	164	4

Year	DE BEQUE				COLLBRAN				TOTAL GARFIELD & MESA							
	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	279	279	0	0	342	342	0	0	104044	104044	0	0				
1981	344	344	0	0	348	348	0	0	113153	113153	0	0				
1982	380	380	0	0	348	348	0	0	116649	116649	0	0				
1983	350	350	0	0	348	348	0	0	115479	115479	0	0				
1984	353	353	0	0	348	348	0	0	115084	115084	0	0				
1985	365	356	9	2	347	347	0	0	115710	115092	618	0				
1986	382	359	23	6	347	347	0	0	117086	116067	1018	0				
1987	431	361	69	19	347	347	0	0	119621	117173	2447	2				
1988	454	364	90	24	347	347	0	0	121807	118193	3613	3				
1989	405	366	39	10	347	347	0	0	121316	119148	2168	1				
1990	445	368	77	21	347	347	0	0	123586	119560	4025	3				
1991	462	369	92	25	346	346	0	0	124791	119500	5290	4				
1992	454	371	82	22	346	346	0	0	125407	120087	5319	4				
1993	434	373	61	16	345	345	0	0	125473	120634	4838	4				
1994	432	374	58	15	345	345	0	0	126075	121064	5011	4				
1995	434	375	59	15	344	344	0	0	126591	121355	5235	4				
1996	445	376	69	18	344	344	0	0	127363	121698	5665	4				
1997	442	377	65	17	344	344	0	0	127617	122018	5598	4				
1998	462	378	84	22	344	343	0	0	128458	122305	6153	5				
1999	469	378	90	23	344	343	1	0	129015	122582	6433	5				
2000	468	379	89	23	344	342	1	0	129339	122831	6508	5				
2001	469	379	90	23	343	341	1	0	129636	123068	6567	5				
2002	473	380	92	24	342	340	2	0	129982	123302	6680	5				
2003	475	380	94	24	341	339	2	0	130294	123535	6759	5				
2004	475	381	93	24	340	338	2	0	130559	123771	6788	5				
2005	476	381	94	24	340	338	2	0	130957	124010	6946	5				
2006	483	382	101	26	340	337	3	1	131727	124250	7476	6				
2007	492	382	109	28	341	336	4	1	132612	124489	8122	6				
2008	503	383	119	31	342	336	7	2	133624	124720	8904	7				
2009	516	384	132	34	344	335	9	2	134778	124936	9842	7				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

DeBeque is expected to have the largest proportional increases in Mesa County, 23 percent in 1999 and 34 percent by 2009. Increases in numbers of people would be 90 in 1999 (peak employment) and 132 by 2009. The population impacts in other communities would range from 2 to 9 percent in the year 2009.

Housing

Existing housing characteristics were described in Section 2.14.4. During the late 1970s and early 1980s, there was a rapid increase in demand and an equally rapid expansion of the housing stock. Battlement Mesa was established as a major residential area to house population growth related to oil shale development. The shutdown of the oil shale projects in mid-1982 dramatically slowed expansion of the housing stock. Prices in Garfield County declined between 10 and 30 percent and vacancy rates climbed. In the fall of 1982, only a third of the 280 new apartment units in Battlement Mesa were rented. In Mesa County, building activity was down by 30 to 40 percent below 1981 levels (DRI, 1983). Given this background, any new project would make a positive contribution to the housing sector of the study area economy.

Pacific proposes to house almost 50 percent of the nonlocal construction employees (about 32 percent of the total) in a construction camp. This facility would provide housing for up to 680 workers. The facility could be built near other Pacific facilities or at any suitable location that would provide easy access to the project site. The workers assigned to the construction camp are not distributed to the communities in the allocation process.

The future demand for housing units (the total number of housing units required at any time) is based on forecasts of households. The number of households is determined by the total number of people, the age structure, and the household size. The housing mix (single family, multifamily, and mobile homes) is estimated based on past experience and the type and location of demand. Table 4.3-20 shows housing demand for the period 1980 to 2009.

The No-Action forecasts for the study area, Garfield and Mesa counties, predict that the housing demand would increase from 41,633 in 1980 to 60,591 in 2009, a 1.3 percent annual rate of change. Single family units would decline from 67.4 to 61.2 percent; multifamily would increase from 19.4 to 24.7 percent; and mobile homes would increase from 13.2 to 14.2 percent. The forecasts for the With Pacific alternative anticipate growth of the housing demand to 65,073 in 2009, 7 percent greater than the No-Action alternative. The configuration of the housing stock would be 60.6 percent single family, 25.0 percent multifamily, and 14.4 percent mobile homes. There would be an increase in the proportion of mobile homes and multifamily units. Single family homes would be a slightly smaller proportion of the stock.

For the period 1980 to 2009, Garfield County housing demand would be expected to record an annual growth rate of 1.3 percent for the No-Action alternative and 2.0 percent for the With Pacific alternative. The housing demand was 9360 in 1980 and is projected to increase to 13,741 and 16,490 with the No-Action and With Pacific alternatives, respectively, by 2009. In 1980, the housing mix was 58.9 percent single family, 22.4 percent multifamily, and 18.7 percent mobile homes. For the No-Action alternative in 2009, these percentages are: 52.2 percent single family, 27.3 percent multifamily, and 20.5 percent mobile homes. The With Pacific alternative forecasts are 51.5 percent single family, 27.7 percent

Table 4.3-20. Summary of changes in housing demand for Pacific

Year	GARFIELD COUNTY With Project	No Action	Impact Number	%	CARBONDALE With Project	No Action	Impact Number	%	GLENWOOD SPRINGS With Project	No Action	Impact Number	%	NEW CASTLE With Project	No Action	Impact Number	%
1980	9360	9360	0	0	787	787	0	0	2046	2046	0	0	249	249	0	0
1981	11565	11565	0	0	845	845	0	0	2146	2146	0	0	276	276	0	0
1982	12668	12668	0	0	872	872	0	0	2178	2178	0	0	295	295	0	0
1983	12181	12181	0	0	898	898	0	0	2203	2203	0	0	289	289	0	0
1984	11475	11475	0	0	926	926	0	0	2228	2228	0	0	288	288	0	0
1985	11619	11376	242	2	939	939	0	0	2242	2242	0	0	291	291	0	0
1986	11988	11486	501	4	963	963	0	0	2268	2268	0	0	295	295	0	0
1987	13042	11625	1416	12	986	986	0	0	2292	2292	0	0	299	275	23	8
1988	13817	11795	2022	17	1008	1008	0	0	2317	2315	1	0	304	279	24	8
1989	13015	11969	1046	8	1027	1027	0	0	2335	2335	0	0	308	283	25	8
1990	14195	12133	2062	17	1049	1049	0	0	2365	2360	5	0	313	286	27	9
1991	14855	12279	2575	21	1070	1067	2	0	2391	2381	10	0	319	290	29	10
1992	14922	12419	2503	20	1089	1084	4	0	2412	2400	11	0	324	293	30	10
1993	14696	12551	2145	17	1105	1100	5	0	2429	2417	11	0	328	297	31	10
1994	14846	12652	2194	17	1122	1112	9	0	2448	2433	14	0	332	300	32	10
1995	15000	12756	2244	17	1137	1125	11	1	2462	2447	14	0	336	303	33	11
1996	15102	12865	2237	17	1155	1139	16	1	2486	2464	21	0	341	306	35	11
1997	14825	12967	1858	14	1171	1152	19	1	2505	2478	27	1	346	309	37	12
1998	14913	13059	1854	14	1187	1163	23	2	2527	2489	37	1	351	312	39	12
1999	15092	13159	1933	14	1201	1175	25	2	2541	2500	40	1	355	314	40	12
2000	15175	13247	1927	14	1213	1186	26	2	2552	2510	42	1	358	317	41	13
2001	15381	13330	2051	15	1246	1196	49	4	2609	2518	90	3	368	319	48	15
2002	15531	13409	2122	15	1257	1206	50	4	2619	2526	92	3	371	321	49	15
2003	15645	13473	2171	16	1266	1214	52	4	2627	2532	94	3	373	323	50	15
2004	15716	13533	2182	16	1275	1221	54	4	2637	2537	100	3	377	325	52	16
2005	15857	13599	2258	16	1289	1229	59	4	2659	2542	116	4	383	327	56	17
2006	16017	13655	2361	17	1304	1236	68	5	2684	2547	137	5	390	328	61	18
2007	16174	13699	2475	18	1320	1242	77	6	2710	2549	160	6	397	330	67	20
2008	16331	13728	2603	19	1335	1246	89	7	2738	2549	188	7	405	331	74	22
2009	16490	13741	2749	20	1352	1249	102	8	2768	2546	221	8	414	331	82	24

Year	PARACHUTE With Project	No Action	Impact Number	%	RIFLE With Project	No Action	Impact Number	%	SILT With Project	No Action	Impact Number	%	BATTLEMENT MESA AA With Project	No Action	Impact Number	%
1980	142	142	0	0	1290	1290	0	0	355	355	0	0	154	154	0	0
1981	388	388	0	0	2057	2057	0	0	435	435	0	0	368	368	0	0
1982	514	514	0	0	2247	2247	0	0	463	463	0	0	626	626	0	0
1983	404	404	0	0	2152	2152	0	0	451	451	0	0	329	329	0	0
1984	297	297	0	0	2026	2026	0	0	447	447	0	0	326	326	0	0
1985	302	301	1	0	2056	2054	1	0	452	452	0	0	351	328	22	6
1986	305	300	5	1	2096	2085	11	0	457	457	0	0	321	263	58	22
1987	321	305	15	5	2167	2119	48	2	464	464	0	0	436	265	170	64
1988	340	309	31	10	2272	2155	117	5	471	471	0	0	621	266	354	132
1989	332	313	18	5	2267	2191	75	3	477	477	0	0	498	269	228	84
1990	362	318	44	13	2408	2227	180	8	485	484	0	0	764	272	492	181
1991	380	322	57	18	2509	2262	247	10	492	490	2	0	933	272	661	242
1992	387	326	60	18	2558	2296	262	11	498	496	2	0	976	273	702	257
1993	388	330	58	17	2581	2327	254	10	504	501	2	0	951	275	676	245
1994	396	334	62	18	2627	2357	269	11	510	506	3	0	981	273	707	258
1995	400	337	63	18	2660	2385	274	11	514	511	3	0	995	273	721	263
1996	411	341	69	20	2719	2416	303	12	521	516	5	1	1068	272	795	292
1997	416	345	70	20	2753	2444	309	12	526	520	6	1	1073	272	800	293
1998	427	349	78	22	2814	2470	344	13	533	524	8	1	1152	273	879	321
1999	433	352	80	22	2849	2495	354	14	537	528	9	1	1177	275	902	327
2000	437	356	81	22	2879	2518	360	14	541	532	9	1	1190	278	912	328
2001	449	359	89	25	2961	2540	421	16	554	535	19	3	1228	280	948	338
2002	454	362	91	25	2992	2562	430	16	558	538	19	3	1251	282	968	342
2003	459	365	93	25	3019	2580	438	17	561	541	20	3	1270	284	986	346
2004	463	368	95	25	3044	2598	445	17	565	544	21	4	1284	286	997	348
2005	469	371	97	26	3079	2617	462	17	572	546	26	4	1301	288	1012	350
2006	475	374	101	27	3119	2633	485	18	580	549	31	5	1318	290	1027	353
2007	482	377	104	27	3158	2648	510	19	589	551	37	6	1335	292	1042	356
2008	488	379	109	28	3198	2659	539	20	598	553	44	8	1350	294	1056	359
2009	494	381	113	29	3239	2667	571	21	607	554	53	9	1364	295	1069	362

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-20 (continued)

	MESA COUNTY				GRAND JUNCTION				PALISADE				FRUITA			
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	32273	32273	0	0	11720	11720	0	0	658	658	0	0	1026	1026	0	0
1981	34378	34378	0	0	12593	12593	0	0	752	752	0	0	1104	1104	0	0
1982	35246	35246	0	0	12885	12885	0	0	785	785	0	0	1142	1142	0	0
1983	35759	35759	0	0	13090	13090	0	0	773	773	0	0	1159	1159	0	0
1984	36305	36305	0	0	13294	13294	0	0	763	763	0	0	1170	1170	0	0
1985	36974	36897	76	0	13551	13528	23	0	775	773	1	0	1190	1185	4	0
1986	37718	37608	109	0	13846	13808	37	0	790	786	4	0	1210	1204	6	0
1987	38538	38320	217	0	14162	14078	83	0	811	798	12	1	1241	1229	11	1
1988	39225	38959	265	0	14419	14315	104	0	826	810	16	2	1267	1252	14	1
1989	39721	39574	147	0	14596	14543	52	0	827	821	6	0	1283	1275	8	0
1990	40264	40028	236	0	14783	14693	90	0	840	827	13	1	1302	1290	12	1
1991	40663	40289	374	0	14909	14751	158	1	847	830	17	2	1316	1300	16	1
1992	41167	40813	354	0	15090	14941	149	1	854	839	15	1	1334	1319	14	1
1993	41619	41313	306	0	15249	15120	128	0	859	848	10	1	1351	1338	12	0
1994	42077	41774	302	0	15413	15287	126	0	866	856	10	1	1368	1356	12	0
1995	42561	42208	353	0	15589	15448	141	0	875	863	11	1	1387	1373	13	1
1996	43116	42678	437	1	15791	15618	172	1	888	872	15	1	1409	1392	17	1
1997	43650	43112	537	1	15987	15775	212	1	899	880	19	2	1429	1409	20	1
1998	44196	43515	680	1	16188	15920	267	1	914	887	27	3	1452	1426	26	1
1999	44660	43893	766	1	16358	16057	300	1	925	894	31	3	1470	1441	28	2
2000	45079	44268	811	1	16510	16192	317	2	934	901	33	3	1487	1457	30	2
2001	45442	44609	833	1	16640	16314	326	2	942	908	33	3	1503	1472	31	2
2002	45814	44955	858	1	16775	16439	336	2	949	914	35	3	1519	1487	32	2
2003	46151	45271	880	1	16897	16552	344	2	956	920	36	3	1533	1501	32	2
2004	46459	45564	894	2	17007	16657	350	2	962	926	36	4	1547	1514	33	2
2005	46779	45868	911	2	17123	16766	356	2	969	931	37	4	1561	1527	34	2
2006	47222	46169	1053	2	17280	16873	407	2	982	937	44	4	1581	1541	40	2
2007	47669	46434	1234	2	17440	16967	472	2	995	942	53	5	1602	1553	48	3
2008	48123	46664	1459	3	17601	17048	553	3	1010	946	64	6	1623	1564	58	3
2009	48582	46850	1732	3	17763	17113	650	3	1027	950	77	8	1645	1574	70	4

	DE BEQUE				COLLBRAN				TOTAL GARFIELD & MESA							
Year	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %	With Project	No Action	Impact Number	Impact %
1980	134	134	0	0	159	159	0	0	41633	41633	0	0				
1981	163	163	0	0	162	162	0	0	45943	45943	0	0				
1982	183	183	0	0	164	164	0	0	47914	47914	0	0				
1983	168	168	0	0	165	165	0	0	47940	47940	0	0				
1984	171	171	0	0	166	166	0	0	47780	47780	0	0				
1985	177	173	3	2	167	167	0	0	48592	48273	319	0				
1986	184	175	8	4	168	168	0	0	49706	49095	610	1				
1987	203	178	25	14	170	170	0	0	51580	49945	1634	3				
1988	213	180	33	18	171	171	0	0	53041	50753	2287	4				
1989	195	182	13	7	172	172	0	0	52736	51542	1193	2				
1990	211	184	27	15	173	173	0	0	54459	52160	2298	4				
1991	218	186	32	17	174	174	0	0	55519	52568	2950	5				
1992	216	187	28	15	176	176	0	0	56089	53232	2857	5				
1993	209	189	19	10	177	177	0	0	56315	53864	2451	4				
1994	209	191	18	9	177	177	0	0	56923	54426	2496	4				
1995	211	192	18	9	178	178	0	0	57561	54963	2597	4				
1996	218	194	23	12	180	180	0	0	58218	55543	2675	4				
1997	220	196	24	12	181	180	0	0	58475	56080	2395	4				
1998	231	197	34	17	182	181	0	0	59109	56574	2534	4				
1999	236	198	37	18	183	182	0	0	59752	57053	2699	4				
2000	238	200	37	18	183	182	0	0	60254	57515	2738	4				
2001	240	201	38	19	184	183	0	0	60822	57938	2884	5				
2002	243	202	40	20	185	184	1	0	61344	58364	2980	5				
2003	245	203	42	20	185	184	1	0	61796	58744	3051	5				
2004	247	204	42	20	185	184	1	0	62174	59097	3077	5				
2005	249	205	43	21	186	185	1	0	62637	59467	3169	5				
2006	254	206	47	22	187	185	1	0	63238	59823	3415	5				
2007	259	207	51	24	188	185	2	1	63844	60133	3710	6				
2008	266	208	57	27	189	186	3	1	64454	60392	4062	6				
2009	273	209	63	30	190	186	4	2	65073	60591	4481	7				

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

multifamily, and 20.8 percent mobile homes. The annual demand of additional housing units for the With Pacific alternative for Garfield County are shown in Table 4.3-20.

The most dramatic increase would take place at Battlement Mesa, where the demand would be more than triple the projected demand without the project. The estimated housing demand in Rifle would be 571 more units in 2009 with the project, a 21 percent impact. A similar proportional impact is forecast for the housing demand in New Castle and Parachute in 2009, 24 and 29 percent more units with Pacific, respectively, as compared to the No-Action alternative.

Mesa County is a more urban area with a much larger housing stock. The PAS estimate for 1983 is that the county has 35,759 units. With the project, the total housing demand in 2009 is estimated to be 48,582, a 1.1 percent average annual rate of growth (see Table 4.3-20). There would be no important change in the housing mix.

Grand Junction would receive the largest increase in housing units. In the year 2009, the Grand Junction housing demand would increase by 650 units. For Palisade, an increase of 77 units is expected. DeBeque would experience the largest proportional impacts, with a demand increase of 30 percent, or 63 more units.

Thus, the housing demand generated by the Pacific Project would be significant, adding 4481 units or 7 percent to the study area by the year 2009. Experience in the recent past shows that the local housing industry is capable of meeting the level of demand forecast in this case. However, a critical element in the analysis is the fact that Battlement Mesa has a well-developed capability to meet future housing demand. Necessary improvements, such as streets, water, community facilities, and planning for housing needs have already been accomplished. Other communities have also upgraded their ability to provide housing in anticipation of impacts from oil shale development.

Education

Projections for the school-age population have been made for five school districts in the study area: RE-2 and RE-16 in Garfield County, Joint District No. 49 (which includes DeBeque and part of eastern Garfield County), and District Nos. 50 and 51 in Mesa County. The background and current conditions in each district are discussed in Section 2.14.

Table 4.3-21 shows the school-age population projections for each school district over the forecast period, 1980 to 2009. For the No-Action alternative, the total population would be expected to remain generally stable for the forecast period while the school-age population would be expected to decline. This would occur mostly because of the fertility rates and the age structure of the population. The trend toward smaller average family size means that in a stable population there will be fewer school-age children. The average annual rate of change for all five school districts over the period 1983 to 2009 will be -0.7 percent. Every district shows a negative average annual rate of change with Mesa County Valley the smallest at -0.5 percent, followed by RE-2 and Joint District No. 49 with -1.6 percent, District No. 50 with -1.7 percent, and the largest proportional decline taking place in RE-16, -2.5 percent per year. While

Table 4.3-21. Summary of school-age population with Pacific

Year	DE BEQUE NO 49J With Project	No Action	Impact Number	%	GARFIELD CTY SCHOOL 2 With Project	No Action	Impact Number	%
1980	124	124	0	0	2117	2117	0	0
1981	141	141	0	0	2551	2551	0	0
1982	144	144	0	0	2691	2691	0	0
1983	129	129	0	0	2590	2590	0	0
1984	127	127	0	0	2501	2501	0	0
1985	118	118	0	0	2441	2383	58	2
1986	121	121	0	0	2471	2402	69	2
1987	133	121	11	9	2528	2411	117	4
1988	138	122	16	13	2602	2434	168	6
1989	124	121	2	2	2600	2453	147	6
1990	134	121	12	10	2674	2462	212	8
1991	137	120	16	13	2720	2459	260	10
1992	134	120	14	12	2727	2450	277	11
1993	129	119	9	7	2723	2448	274	11
1994	128	118	9	7	2730	2440	289	11
1995	128	116	11	9	2708	2412	296	12
1996	129	115	13	11	2690	2373	316	13
1997	125	114	11	10	2651	2333	317	13
1998	128	112	16	14	2617	2283	333	14
1999	129	110	19	17	2543	2208	335	15
2000	126	107	19	18	2476	2140	335	15
2001	124	104	19	18	2407	2070	336	16
2002	121	101	20	20	2342	2004	337	16
2003	119	98	21	21	2280	1943	337	17
2004	116	95	20	21	2224	1888	336	17
2005	113	92	20	22	2181	1838	342	18
2006	112	90	21	24	2149	1797	351	19
2007	111	88	23	26	2128	1766	362	20
2008	112	86	25	29	2119	1744	374	21
2009	113	85	27	32	2120	1729	390	22

Year	GRAND VALLEY SCHOOL NO 16 With Project	No Action	Impact Number	%	PLATEAU VALLEY SCHOOL 50J With Project	No Action	Impact Number	%
1980	321	321	0	0	500	500	0	0
1981	643	643	0	0	447	447	0	0
1982	917	917	0	0	430	430	0	0
1983	547	547	0	0	403	403	0	0
1984	470	470	0	0	386	386	0	0
1985	518	494	24	5	374	374	0	0
1986	502	441	60	13	365	365	0	0
1987	639	459	180	39	359	359	0	0
1988	786	471	314	66	354	354	0	0
1989	648	481	166	34	350	350	0	0
1990	881	485	396	81	345	345	0	0
1991	1009	482	527	109	341	341	0	0
1992	1026	476	550	115	336	336	0	0
1993	992	470	522	111	334	334	0	0
1994	1020	461	559	121	332	332	0	0
1995	1031	449	582	129	329	328	1	0
1996	1065	434	631	145	327	325	2	0
1997	1035	419	616	147	324	322	2	0
1998	1071	402	669	166	321	318	2	0
1999	1069	382	687	179	316	313	3	1
2000	1052	364	688	188	310	306	3	1
2001	1036	348	687	197	303	299	3	1
2002	1020	331	688	207	296	292	4	1
2003	997	316	681	215	289	285	4	1
2004	967	303	664	219	283	278	4	1
2005	942	292	650	222	277	272	4	1
2006	920	283	637	224	273	267	6	2
2007	900	276	623	225	271	262	8	3
2008	882	269	612	227	269	259	10	4
2009	867	266	600	225	270	257	13	5

Year	MESA COUNTY VALLEY SCHOOL With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1980	17659	17659	0	0												
1981	18158	18158	0	0												
1982	18066	18066	0	0												
1983	17828	17828	0	0												
1984	17782	17782	0	0												
1985	18045	17988	57	0												
1986	18411	18328	82	0												
1987	18894	18729	165	0												
1988	19302	19100	202	1												
1989	19543	19431	112	0												
1990	19760	19580	180	0												
1991	19840	19579	260	1												
1992	19733	19688	244	1												
1993	20074	19866	207	1												
1994	20158	19954	204	1												
1995	20197	19971	226	1												
1996	20220	19965	255	1												
1997	20148	19867	280	1												
1998	20022	19686	336	1												
1999	19796	19417	379	2												
2000	19414	19014	399	2												
2001	18979	18569	409	2												
2002	18533	18110	423	2												
2003	18088	17652	436	2												
2004	17657	17214	443	2												
2005	17256	16805	450	2												
2006	16960	16442	517	3												
2007	16737	16135	602	3												
2008	16590	15885	705	4												
2009	16523	15693	830	5												

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

these five systems had 21,497 school-aged children in their districts in 1983, they are projected to have only 18,030 in 2009 for the No-Action alternative.

The With Pacific alternative would result in significant additional school-age children in the study area. However, even with Pacific, the total number of school-age children would only be 19,893 in 2009, less than the 21,497 recorded for 1983. During the years of peak construction through 2003, there would be more school-age children than during 1983. In 1999, school-age population would reach 23,853. This means 1423 more children with the Pacific case than without it, a 6.3 percent increase. By 2009, the school-age population would have declined to 19,893 With Pacific, but the impact still would be about 1860, a 10 percent increase over the No-Action alternative.

Garfield County District No. RE-2 serves the communities of Rifle, New Castle, and Silt, and in 1983, contained about 2590 school-age children. The current maximum capacity is estimated at 3475. The peak number of children projected for the Pacific Project is 2730 in 1994. The impact, 290, would mean about an 11 percent increase over existing projections. The maximum impact would be 390 children in 2009, a 22 percent increase over existing projections. Because of the in-place capacity, it would appear that the district could accommodate this level of increased demand during the projection period.

Garfield County District No. RE-16 includes Parachute, the unincorporated community of Battlement Mesa, and the surrounding areas. The enrollment in 1983 was 547. Construction of two new schools at Battlement Mesa raised the capacity of the district to 1105. The district has no outstanding debt since the recent construction has taken place with assistance from the oil shale developers. The maximum school-age population for the district is forecast for 1999 at 1069, with 687 of these being because of the Pacific Project. This is a 179 percent increase over the No-Action alternative. By 2009, total school-age children with the Pacific Project would be 867, a 225 percent increase over the No-Action alternative. These projections show that the number of school-age children would not exceed the current capacity of the school district at any time during the forecast period.

Mesa County Joint District No. 49 serves DeBeque and parts of rural Mesa and Garfield counties. In 1983, there were 129 school-age children in the district and a maximum enrollment capacity of about 180 to 190. The No-Action forecast shows generally declining numbers of school-age population and the With Pacific alternative shows relatively small impacts. The peak impact is expected to occur in the year 2009 when 27 additional school-age children would be in the district, a 32 percent increase over current forecasts. Maximum enrollment would be 138 in 1988, well below the enrollment capacity and below the previous maximum enrollment of 144 in 1982.

Plateau Valley School District No. 50 serves the communities of Collbran, Mesa, Plateau City, and Molina. The district had 403 school-age children in 1983, and was operating at capacity. The impacts from the Pacific Project would be 3 additional children in 1999 and an increase of 13 by 2009, when overall enrollment would be 270.

Mesa County Valley School District No. 51 serves Grand Junction, Fruita, Palisade, and surrounding portions of Mesa County. It is the largest district in the study area and contained 17,828 school-age children in 1983. The No-Action alternative projects gradual increases for the district until 1995 when annual decreases would begin to take effect. The No-Action total number forecast for 2009 is 15,693, a decline of more than 11 percent from the 1983 figure. The maximum impact as a result of the proposed project would occur in 2009 with 830 additional children. The Pacific impacts would increase the maximum number of school-age children in the district to 20,220 in 1996. The school district has an ability to accommodate approximately 600 to 900 additional students at the present time. For the No-Action alternative, the greatest number of additional school-age children would be 2143 more than the 1983 figure; for the With Pacific alternative, the number would be nearly 2400 higher.

The school districts within the region should be able to accommodate the projected impacts which would result from the Pacific Project. Operating costs are subsidized by the state equalization process which provides adequate resources for instruction, even during periods of rapid growth. The ability of the districts to meet requirements for capital expenditures depends on their bonding capacity and outside funding sources. For example, both RE-2 and RE-16 have received substantial funds for new facilities from the Oil Shale Trust Fund and from oil shale developers. These sources of capital funding can be considered a precedent for future needs caused by major resource development. Because of the size of the increases and the demands made upon school districts to provide education, the impact of increased school-age children must be considered to be important for RE-2 and RE-16 in Garfield County and Mesa County School District No. 51.

Public facilities, services, and fiscal impacts

The presentation of financial information on local facilities, services, and fiscal conditions quickly can become very involved and difficult to follow. This is because local jurisdictions operate under restraints imposed by a number of other public authorities, including state and Federal agencies, legislatures, constitutions, statutes, and the legal decisions pertaining to all these areas. Through the years, numerous revenue sources and expenditure obligations have developed for local jurisdictions. The purpose of this section is to take into account potential revenues, expenditures, and capital spending needs associated with the proposed action. Revenues and expenditures are based on current conditions for the appropriate jurisdictions and both categories are projected separately for the two alternative cases. All the revenue sources currently in effect are calculated based on present rates. All expenditures are forecast based on current levels of service. The differences between revenues and expenditures for the two alternatives using this approach are designated as the fiscal impacts.

Projections made in this way will show either positive or negative balances both annually and cumulatively. In fact, of course, local jurisdictions are required to balance their budgets annually and they are not allowed to accumulate deficits or surpluses except through the bonding process. Generally, budgets are balanced by increasing revenues or decreasing expenditures, as needed. Such adjustments are a normal part of the annual budgeting process.

It is not the purpose of the EIS to speculate about how future budgets might be balanced, a process that involves complex changes to numerous variables. Rather, the purpose is to isolate one variable which will represent the magnitude, duration, and direction (positive or negative) of fiscal impacts. By holding current tax rates, procedures, expenditure patterns, and levels of service constant, an exogenous variable (the difference between revenues and expenditures) is created.

The projections are the output of FISPLAN, a computer model which estimates revenues, expenditures, and capital requirements by jurisdiction. FISPLAN uses inputs from PAS; therefore, the projections are compatible with figures used in the sections above (i.e., employment, population, housing, etc.). Direct project additions to local revenues are specified (i.e., assessed valuation of the Pacific site for property taxes and severence taxes) but other tax base increases and decreases for jurisdictions are estimated by FISPLAN based on PAS inputs.

Table 4.3-22 shows the cumulative fiscal balances by jurisdiction for the years 1982 to 2009. Each column presents a running total of the net difference between revenues and expenditures for each jurisdiction or significant fund. If revenues exceed expenditures according to the FISPLAN projections, the difference is shown as positive; if expenditures exceed revenues, it is shown as negative. It is possible for the No-Action and the With Pacific columns to both show a negative cumulative balance but a positive impact. This happens when the negative balance is smaller with the project (a positive difference) than without it. It might be noted that impacts are shown for as early as 1982 for some jurisdictions. This is a function of the model which allocates certain capital expenditures in anticipation of demand. While these procedures may tend to overstate the expenditures in the short term, the model's assumptions are thought to be necessary to present a useful picture of the long-term conditions. The major focus of making these projections is for the long term, a period of more than 25 years altogether.

For Mesa and Garfield counties, as shown in Table 4.3-22, the projections estimate a total net fiscal impact with Pacific of about $325 million at the year 2009. This means that these two counties together would realize a net balance (revenues in excess of expenditures) of about $325 million more with implementation of the proposed action, as compared with a scenario without the project. However, these balances would not be equally distributed, and the greatest advantages would accrue to those jurisdictions that have access to the tax bases most positively affected by the Pacific Project. Garfield County would realize a significant increase in its property tax base as the Pacific facilities are added to the county's assessed valuation. As the regional market center, Mesa County would realize significant increases in sales tax revenues because of project-induced spending. This source of revenue would be even more important to Mesa County because of the restructuring of the sales tax shares, through which the county now collects a 2 percent levy on sales.

The cumulative balance for Garfield County shows a net positive balance of $285 million, over 87 percent of the total gain. This increase would be produced by dramatic increases in property taxes and severance taxes. Garfield County's assessed valuation for property tax increases from $124 million in 1982 to $1.8 billion in the first decade of the 21st century (an increase of almost 15 times), and local property taxes rise from $2.4 million to over $35 million per year. Severance taxes, which are less than $25,000 in 1983, would increase to over $1.6 million per year when the Pacific Project would be in full operation.

With its share of the net gain in income from the Pacific Project, it is clear that Garfield County's financial position would be greatly strengthened.

Table 4.3-22. Cumulative net fiscal impact with Pacific (1000s 1982 $$)

Year	GRAND JUNCTION ALL FUNDS With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-16600	-16411	-189	-1
1984	-41164	-40953	-211	-0
1985	-59987	-59783	-203	-0
1986	-74917	-74734	-182	-0
1987	-83691	-83582	-108	-0
1988	-97673	-98157	483	0
1989	-105537	-105430	-106	-0
1990	-113089	-113118	29	0
1991	-119677	-119918	240	0
1992	-125780	-126297	517	0
1993	-131779	-132629	850	0
1994	-137523	-138922	1399	1
1995	-142379	-144817	2437	1
1996	-147169	-149735	2565	1
1997	-151344	-154519	3175	2
1998	-155056	-159260	4203	2
1999	-158672	-163955	5282	3
2000	-162218	-168605	6386	3
2001	-165752	-173273	7521	4
2002	-169863	-178621	8757	4
2003	-173527	-183312	9784	5
2004	-177098	-187969	10871	5
2005	-180506	-192589	12083	6
2006	-183833	-197173	13341	6
2007	-187080	-201729	14649	7
2008	-190246	-206419	16173	7
2009	-193329	-210946	17617	8

Year	GRAND JUNCTION GEN FUND With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-9237	-9172	-65	-0
1984	-27444	-27369	-75	-0
1985	-36296	-36239	-56	-0
1986	-43925	-43899	-26	-0
1987	-49303	-49357	54	0
1988	-56050	-56394	343	0
1989	-60489	-60687	198	0
1990	-65260	-65616	355	0
1991	-68995	-69580	584	0
1992	-72296	-73176	879	1
1993	-75520	-76753	1232	1
1994	-78489	-80290	1801	2
1995	-81504	-84057	2552	3
1996	-84581	-87684	3102	3
1997	-87522	-91265	3742	4
1998	-90006	-94803	4796	5
1999	-92398	-98299	5900	6
2000	-94721	-101751	7029	6
2001	-97035	-105223	8188	7
2002	-99927	-109238	9310	8
2003	-102209	-112722	10513	9
2004	-104547	-116174	11626	10
2005	-106726	-119591	12864	10
2006	-108827	-122974	14146	11
2007	-110853	-126328	15474	12
2008	-112804	-129819	17014	13
2009	-114679	-133148	18469	13

Year	GRAND JUNCTION WATER With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-1633	-1511	-122	-8
1984	-4532	-4398	-134	-3
1985	-11980	-11835	-145	-1
1986	-18840	-18684	-155	-0
1987	-21782	-21621	-161	-0
1988	-28720	-28859	138	0
1989	-31848	-31546	-301	-1
1990	-34349	-34026	-323	-0
1991	-36849	-36508	-340	-0
1992	-39291	-38932	-358	-0
1993	-41729	-41350	-378	-0
1994	-44164	-43766	-398	-0
1995	-46589	-46474	-115	-0
1996	-48880	-48348	-532	-1
1997	-50697	-50135	-561	-1
1998	-52508	-51920	-588	-1
1999	-54317	-53703	-613	-1
2000	-56123	-55485	-637	-1
2001	-57927	-57265	-662	-1
2002	-59729	-59179	-550	-0
2003	-61693	-60969	-723	-1
2004	-63508	-62758	-750	-1
2005	-65322	-64545	-776	-1
2006	-67131	-66331	-800	-1
2007	-68936	-68115	-820	-1
2008	-70735	-69898	-837	-1
2009	-72528	-71679	-848	-1

Year	GRAND JUNTION SANITATION With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-5729	-5727	-1	-0
1984	-9187	-9185	-1	-0
1985	-11710	-11708	-1	-0
1986	-12151	-12149	-1	-0
1987	-12606	-12604	-1	-0
1988	-12901	-12903	2	0
1989	-13199	-13195	-3	-0
1990	-13480	-13476	-3	-0
1991	-13832	-13829	-3	-0
1992	-14192	-14189	-3	-0
1993	-14529	-14526	-3	-0
1994	-14869	-14865	-3	-0
1995	-14285	-14285	0	0
1996	-13707	-13702	-4	-0
1997	-13124	-13119	-5	-0
1998	-12540	-12535	-5	-0
1999	-11957	-11952	-5	-0
2000	-11374	-11369	-5	-0
2001	-10790	-10785	-4	-0
2002	-10206	-10203	-3	-0
2003	-9625	-9620	-5	-0
2004	-9041	-9036	-5	-0
2005	-8457	-8453	-4	-0
2006	-7874	-7869	-4	-0
2007	-7290	-7285	-4	-0
2008	-6706	-6701	-4	-0
2009	-6121	-6118	-3	-0

Year	FRUITA ALL FUNDS With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-3477	-3471	-5	-0
1984	-4764	-4758	-6	-0
1985	-6426	-6423	-2	-0
1986	-7497	-7497	-0	-0
1987	-9190	-9197	6	0
1988	-10310	-10338	28	0
1989	-11495	-11499	3	0
1990	-12642	-12652	10	0
1991	-13789	-13809	19	0
1992	-14917	-14947	30	0
1993	-16041	-16085	43	0
1994	-17139	-17212	73	0
1995	-18221	-18343	122	0
1996	-19261	-19410	148	0
1997	-20276	-20481	204	1
1998	-21275	-21553	278	1
1999	-22277	-22628	351	1
2000	-23281	-23710	428	1
2001	-24421	-24799	377	1
2002	-24786	-25239	453	1
2003	-25110	-25646	536	2
2004	-25428	-26049	620	2
2005	-25741	-26447	705	2
2006	-26043	-26842	799	3
2007	-26336	-27234	897	3
2008	-26619	-27637	1018	3
2009	-26891	-28024	1133	4

Year	FRUITA GEN FUND With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-4062	-4058	-4	-0
1984	-4825	-4820	-4	-0
1985	-5433	-5432	-1	-0
1986	-6028	-6029	1	0
1987	-6611	-6619	7	0
1988	-7190	-7214	24	0
1989	-7793	-7798	5	0
1990	-8358	-8369	11	0
1991	-8934	-8954	20	0
1992	-9497	-9527	30	0
1993	-10061	-10105	43	0
1994	-10603	-10676	73	0
1995	-11134	-11252	118	1
1996	-11675	-11823	147	1
1997	-12191	-12393	202	1
1998	-12687	-12962	275	2
1999	-13181	-13530	348	2
2000	-13682	-14107	425	3
2001	-14310	-14684	373	2
2002	-14364	-14814	449	3
2003	-14387	-14919	531	3
2004	-14405	-15020	614	4
2005	-14418	-15118	697	4
2006	-14420	-15212	791	5
2007	-14413	-15302	889	5
2008	-14398	-15402	1003	6
2009	-14372	-15488	1115	7

Year	FRUITA WATER With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	603	604	-1	-0
1984	100	101	-1	-1
1985	-289	-288	-1	-0
1986	-682	-680	-1	-0
1987	-1334	-1333	-1	-0
1988	-1755	-1759	3	0
1989	-2179	-2177	-2	-0
1990	-2608	-2606	-1	-0
1991	-3031	-3030	-1	-0
1992	-3460	-3459	-0	-0
1993	-3886	-3886	-0	-0
1994	-4315	-4315	-0	-0
1995	-4745	-4748	3	0
1996	-5178	-5178	0	0
1997	-5611	-5612	0	0
1998	-6047	-6049	1	0
1999	-6489	-6490	1	0
2000	-6927	-6929	1	0
2001	-7373	-7375	2	0
2002	-7617	-7619	1	0
2003	-7852	-7854	2	0
2004	-8087	-8090	3	0
2005	-8321	-8325	3	0
2006	-8555	-8560	4	0
2007	-8789	-8794	5	0
2008	-9022	-9033	11	0
2009	-9254	-9268	13	0

Year	FRUITA SANITATION With Project	No Action	Impact Number	%
1982	0	0	0	0
1983	-17	-17	0	0
1984	-39	-39	0	0
1985	-703	-703	0	0
1986	-787	-787	0	0
1987	-1245	-1245	0	0
1988	-1364	-1365	0	0
1989	-1523	-1523	0	0
1990	-1675	-1676	0	0
1991	-1823	-1823	0	0
1992	-1960	-1961	0	0
1993	-2092	-2093	0	0
1994	-2220	-2220	0	0
1995	-2341	-2342	1	0
1996	-2407	-2408	1	0
1997	-2473	-2474	1	0
1998	-2539	-2541	1	0
1999	-2605	-2607	1	0
2000	-2671	-2673	1	0
2001	-2737	-2739	1	0
2002	-2804	-2806	2	0
2003	-2870	-2872	2	0
2004	-2936	-2938	2	0
2005	-3001	-3004	2	0
2006	-3067	-3070	2	0
2007	-3133	-3136	3	0
2008	-3199	-3202	3	0
2009	-3264	-3268	3	0

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-22 (continued)

Year	RIFLE ALL FUNDS With Project	RIFLE ALL FUNDS No Action	RIFLE ALL FUNDS Impact Number	RIFLE ALL FUNDS Impact %	RIFLE GEN FUND With Project	RIFLE GEN FUND No Action	RIFLE GEN FUND Impact Number	RIFLE GEN FUND Impact %	RIFLE WATER With Project	RIFLE WATER No Action	RIFLE WATER Impact Number	RIFLE WATER Impact %	RIFLE SANITATION With Project	RIFLE SANITATION No Action	RIFLE SANITATION Impact Number	RIFLE SANITATION Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-39	-39	0	0	-38	-38	0	0	-99	-99	0	0	98	98	0	0
1984	-37	-37	0	0	-89	-89	0	0	-138	-138	0	0	190	190	0	0
1985	-25	-23	-2	-8	-128	-126	-2	-1	-180	-180	-0	-0	283	283	0	0
1986	111	119	-8	-6	-65	-56	-8	-15	-221	-221	-0	-0	397	396	0	0
1987	383	412	-29	-7	134	166	-32	-19	-264	-264	-0	-0	513	510	3	0
1988	566	634	-67	-10	239	314	-74	-23	-305	-304	-1	-0	632	624	7	1
1989	747	837	-89	-10	346	445	-99	-22	-349	-347	-1	-0	750	739	11	1
1990	776	974	-198	-20	319	508	-189	-37	-407	-388	-19	-4	864	854	10	1
1991	956	1224	-268	-21	365	630	-264	-42	-397	-375	-22	-5	988	969	18	1
1992	1151	1509	-357	-23	427	787	-360	-45	-388	-363	-25	-6	1112	1085	27	2
1993	1393	1838	-445	-24	534	987	-453	-45	-378	-350	-27	-7	1237	1201	35	3
1994	1725	2187	-462	-21	734	1208	-474	-39	-368	-338	-30	-9	1359	1317	42	3
1995	2094	2588	-494	-19	969	1481	-511	-34	-359	-325	-33	-10	1484	1433	51	3
1996	2464	2992	-528	-17	1203	1755	-552	-31	-350	-313	-36	-11	1610	1550	60	3
1997	2914	3394	-480	-14	1534	2028	-494	-24	-353	-301	-52	-17	1733	1667	66	4
1998	3484	3794	-310	-8	1971	2299	-328	-14	-345	-288	-56	-19	1858	1783	74	4
1999	4081	4193	-111	-2	2433	2569	-135	-5	-337	-276	-60	-22	1985	1900	84	4
2000	4695	4589	105	2	2912	2836	76	2	-329	-264	-65	-24	2112	2018	94	4
2001	5370	5025	344	6	3451	3142	309	9	-321	-252	-69	-27	2240	2135	105	4
2002	6056	5463	593	10	4003	3450	553	16	-313	-239	-74	-31	2366	2252	114	5
2003	6756	5901	855	14	4567	3758	809	21	-306	-227	-78	-34	2495	2370	124	5
2004	7455	6340	1115	17	5137	4067	1069	26	-303	-215	-88	-41	2622	2488	134	5
2005	8153	6780	1373	20	5711	4377	1333	30	-308	-203	-105	-51	2751	2605	145	5
2006	8878	7221	1657	23	6302	4688	1614	34	-302	-190	-111	-58	2878	2723	154	5
2007	9612	7662	1950	25	6900	4998	1901	38	-296	-178	-118	-66	3009	2842	166	5
2008	10352	8103	2248	27	7503	5309	2193	41	-291	-166	-124	-74	3140	2960	179	6
2009	11097	8544	2552	29	8111	5620	2490	44	-285	-154	-131	-85	3272	3078	193	6

Year	PARACHUTE ALL FUNDS With Project	PARACHUTE ALL FUNDS No Action	PARACHUTE ALL FUNDS Impact Number	PARACHUTE ALL FUNDS Impact %	PARACHUTE GEN FUND With Project	PARACHUTE GEN FUND No Action	PARACHUTE GEN FUND Impact Number	PARACHUTE GEN FUND Impact %	PARACHUTE WATER With Project	PARACHUTE WATER No Action	PARACHUTE WATER Impact Number	PARACHUTE WATER Impact %	PARACHUTE SANITATION With Project	PARACHUTE SANITATION No Action	PARACHUTE SANITATION Impact Number	PARACHUTE SANITATION Impact %
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-1230	-1102	-127	-11	-1101	-1029	-71	-6	-134	-77	-56	-73	5	5	0	0
1984	-1577	-1436	-140	-9	-1454	-1376	-78	-5	-128	-66	-62	-94	6	6	0	0
1985	-1914	-1768	-146	-8	-1803	-1721	-82	-4	-120	-54	-66	-121	10	8	2	27
1986	-2260	-2101	-159	-7	-2157	-2066	-91	-4	-114	-43	-70	-161	11	8	2	31
1987	-2562	-2428	-134	-5	-2492	-2408	-83	-3	-97	-31	-65	-208	26	11	15	128
1988	-2860	-2755	-105	-3	-2828	-2750	-77	-2	-76	-19	-57	-301	44	14	29	203
1989	-3209	-3082	-127	-4	-3187	-3093	-93	-3	-68	-6	-61	-970	46	17	28	165
1990	-3544	-3426	-118	-3	-3546	-3442	-103	-3	-71	-3	-67	-1903	73	20	53	263
1991	-3845	-3734	-110	-3	-3883	-3765	-117	-3	-52	8	-60	-734	89	22	66	293
1992	-4165	-4010	-155	-3	-4222	-4055	-166	-4	-39	20	-59	-298	96	25	71	280
1993	-4474	-4258	-216	-5	-4545	-4318	-226	-5	-29	31	-61	-192	100	27	72	259
1994	-4714	-4478	-235	-5	-4805	-4553	-252	-5	-16	43	-60	-137	107	30	77	254
1995	-4943	-4666	-276	-5	-5051	-4754	-296	-6	-4	55	-60	-108	112	32	80	245
1996	-5165	-4856	-308	-6	-5297	-4959	-337	-6	10	68	-57	-85	121	35	86	247
1997	-5365	-5052	-312	-6	-5506	-5169	-337	-6	15	79	-63	-80	125	37	88	235
1998	-5495	-5249	-246	-4	-5661	-5380	-280	-5	30	91	-60	-66	135	40	95	238
1999	-5627	-5449	-178	-3	-5812	-5595	-217	-3	43	103	-60	-58	141	42	99	233
2000	-5757	-5652	-104	-1	-5960	-5813	-146	-2	55	116	-60	-52	146	45	101	226
2001	-6177	-6033	-143	-2	-6244	-6109	-134	-2	-87	28	-115	-408	154	47	106	224
2002	-6310	-6244	-65	-1	-6391	-6335	-55	-0	-79	40	-120	-295	160	50	110	219
2003	-6438	-6455	16	0	-6533	-6561	28	0	-72	53	-125	-235	166	53	113	214
2004	-6562	-6665	103	1	-6670	-6787	116	1	-64	65	-130	-198	172	55	116	209
2005	-6677	-6876	198	2	-6801	-7013	212	3	-56	78	-134	-171	179	58	121	206
2006	-6784	-7086	301	4	-6925	-7240	314	4	-46	91	-138	-150	187	61	126	204
2007	-6886	-7297	410	5	-7045	-7466	420	5	-36	104	-141	-135	195	64	131	203
2008	-6981	-7507	525	7	-7160	-7693	532	6	-26	118	-144	-122	204	67	136	202
2009	-7071	-7718	647	8	-7270	-7919	649	8	-14	131	-145	-111	213	70	143	202

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-22 (continued)

Year	PALISADE ALL FUNDS With Project	No Action	Impact Number	%	PALISADE GEN FUND With Project	No Action	Impact Number	%	PALISADE UTILITY With Project	No Action	Impact Number	%	DEBEQUE ALL FUNDS With Project	No Action	Impact Number	%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	-158	-158	0	0	-35	-35	0	0	-123	-123	0	0	66	66	0	0
1984	-259	-259	0	0	-61	-61	0	0	-197	-197	0	0	-94	-80	-14	-17
1985	-2790	-2792	2	0	-86	-86	-0	-0	-2704	-2706	2	0	-107	-33	-73	-222
1986	-3088	-3093	5	0	-111	-110	-0	-0	-2976	-2983	6	0	-73	16	-90	-545
1987	-3403	-3408	5	0	-145	-134	-11	-8	-3257	-3274	17	0	-38	68	-106	-156
1988	-3683	-3701	18	0	-168	-156	-12	-8	-3514	-3545	30	0	-10	120	-131	-108
1989	-3956	-3979	23	0	-188	-174	-14	-8	-3767	-3804	37	1	28	175	-146	-83
1990	-4230	-4265	34	0	-204	-190	-14	-7	-4025	-4074	49	1	-268	-89	-178	-199
1991	-4494	-4550	55	1	-213	-204	-9	-4	-4281	-4346	64	1	-265	-63	-202	-316
1992	-4755	-4838	83	1	-210	-214	4	1	-4545	-4624	79	1	-253	-33	-219	-654
1993	-4992	-5110	117	2	-195	-222	27	12	-4797	-4888	90	1	-222	0	-223	-2687
1994	-5238	-5396	158	2	-169	-227	57	25	-5068	-5169	101	2	-153	39	-193	-486
1995	-5396	-5625	228	4	-113	-229	115	50	-5282	-5396	113	2	-72	80	-152	-190
1996	-5551	-5852	301	5	-54	-229	174	76	-5496	-5623	127	2	7	124	-117	-94
1997	-5478	-5882	404	6	35	-226	261	115	-5513	-5656	142	2	123	168	-45	-26
1998	-5400	-5934	534	9	151	-220	372	168	-5552	-5714	162	2	279	212	67	31
1999	-5327	-6000	672	11	276	-212	488	230	-5604	-5788	184	3	439	256	182	71
2000	-5259	-6074	815	13	406	-201	608	301	-5665	-5872	207	3	603	300	303	101
2001	-5199	-6150	951	15	531	-189	720	380	-5730	-5961	230	3	732	302	429	141
2002	-4670	-5771	1100	19	672	-174	846	485	-5343	-5596	253	4	864	304	560	184
2003	-4135	-5390	1254	23	817	-159	977	614	-4953	-5231	277	5	1001	307	693	225
2004	-3594	-5004	1410	28	968	-140	1108	791	-4562	-4864	301	6	1126	311	815	261
2005	-3046	-4615	1569	34	1124	-118	1243	1046	-4170	-4496	326	7	1221	316	904	285
2006	-2486	-4222	1735	41	1285	-95	1380	1447	-3772	-4126	354	8	1358	322	1036	321
2007	-1924	-3825	1900	49	1442	-69	1512	2167	-3367	-3755	388	10	1505	329	1176	357
2008	-1339	-3425	2085	60	1615	-42	1657	3931	-2954	-3383	428	12	1654	336	1318	391
2009	-738	-3021	2283	75	1794	-12	1806	14292	-2532	-3009	477	15	1807	344	1463	424

Year	DEBEQUE GEN FUND With Project	No Action	Impact Number	%	DEBEQUE UTILTY With Project	No Action	Impact Number	%	MESA COUNTY With Project	No Action	Impact Number	%	GARFIELD COUNTY With Project	No Action	Impact Number	%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	70	70	0	0	-4	-4	0	0	9048	9102	-53	-0	115	115	0	0
1984	-72	-72	0	0	-21	-7	-14	-181	-2464	-2405	-59	-2	1884	1884	0	0
1985	-53	-21	-31	-145	-53	-11	-42	-366	-4105	-4641	536	11	4047	4051	-3	-0
1986	-7	31	-39	-123	-66	-15	-50	-330	-3014	-3846	831	21	6224	6234	-9	-0
1987	31	88	-56	-64	-69	-20	-49	-244	-730	-2527	1797	71	8435	8406	28	0
1988	68	146	-77	-53	-78	-25	-53	-210	1472	-786	2258	287	11562	11498	63	0
1989	118	205	-87	-42	-89	-30	-59	-195	2534	1482	1051	70	16835	16830	5	0
1990	-59	53	-112	-211	-209	-142	-66	-46	4496	2660	1836	69	28265	24241	4024	16
1991	-35	94	-130	-137	-230	-158	-71	-45	7114	4431	2682	60	43031	33798	9233	27
1992	0	141	-140	-99	-254	-174	-79	-45	9894	7320	2573	35	60372	45452	14920	32
1993	55	191	-136	-71	-277	-190	-87	-45	12612	10378	2233	21	81132	59718	21413	35
1994	147	247	-99	-40	-301	-207	-93	-45	16181	13900	2281	16	106141	75728	30412	40
1995	251	306	-54	-17	-324	-225	-98	-43	19395	16673	2722	16	133886	92657	41228	44
1996	357	366	-9	-2	-349	-242	-107	-44	22827	19745	3081	15	164316	110737	53578	48
1997	501	428	73	17	-377	-259	-118	-45	26692	23012	3679	16	197305	128660	68645	53
1998	680	489	190	39	-400	-277	-123	-44	31013	26237	4776	18	231666	146439	85227	58
1999	866	551	314	57	-427	-294	-132	-44	35180	29665	5515	18	266378	164052	102326	62
2000	1057	613	443	72	-453	-312	-140	-44	39198	33216	5982	18	301103	181526	119576	65
2001	1208	630	577	91	-476	-327	-148	-45	43513	37196	6317	17	336163	198959	137203	69
2002	1363	647	716	110	-498	-343	-155	-45	48014	41316	6697	16	371388	216413	154975	71
2003	1523	665	857	128	-521	-358	-163	-45	53189	46217	6971	15	406900	233887	173013	74
2004	1686	684	1001	146	-559	-373	-186	-49	58496	51221	7275	14	442599	251382	191216	76
2005	1833	704	1128	160	-612	-388	-223	-57	63915	56290	7624	13	478552	268900	209651	78
2006	2003	725	1277	176	-644	-403	-241	-59	70252	61451	8801	14	514671	286438	228233	79
2007	2176	747	1429	191	-671	-418	-253	-60	76938	66672	10265	15	551030	303995	247035	81
2008	2353	769	1583	205	-698	-433	-265	-61	83990	71940	12050	16	587537	321567	265969	82
2009	2533	792	1740	219	-725	-448	-277	-61	91426	77234	14192	18	624298	339154	285144	84

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

Table 4.3-22 (continued)

	NEW CASTLE ALL FUNDS				NEW CASTLE GEN FUND				NEW CASTLE WATER				NEW CASTLE SANITATION			
Year	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1982	-146	-144	-1	-1	-90	-88	-1	-1	-19	-19	0	0	-36	-36	0	0
1983	-1030	-1028	-1	-0	-593	-592	-1	-0	-280	-280	0	0	-156	-156	0	0
1984	-1464	-1462	-1	-0	-1017	-1016	-1	-0	-271	-271	0	0	-174	-174	0	0
1985	-1497	-1495	-1	-0	-1040	-1039	-1	-0	-262	-262	0	0	-193	-193	0	0
1986	-1530	-1529	-0	-0	-1063	-1062	-0	-0	-254	-253	-0	-0	-212	-212	0	0
1987	-1561	-1558	-2	-0	-1085	-1083	-2	-0	-245	-245	0	0	-231	-230	-1	-0
1988	-1592	-1588	-4	-0	-1106	-1103	-2	-0	-236	-237	1	0	-250	-247	-3	-1
1989	-1624	-1618	-5	-0	-1127	-1124	-2	-0	-227	-229	2	1	-270	-265	-5	-1
1990	-1654	-1648	-6	-0	-1147	-1144	-2	-0	-217	-221	3	1	-289	-282	-6	-2
1991	-1684	-1675	-8	-0	-1166	-1162	-3	-0	-208	-212	4	1	-307	-300	-8	-2
1992	-1712	-1699	-12	-0	-1184	-1177	-6	-0	-199	-204	5	2	-328	-318	-10	-3
1993	-1741	-1720	-20	-1	-1202	-1189	-13	-1	-190	-196	6	3	-348	-335	-13	-3
1994	-1765	-1738	-27	-1	-1216	-1197	-19	-1	-180	-187	7	3	-368	-353	-15	-4
1995	-1788	-1752	-36	-2	-1228	-1201	-27	-2	-171	-179	8	4	-388	-371	-17	-4
1996	-1812	-1765	-46	-2	-1242	-1205	-36	-3	-161	-171	9	5	-408	-389	-19	-5
1997	-1834	-1779	-55	-3	-1253	-1209	-43	-3	-152	-162	10	6	-428	-406	-22	-5
1998	-1856	-1793	-62	-3	-1263	-1214	-49	-4	-142	-154	11	7	-449	-424	-24	-5
1999	-1876	-1807	-68	-3	-1273	-1219	-54	-4	-133	-146	12	8	-469	-442	-27	-6
2000	-1895	-1821	-74	-4	-1282	-1223	-58	-4	-123	-137	14	10	-490	-460	-29	-6
2001	-1915	-1835	-79	-4	-1290	-1228	-62	-5	-114	-129	15	11	-510	-478	-32	-6
2002	-1934	-1849	-84	-4	-1298	-1232	-66	-5	-104	-121	16	13	-531	-495	-35	-7
2003	-1952	-1862	-89	-4	-1305	-1236	-69	-5	-94	-112	17	15	-551	-513	-37	-7
2004	-1973	-1875	-97	-5	-1315	-1240	-75	-6	-85	-104	19	18	-572	-531	-41	-7
2005	-1991	-1889	-102	-5	-1322	-1244	-78	-6	-75	-96	20	21	-593	-549	-44	-8
2006	-2009	-1902	-107	-5	-1329	-1247	-82	-6	-65	-87	22	25	-614	-567	-47	-8
2007	-2028	-1915	-113	-5	-1336	-1250	-86	-6	-55	-79	24	30	-636	-584	-51	-8
2008	-2047	-1927	-119	-6	-1344	-1254	-90	-7	-44	-70	26	36	-658	-602	-55	-9
2009	-2066	-1940	-126	-6	-1351	-1256	-94	-7	-34	-62	28	45	-680	-620	-60	-9

	SILT ALL FUNDS				TOTAL											
Year	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%	With Project	No Action	Impact Number	%
1982	-1593	-1589	-3	-0	-1739	-1734	-5	-0								
1983	-1525	-1521	-3	-0	-14830	-14448	-382	-2								
1984	-1418	-1414	-3	-0	-51359	-50922	-437	-0								
1985	-1309	-1305	-4	-0	-74116	-74216	100	0								
1986	-1448	-1445	-3	-0	-87495	-87878	383	0								
1987	-1634	-1635	0	0	-93994	-95452	1458	1								
1988	-1516	-1523	6	0	-104046	-106597	2550	2								
1989	-1399	-1410	11	0	-107075	-107695	619	0								
1990	-1278	-1295	17	1	-103168	-108620	5451	5								
1991	-1154	-1177	22	1	-93810	-105475	11664	11								
1992	-1028	-1051	23	2	-81195	-98597	17401	17								
1993	-918	-930	12	1	-65032	-88798	23765	26								
1994	-783	-792	9	1	-43269	-76685	33415	43								
1995	-647	-648	1	0	-18072	-63853	45780	71								
1996	-510	-504	-5	-1	10145	-48524	58669	120								
1997	-369	-359	-9	-2	42367	-32839	75207	229								
1998	-232	-217	-14	-6	77127	-17325	94452	545								
1999	-87	-73	-14	-19	112210	-1746	113956	6525								
2000	57	71	-13	-18	147246	13839	133406	963								
2001	223	231	-7	-3	182536	29622	152913	516								
2002	376	379	-3	-1	219133	46150	172982	374								
2003	529	529	0	0	257211	64175	193036	300								
2004	659	673	-14	-2	295680	82364	213316	259								
2005	815	823	-7	-0	334694	100693	234000	232								
2006	974	973	0	0	374977	119178	255799	214								
2007	1135	1124	10	0	415964	137781	278182	201								
2008	1297	1275	22	1	457598	156305	301293	192								
2009	1463	1426	36	2	499997	175053	324943	185								

Note: Percentages less than 1.0 are reported as zero.
Source: Mountain West Research - Southwest, Inc., June, 1983.

In fact, the net positive balance would be 84 percent higher with the Pacific Project. It should be noted that one of the areas most affected in other categories, Battlement Mesa, is not included in the fiscal balance table. This is because Battlement Mesa is not an incorporated municipality, but rather a PUD, and public services are provided by the developer and by the county. It may be that significant growth will produce pressure for the incorporation of Battlement Mesa in order to provide higher levels of service.

The fiscal balances are shown for various funds and services provided by the City of Rifle. The Rifle water fund is structured so that it operates at a loss under all circumstances and the size of the negative balance will increase with rising demand. The sanitation fund and the general fund, on the other hand, are structured to show surpluses. The impact of the project on Rifle's general fund would be negative up until the year 2000, at which point the surplus would be 2 percent more with Pacific than with the No-Action alternative. This means that up to this point, expenditures because of increased demand would exceed revenues. The balance would be helped in 1992 when Rifle would begin to receive severance taxes, estimated at $91,000 the first year. As these severance taxes increase to over $500,000 by the year 2002, the negative impact of the project on the fiscal balance would decrease. By the year 2000, the impacts would be positive for the general fund. The net fiscal balance in year 2009 would be about $2.5 million.

For Parachute, the situation would be similar to that outlined for Rifle. Increased demand would produce a proportional deficit in the fiscal balance until the severance tax comes on line, at which time a positive annual effect would result. During full operation, severance taxes are estimated to produce over $250,000 annually, about 60 percent of the expected total revenues. By the year 2009, Parachute (all funds) would show a $647,000 net fiscal balance. Silt would also show the influence of severance taxes on the cumulative fiscal balance, and by the year 2009, would record a positive impact of $36,000. For New Castle, the impacts are projected to show a steady deficit which would accumulate to a total of about -$126,000 by 2009.

The situation in Mesa County and its jurisdictions is somewhat different. No jurisdiction in Mesa County would qualify for property taxes from the Pacific Project, and severance taxes would never reach the same proportion of revenues as with Garfield County. Mesa County would obtain no direct increase in its assessed valuation base since the project facilities would be located in Garfield County, and its severance tax revenues would be modest, about $100,000 (2.5 percent of the county budget) during full production. There would be an increase of up to $1 million annually in sales taxes. Mesa County's tax structure, with its emphasis on sales taxes, coupled with its position as the market center for the Western Slope, and especially the oil shale development area of south-central Garfield County, makes it possible to forecast a net fiscal balance gain with the Pacific Project. The projected fiscal balance is projected to be about $14 million by the year 2009.

The Mesa County municipalities (Grand Junction, Fruita, Palisade, and DeBeque) would all show net fiscal balance gains by the year 2009. The Grand Junction and DeBeque water funds would show negative impacts, which means that the annual deficits would be more severe with the added demands of the Pacific Project. Fruita water would show a balance where increased demand is paid for out of increased revenues. For the Palisade water fund, increased demand would produce a positive impact.

The general funds for Grand Junction and Fruita would show a steady positive impact that would increase once the severance tax begins to become a significant revenue source. For DeBeque and Palisade, a pattern of negative impacts would develop, until the severance tax revenues begin. With the addition of these revenues, the net balances by the year 2009 would be positive for both jurisdictions.

The capital facilities needed for these jurisdictions are outlined in Table 4.3-23. The capacities of current and committed facilities are included in the No-Action projections. Expansion of these capacities are made within the decision parameters reviewed and approved by CITF. The additional demand for capital expenditures through the year 2009 with the project over that without the project is shown in the impact column. The most significant monetary increases would be needed in Parachute, Rifle, DeBeque, and Grand Junction. Not surprisingly, these areas are expected to be the locations of significant population effects.

In summary, the total tax revenues expected to be generated by the Pacific Project would exceed the required expenditures by a substantial amount, about $325 million for the period 1983 to 2009. However, these fiscal benefits would not be equally distributed with the population which generates the expenditure demands. Garfield County would realize dramatic revenue increases while other jurisdictions would face either long- or short-term periods where projected expenditures exceed revenues. Capital expenditure needs are projected for most jurisdictions, but in each case, they seem modest. The largest proportional increases would be in Garfield County, Rifle, and Parachute.

Social structure

The current study area social structure was outlined in Section 2.14.7. The basic attributes for defining functional groups and the activity patterns which distinguish intergroup relationships were discussed. Historical events, including the recent oil shale developments, have shaped the social structure in important ways. The discussion of the current social structure was concentrated on two distinct areas, south-central Garfield County and the Grand Junction metropolitan region of Mesa County.

The purpose of this section is to describe the social structure for the No-Action alternative, and then to distribute the effects of the With Pacific alternative. The types of effects distributed to the groups parallel those distributed to communities and jurisdictions; economic, demographic, housing, public facilities and services, and fiscal. Since there are no quantified data on the social groups as such, the distribution of effects and the probable response of the groups is qualitative. The social effects for the Pacific case parallel those outlined for Mobil. This would be expected for two cases that are basically similar, located in the same area, and scheduled for the same general time period.

Project-generated effects can be expected to produce social changes within the groups and in the interaction patterns between groups. Changes in both these dimensions can be expected to influence the evaluation of the project by the group. In a number of cases, some project effects may be evaluated as positive and some as negative. The group values would determine the final assessment. The overall changes for the groups would cause some change in the interaction

Table 4.3-23. Cumulative total capital expenditures, 1982-2009

Jurisdiction	Expenditures ($000)		Impact	
	No action	With Pacific	$	%
Mesa County				
All funds	$41,241.31	$41,588.18	$346.87	0.84
Grand Junction				
General fund	72,142.59	72,798.62	656.03	0.91
Water fund	23,943.96	24,497.21	553.25	2.31
Grand Junction City/County				
Sanitation	10,137.96	10,139.50	1.54	0.02
Fruita				
General fund	7,925.18	7,929.82	4.64	0.05
Water fund	2,657.94	2,659.63	1.69	0.06
Sewer fund	1,018.01	1,118.01	0	--
Palisade				
General fund	0	45.74	45.74	--
Utility fund	4,548.55	4,548.55	0	--
DeBeque				
General fund	431.08	491.33	60.25	13.98
Utility fund	111.55	219.41	107.86	96.69
Garfield County				
All funds	3,164.63	3,339.53	174.90	5.53
Rifle				
General fund	684.11	748.90	64.79	9.47
Water fund	64.24	93.46	29.22	45.49
Sewer fund	0	17.53	17.53	--
Parachute				
General fund	2,551.47	2,712.43	160.96	6.31
Water fund	233.34	361.73	128.39	55.02

Source: FISPLAN, Bureau of Economic Analysis, 1983.

patterns between groups. Altogether, the intra- and the intergroup changes describe the impacts of the project on the social structure.

Garfield County. Five groups were identified to help explain the social structure of south-central Garfield County. These groups were: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) other long-time residents, and (5) newcomers. The first four groups are dominated by natives and people who have been in the area for a considerable time. The newcomers, in contrast, are mostly oil shale people who recently have come into the area.

- No-Action alternative

Under the No-Action projections, growth rates for employment, income, and population are expected to be quite small; Garfield County's projection is for a 0.1 percent average annual rate of growth between 1985 and 2009. In fact, this is less than the rate of natural increase (birth minus deaths) and implies annual out-migration. Therefore, there would be no significant socioeconomic effects with the No-Action alternative that would of themselves produce important changes in the social structure. The major adjustment in the short term would be the decline and disappearance of the newcomers group as they leave the area for employment opportunities elsewhere or as they adapt and become long-time residents. There would be no replacement for this group under the No-Action alternative.

(It should be noted that there undoubtedly will be exogenous influences on these groups during the forecast period. Changes in the national, regional, and state economic, political, and social life can greatly affect local areas. Technological change alone has transformed rural life in the last few decades and might produce equal or greater impacts in the future. These exogenous factors may rearrange the study area groups and create entirely new intergroup patterns of behavior. However, the focus here is on factors that are specific to the study area and evaluation of the possible influence of these larger effects is beyond the scope of this analysis.)

The qualitative distribution of socioeconomic effects for the With Pacific alternative is based on the distribution of the effects to groups, and their likely significance to the groups.

- With Pacific alternative

The farmers and ranchers who make up the majority of the agriculturalist group in Garfield County are not expected to benefit from the employment, income, purchases, or population effects. The most significant impacts would be those that influence land values and taxes. Property would be expected to rise in value because of increased demand for land, and some landholders may realize substantial gains. The addition of a major project to the county's assessed valuation could result in lower tax rates or higher levels of service, or both. Overall, the effects on the group are considered to be very important because of these two types of effects. The group evaluation would also include consideration of the overall affect on the agricultural lifestyle of the area, and on the relative position of farmers and ranchers in county politics. Both the lifestyle and the political position are likely to diminish in importance, although a substantial group presence would be expected to continue for the foreseeable future.

The businessmen and professionals group would not be directly employed on the project, but would benefit from the project purchases and especially from the nonbasic employment and income. There would be some growth in the group size, and the overall housing demand would be important to the construction, finance, real estate, and legal sectors of the local economy. Public facilities and services should improve as a result of increased demand and the increased tax revenues. Overall, the businessmen and professionals group would experience significant but moderate effects. There would be some geographical distribution of impacts that could be important. For example, businesses in Parachute and

Battlement Mesa would be more impacted by the Pacific Project than would those in Rifle, even though the economic benefits would be very important in Rifle. The group may attract new people who would not be directly dependent upon oil shale development. In some cases, these people may choose the area for its outdoor and recreational attractions, as well as for employment. This could lead to a vocal environmental segment within the business and professional community.

A large majority of the elderly group are either retired or not vitally interested in new economic opportunities. Therefore, no effects from employment, income, or purchases have been assigned to them. The size of the group would not decrease in numbers, but their proportion of the total population would decline. For those who rent, increased housing costs because of rising demand may be a problem. The increased public facilities and services, along with the fiscal benefits, may be especially well used by the elderly. Overall, the effects would be expected to be minor. There may be concern among the elderly about how the community responds to project-related growth and its affect on family and community life.

The other long-time residents group would directly benefit from the onsite employment and wages the Pacific Project would generate, as well as from the increased nonbasic employment and income. There would be only a small affect on the group size for the first decade, but after that, their number would increase as newcomers become long-time residents. The housing effects would be small for homeowners, but more important for renters. The public facilities and services, and the fiscal effects would be relatively high. There may be some resistance to rapid growth within the group, especially by the nonbasic workers. They may feel that the lifestyle benefits they sought in moving to the area are being undercut by rapid growth.

The newcomers group would be the most impacted by the project; in fact, without the project, the group would most likely diminish greatly, or even cease to exist. With Pacific, it would become a significant presence in the social structure. The onsite employment would require worker in-migration, as would rapid expansion of the nonbasic portions of the economy, because of increased income and purchases. Population and housing effects would be directly responsive to employment. The public facilities and services and fiscal effects would be important to the newcomers because they are the group that would generate increased levels of demand. Overall, the socioeconomic effects from Pacific would have a high level of impact on the newcomers group. Their jobs and residence in the area would be both directly and indirectly affected by the project.

The No-Action alternative would produce little change in the economic, political, and social relationships between the groups since the growth in the economy and population would be very small. The With Pacific alternative would produce significant changes, mostly through the shift in the size and dynamics of the groups most responsive to rapid growth.

The agriculturalists and the elderly could expect to lose political and social power as they become a smaller segment of the social structure. Their established positions could provide them with influence beyond their mere size, but overall, these two groups would decline in importance. The simultaneous erosion of their lifestyles and value system may provoke a negative evaluation from them of projects that would seem to be the cause of rapid growth.

The businessmen and professionals group is likely to be strongly pro-growth because of the economic benefits. They should strengthen their position on all levels: socially, politically, and economically. This is because they would realize significant economic benefits and because they tend to be well organized in the civic, community, business, and political spheres. However, a minority with strong environmental values may oppose large-scale development.

The other long-time residents and the newcomers would increase in size most rapidly. Their links with each other would tend to merge the two groups within a few years. Although they make up the largest groups, they are less well-organized than the others on political issues, and less well-positioned for social and economic advancement. Numerous small subgroups would form, based on occupation, residential location, family lifestyle, ethnic, or religious characteristics. Once the newcomers have been in the area for a decade or so, the other long-time residents group would increase with transfers, and the newcomers group would decline to include mostly replacement people.

Overall, the effect of the large number of newcomers would be very significant. These people would have to be integrated into the social structure, both as individuals and as a large, important new group. The result is likely to be a major realignment of the social structure where the numbers, income, and lifestyles of the working-class people become more important. The ability of the business and professional group to manage change and to adapt to the new social structure should work to their advantage.

Grand Junction and Mesa County. The context for the social structure in Mesa County is determined to a large degree by Grand Junction, which is the population, market, and service center for the Western Slope. Although there are many ties with the neighboring rural communities, the urban characteristics are marked and this fact has served to shape the social groups and their interaction patterns. In addition, Mesa County has a relatively large population and a history of assimilating growth. The six groups identified in Section 2.14.7 were: (1) agriculturalists, (2) businessmen and professionals, (3) elderly, (4) Hispanics, (5) other long-time residents, and (6) newcomers.

- No-Action alternative

The PAS projections for the No-Action alternative indicate that Mesa County will have a population of 89,173 in 1985 and this will increase to 98,149 by the year 2009. This would be a very modest growth rate, a 0.4 percent average annual rate of increase. The natural population increase would be expected to be greater than this rate; consequently, there would be an out-migration of local workers who would have to seek jobs in other areas. Under these conditions, there would be little pressure from local conditions to change the group characteristics or the patterns of intergroup relationships. The newcomers would become fewer and as a significant group they might disappear. There could be shifts within groups. For example, those in the business community devoted to building and development activities would be less active than they have been in the recent past. Overall, the projection of stable economic, income, and population conditions also implies a stability on the part of the social structure.

• <u>With Pacific alternative</u>

Unlike Garfield County, where employment, income, and population impacts are projected to peak in the 15 to 40 percent range, for Mesa County, the level of impacts is much smaller. Employment could rise 7 percent and income 10 percent, but population would only be expected to increase by 4 percent over the No-Action alternative. While these increases are important and may mark the difference between a dynamic growing social structure and a stable or even stagnant one, the effects must be considered as moderate even at their peak. The qualitative distribution of these effects serves as the basis for the group-by-group discussion.

Three groups are likely to experience small overall impacts from the Pacific Project: the agriculturalists, elderly, and other long-time residents. The additional demand for land (residential, commercial, and industrial) will affect the agriculturalists, especially the orchardists east of Grand Junction. Whether this is viewed as a benefit or not will depend on whether the group assesses increased land values as more important than the traditional agricultural uses. The current differences in opinion on this issue within the group can be expected to continue into the future. A possible increase in rents may also affect the elderly and other long-time residents. Employment and income effects are likely for small numbers of the other long-time residents group, but unlikely for the elderly or agriculturalists. Purchases might produce some nonbasic employment and income for the other long-time residents group. Eventually, members of the newcomers group would become long-time residents. Little or no population effects are expected for the agriculturalists or the elderly. Since the property taxes for the Pacific Project would go primarily to Garfield County, none of these groups would be expected to experience measurable fiscal effects.

The businessmen and professionals group was assessed as likely to experience a moderate level of effects overall. Employment, population, and fiscal effects were estimated to be small. Increased spending, because of higher overall income and purchases on behalf of the Pacific Project, would be positive but moderate benefits that would accrue to this group. The housing impacts would mostly be felt in terms of a business response to rising demand.

The newcomers would be the most affected of all groups; their very presence in the area would depend on the employment and income effects. The increase in population and housing would produce public facilities and services impacts.

At the current time, the social structure is dominated by the businessmen and professionals group. This is unlikely to change. The agriculturalists and the elderly would both become a somewhat smaller proportion of the population because of overall growth. However, the size of the population shifts would not be enough to change the relative position of these groups nor to disturb their established patterns of interaction. The other long-time residents would be stabilized with the increased employment and diminished out-migration. Eventually, the newcomers would increase the size of the long-time residents group. In fact, over the life of the project, given the stability of the operations work force, the newcomers group would eventually be fully integrated and its distinguishing characteristics would become less obvious over time.

Premature shutdown

An understandable concern in the region is the possibility of delay, temporary shutdown, or premature abandonment of the Pacific Project. Regional residents presently have a sophisticated understanding of the largely uncontrollable technological and economic factors that can suddenly alter a project's viability. If such conditions combine to force either temporary shutdown or premature abandonment of a project, the impacts on the region would be driven by large losses of jobs and tax base. If there were no substitute sources of employment, population could be expected to out-migrate from the region.

The public sector might face a particularly difficult situation during the transition period, because service demands might actually increase while revenue sources fall. In the longer term, service demand should decline, but a problem might exist if existing residents had adjusted to new, higher levels of service standards that resulted from the availability of resources. As those resources disappeared, the downward adjustment of service standards might be painful. Further, there might be cases where large capital facilities were involved and the service levels could not be adjusted. The result might be that the public sector would be forced to try to sustain oversized facilities.

Socioeconomic conclusions for the study area

Construction employment is expected to peak twice over 2100, once in 1988 and again in 1991. Between 1990 and 1995, construction employment would range from 1240 to 2130. Operations employment is expected to increase to 3365 by the year 1998 and maintain that level for the rest of the projection period. The employment demand would exceed local supply and would require in-migration of workers and their households to the study area.

Income from basic employment and purchases on behalf of the project would produce additional nonbasic employment and income in the study area. This nonbasic demand would also require workers in excess of local labor market availability. Total study area employment impacts are expected to rise to over 6900 or a 12 percent increase by 1999; for the operations period, the increase is expected to be over 6800 or about an 11 percent increase. The nonbasic employment would also add households and population through in-migration and diminished out-migration.

Population increases are projected to be 9842 in 2009, an increase of 7 percent over the No-Action alternative. The population impacts would be expected to be greatest in Garfield County (increases of up to 22 percent) compared to Mesa County (increases of about 2 to 4 percent). Battlement Mesa, with a 375 percent increase by 2009, would be the most impacted community.

The study area housing industry has demonstrated its ability to provide new units as demand increases. For the study area, the housing demand is expected to increase by 4481 units during the impact period, 1985 to 2009. About 61 percent of this addition would be in Garfield County with Rifle accounting for 571 units, Battlement Mesa 1069 units, and Parachute 113 units. Together, these three communities would accommodate almost 40 percent of the total study area demand.

The school-age population, ages 5 to 18, would show some increases during construction and then decline to 2009. Five school districts provide education in the region. All except District RE-16 would show negative average annual rate of change from 1983 to 2009 for both the No-Action and the With Pacific alternatives. In 1999 peak employment, the impact is projected to be over 1433 children. More than two-thirds of these children would be in Garfield County school districts, over 680 in RE-16, and over 330 in RE-2. Joint District No. 49 and Mesa County District No. 50 would receive small impacts relative to their size. The numbers of school-age children would decline during operations and the proportional distribution to school districts would shift with School District No. 51 gaining a larger proportion. Only School District No. 51 is expected to have demand exceeding current capacity at any time during the forecast period.

The public fiscal impacts of Pacific would be significant and positive for the overall study area; the net cumulative balance by 2009 is projected to be about $325 million. The most important revenue increases would be from the property tax, severance tax, and sales tax. Garfield County would realize 87 percent of the fiscal benefits through property tax increases because of onsite improvements by Pacific. Property tax increases because of residential, commercial, and industrial uses for other jurisdictions, would not produce any significant positive or negative fiscal impacts for several jurisdictions. Because the severance tax would be phased in after production begins, negative fiscal balances would be forecast for Rifle, Parachute, Silt, Palisade, and DeBeque only during the construction period. Sales tax revenues would mainly benefit Mesa County and Grand Junction because of the tax rate and the role of the Grand Junction metropolitan area as the market center for the Western Slope. The positive fiscal balances from this source are quite modest but they would contribute to Mesa County's projected $14 million cumulative balance by 2009.

With the addition of currently committed capital projects, the physical and service capacities of most jurisdictions are adequate to accommodate both the No-Action and the With Pacific alternatives. Significant additional capital funding needs for the With Pacific scenario were identified for Mesa County School District No. 51, and the municipalities of Grand Junction, DeBeque, Rifle, and Parachute.

Changes in the social structure would be expected to take place in both counties but would be most significant in Garfield County because of the magnitude of the impacts relative to the small size of the in-place social structure. In Garfield County, the large in-migration of newcomers would make them a major factor. The other long-time residents would be strengthened through increased employment and income, and because of diminished out-migration. The businessmen and professionals group would be expected to increase its influence because of its strategic position and its organizational abilities. A declining position would be expected for the agriculturalists and the elderly. In Mesa County, the newcomers group would grow and become more important. However, the overall impacts would be modest and they would appear to be well within the current social structure's ability to integrate them.

4.3.3.15 Transportation

The major transportation impacts of the Pacific Project would be associated with motor vehicle transportation and the road system within the project area. The population growth that is projected as a result of the project (including the construction and operation workers and their families), and the secondary growth would add traffic to the state, county, and local road systems. Air transportation would also increase as a result of the increase in population. Rail traffic would increase because of incoming shipments of materials and supplies for the project and other associated activities and, potentially, the shipment of products from the project area.

Road and highway impacts

The analysis of the impacts on the road system was performed using techniques developed by BLM (1982b). Data used in the calculations were obtained from the Colorado Department of Highways, the socioeconomic impact assessment, and the CCSOP DEIS (BLM, 1983b).

The traffic impacts associated with the proposed action are presented in Table 4.3-24. The impacts are expressed in terms of the ratio of the peak hourly traffic (PHT) to the capacity of the road segment at service level "C", the service level that is applicable to roads in rural areas. For segments A through E, which correspond to parts of Interstate 70 (see Figure 3.3-11 on page 3-169), all of the ratios under the With Pacific scenario are below 0.8. This means that the road segments have adequate capacity to handle the anticipated traffic. In 1991, the peak year of construction, the ratio for segment G would be greater than 1.0 for both the No-Action and the With Pacific cases, indicating signficant delays; however, the impact of the project would not be significant. A similar pattern is shown for both segment F and segment G in the year 2009. The impact of the proposed action on segment F would not be significant. Although the impact of the project on segment G in terms of the percentage change in the ratio would be greater in 2009 than it is in 1991, the analysis indicates that certain actions would have to be taken to avoid congestion and delays on segment G whether the project developed or not.

Table 4.3-24. Impact of Pacific Project on major highway segments (PHT/capacity ratio)[a]

Segment[b]	1991[c] No action	1991[c] With Pacific Project	1991[c] Percent difference	2009 No action	2009 With Pacific Project	2009 Percent difference
A	0.17	0.17	0	0.25	0.25	0
B	0.29	0.31	6.9	0.42	0.44	4.8
C	0.31	0.36	16.1	0.45	0.52	15.5
D	0.30	0.34	13.3	0.44	0.49	11.4
E	0.33	0.37	12.1	0.49	0.54	10.2
F	0.72	0.73	1.4	1.04	1.05	1.0
G	1.41	1.43	1.4	1.72	1.85	7.5
H	0.54	0.56	3.7	0.76	0.76	0

[a]Ratio of Peak Hourly Traffic to Capacity.
[b]See Figure 3.3-9 for location of segments.
[c]Peak Year of Construction.

The Roan Creek Road would be significantly impacted by the proposed action. The road is presently paved up to 3 to 4 miles north of DeBeque. Given the expected increases in traffic volume, the existing road is substandard and would have to be upgraded. The remaining 15 miles of road to the project site would have to be reconstructed and paved to accommodate the increase in traffic.

Airports

The increase in population as a result of the Pacific Project would cause increases in air traffic to both Walker Field at Grand Junction and the Garfield County airport at Rifle. The impact on air traffic would not be significant since recent or planned expansions and improvements in both airports would accommodate the expected increases.

Railroads

A railroad spur would be constructed near DeBeque. During construction, incoming materials and supplies that arrive by rail would be off-loaded from this spur. Ammonia and by-products of the retorting and upgrading processes may be shipped by rail. Small quantities of oil from the early stages of production may also be shipped by rail. These shipments would not significantly affect rail traffic. The impacts on at-grade crossings would not be significant given the low level of rail traffic.

Pipeline

The synthetic crude oil would be transported to market by an industry pipeline. This pipeline most likely would originate near Parachute and terminate at Casper, Wyoming. A buried pipeline from the plant site would be constructed to carry shale oil to the industry pipeline.

4.3.4 Unavoidable adverse impacts

Implementation of the proposed action would result in several unavoidable adverse impacts, as summarized below.

- Minor degradation of air quality would occur during construction, particularly from particulates; moderate degradation of ambient air quality and visibility is possible during operation, primarily through increases in concentrations of TSP, NO_x, and SO_2. However, because the project must be in compliance with state and Federal air quality regulations, these impacts will be lower than predicted.

- Significant alteration of topographic contours would occur in Deer Park Gulch and Scott Gulch as a result of construction of facilities and surface disposal of retorted shale; minor topographic changes would occur along the Roan Creek corridor.

- Potentially valuable paleontological resources in the Green River Formation could be lost.

- There would be destruction of established soil profiles, loss of topsoil through erosion, and a decrease in soil productivity on areas of surface disturbance.

- Discharge from springs and seeps adjacent to the mine zone could potentially decrease for at least the life of the project.

- There would be a potential for accidental release of pollutants (chemicals, contaminated water, oil and gasoline, etc.) into surface and ground water systems from transportation accidents or spills.

- Minor flooding could potentially occur as a result of ruptures to water system pipelines and retention/detention structures.

- It is expected that there could eventually be erosion of topsoil on the retorted shale embankment, potentially exposing the retorted materials to wind and water erosion that could lead to degradation of water quality.

- There would be impingement and entrainment of aquatic biota by the water intake structure in the Colorado River.

- There would be losses of terrestrial and aquatic habitats during construction and operational phases of the project.

- There would be losses of populations of dragon milkvetch and Barneby's columbine, which are candidates for listing as threatened or endangered species.

- There would be losses of 687 acres of critical elk and mule deer winter range and calving areas.

- Alteration of the visual quality of the landscape would occur through modifications to existing landforms and vegetation patterns and the introduction of industrial structures into the rural setting; the most prominent impact would be the long-term effects of the mesa-top access road.

- Moderate short-term increases in noise levels would occur in areas of activity during construction and operation.

- Changes in land use would occur through which approximately 900 acres of rangeland and 100 acres of cultivated land would be converted to industrial use for at least the life of the project.

- During project operation, downstream users of junior water rights may not have water available which is currently being used.

- There would be increased useage of recreational facilities, including increased hunting and fishing pressure and use of wilderness areas by the project-related increase in population.

- There would be increased traffic on surface roads, with the attendant possibility of an increase in the number of traffic accidents.

4.3.5 Irreversible and irretrievable commitments of resources

Various resources would be irreversibly and irretrievably committed for the life of the project and beyond. These resources include economic, natural, and cultural values, and are summarized below.

- Approximately 880 million tons of oil shale (590 million barrels of shale oil) would be mined over the 25-year life of the mine.
- Unmined oil shale resources may be precluded from future recovery, given current technology.
- Topsoil would be lost through erosion.
- There would be losses of both wildlife and wildlife habitat.
- The mesa-top access road and the retorted shale disposal area would permanently influence the visual landscape.
- Cultural and paleontological resources would be lost.
- Some springs and seeps adjacent to the mining area could become dry.
- There would be some degradation of air quality within the region as a result of permanent urbanization induced by the project.

4.3.6 Relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity

Short-term uses are those that would result directly and indirectly as a result of construction and operation of the project over a period of approximately 26 years. The relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity is discussed below.

- The use of about 880 million tons of oil shale from the Mahogany Zone to produce synthetic crude oil would occur during the short term and, as this resource is not renewable, would affect long-term productivity. The energy provided by the oil would certainly fulfill part of the nation's needs in the short term. In addition, the new technology and knowledge gained through this process could allow future use of lower-grade reserves and could elevate them to the status of potential resources. Thus, while large tonnages of oil shale would be used up, an even larger resource base could be made available by the project.
- Air emissions would use some or all of the increments allowable under PSD regulations. This could, in the short term, restrict other nearby development and use. No effect on long-term productivity is expected, however, as emissions would cease at abandonment of the project.
- Uses of ground water from wells and from springs and seeps might be changed as the underground mine intercepted ground-water aquifers and

changed their water balance and perhaps their water quality. These would be changes that could alter long-term patterns of dependency upon water supplies.

- Structural modifications to visual resources would be short term (life of the project). Some landform and vegetation impacts would be of longer term. That is, reclamation would begin at the termination of the project and time will be required for restoration of vegetation patterns. Landform and vegetation impacts on the Roan Cliffs, however, would definitely be long term. The most extensive of these would be the mesa-top access road, which would remain a long-term highly prominent visual impact.

- An estimated 1314 acres of soils would be disturbed during the life of the Pacific Project (see Section 4.3.3.4). A loss in productivity of these soils would occur over this short-term period, but productivity should be reestablished through reclamation. Within an estimated 5 to 10 years after reclamation, the soils would be producing suitable wildlife habitat and livestock forage for the long term.

- Over the short term, some cultural resources would be recovered for scientific investigation, while others would be permanently lost and unavailable for future investigation.

- During the short-term operation of the project an estimated 1314 acres of wildlife habitat and grazing lands would be removed from production. Use of grazing lands in Clear Creek valley and on the mesa top for industrial purposes would reduce the regional wildlife carrying capacity through the loss of wildlife habitat. This would be a short-term effect which could affect long-term productivity positively or negatively, depending on the success of reclamation efforts. The changes in topography resulting from retorted shale disposal in Deer Park Gulch may increase the long-term productivity of the area for domestic grazing animals, but would also decrease productivity of native species that now occupy specialized habitats in the gulch and on cliffs.

- Use of recreational facilities in the project vicinity would increase as the population in the area increases. The changes in use would be short-term as related to this project. The people who come to the area for this project could remain in the area, changing the short-term use into long-term uses.

- Employment by the Pacific Project would reduce area unemployment and bolster the local economy. This short-term direct effect of the project could extend into an indirect long-term effect on the regional economy and productivity, if most of this population remained in the area. Associated with the population increase would be the development of an infrastructure of facilities and organizations in surrounding counties. This infrastructure could enhance the long-term productivity of the region.

4.3.7 Committed mitigation

Mitigation is defined as avoiding, minimizing, compensating, rectifying, reducing, or eliminating an adverse environmental impact (BLM, 1981a). BLM actions regarding public lands (e.g., sale or leasing of rights-of-way) will include site-specific stipulations which will mitigate potential impacts.

4.3.7.1 Service corridor

Please refer to Table 4.3-1 (pages 4-86 and 4-87) for operator-committed mitigation.

4.3.7.2 Wildlife

Pacific has agreed to the following wildlife mitigation stipulation: "The applicant shall be required to mitigate for loss or displacement of wildlife habitats in accordance with applicable law and regulations.

Prior to each construction phase, the applicant shall provide a habitat recovery and replacement plan which would analyze the site-specific loss or displacement of wildlife habitats due to oil shale recovery operations. Such analyses shall employ best current practices and shall be approved by BLM after consultation with USF&WS and CDW and will involve participation by project sponsors. These evaluations shall be conducted within a sufficient time frame to ensure that all affected habitats will be fully evaluated prior to disturbances and to ensure that appropriate mitigation measures are identified and committed to.

Prior to initiation of construction activities, applicant shall develop a mitigation plan that will detail how applicable mitigation measures identified in the FEIS, ROD, or the habitat recovery and replacement plan will be implemented.

The habitat recovery and replacement plan shall include the following:

(1) A habitat analysis of the area affected by construction which:

(i) identifies the important wildlife species and important plant communities which occupy the project area, and

(ii) includes an analysis of the quality and quantity of the habitats under pre- and post-project condition.

(2) A detailed description of the methods available to mitigate habitat loss, together with comparative analyses of alternative methods which were considered and rejected by the applicant and the rationale for the decision to select the proposed methods.

The methods used by the applicant for recovery and replacement may include, but not limited to, the following techniques:

(i) Avoidance of critical/high quality habitats.

(ii) Increasing the quantity and quality of forage available to wildlife.

(iii) The acquisition of critical wildlife habitats.

(iv) Manipulation of low quality wildlife habitat to increase carrying capacity for selected wildlife species.

(v) Recovery, replacement, or protection of important wildlife habitat by selected control methods.

(3) A timetable will be developed which details when the work will be done and which demonstrates the tie-in with the overall mining plan.

(4) A description of the means by which mitigation progress and success will be monitored.

To the extent practical, BLM, USF&WS, and CDW will assist project proponents in development and monitoring of wildlife mitigation efforts."

4.3.8 Uncommitted mitigation

The mitigation measures discussed below are uncommitted actions suggested by the BLM for consideration by Pacific, or by regulatory agencies in their permitting processes. They are measures that have been used in the past for projects with similar features and could reduce the impacts discussed in Section 4.3.3.

4.3.8.1 Climate and air quality

Pacific has outlined a detailed program of potential control and/or mitigative actions to minimize atmospheric emissions and ensure compliance with BACT and New Source Performance Standards (NSPS) requirements. For mining and material handling emissions, mitigative measures include covered conveyors, baghouses, scrubbers, water-sprays, and cyclones. For process emissions, mitigative measures include high efficiency cyclones and venturi scrubbers, wet scrubbers, baghouses, low NO_x burners with ammonia injection, a sulfur recovery plant, flue gas desulfurization (FGD) equipment, and amine scrubbing for the hydrogen plant reformer furnaces (to remove hydrogen sulfide). Hydrocarbon control would include recognized techniques and a specific maintenance program. Mitigative measures would be defined during the permitting process.

4.3.8.2 Topography, geology, and mineral resources

Topography

Topographic impacts would be minimized by proper engineering design of roads and facility sites, and by proper emplacement of retorted shale. Further reduction of topographic impacts would be made by appropriate recontouring and reclaiming of disturbed areas after cessation of project activities.

Geology and mineral resources

Possible impacts because of unstable ground, rockfalls, and faults may be reduced or avoided by following currently accepted engineering procedures, including avoiding unstable ground, grouting areas in the vicinity of faults, installing barriers in areas of potential rockfall, and installing proper drainage in landslide areas and talus slopes. Unmined oil shale in the Mahogany Zone and deposits of lower grade oil shale above the Mahogany Zone may possibly be recovered through in situ extraction or other methods.

4.3.8.3 Paleontology

In most instances, salvage of areas of significant paleontological sensitivity is the most effective means of mitigation. Based on the paleoenvironment of the larger part of the Green River Formation, there is a definite potential for paleontological values even though it is not readily recognizable through surface exposures. A trade-off is to sample or monitor areas proposed for disturbance to allow discoveries. Therefore, it is recommended that an intensive onsite survey be conducted to determine the quality and geographic extent of paleontological resources in areas that would be disturbed. The survey should be followed by sampling or salvage of the threatened resource, as practicable. Routine sampling and monitoring during construction and operation, as dictated by pre-operation surveys of known or potentially fossiliferous units, would allow recovery of paleontological materials for examination, evaluation, and preservation, as appropriate. Total salvage of the paleontological resource is often the most practical and expeditious means of mitigation.

4.3.8.4 Soils

Impacts to soils on the 1314 acres that would be used for the various components of the Pacific Project would be mitigated, insofar as feasible, to reduce losses. Measures would include stripping and stockpiling soil; stabilizing stockpiled soils against erosion; dismantling and cleanup of project installations; regrading to reach favorable contours; selected placement of stockpiled soil; and revegetation using introduced and native plant species. All acreage with the exception of the 676 acres used for retorted shale disposal would be returned to pre-project uses by the application of reclamation measures.

The retorted shale disposal site would receive a cover of topsoil designed to abate erosion of the retorted shale. Precautions would need to be made to protect the soil layer from erosion, such as fencing the area to protect the seeded area from wildlife and promote long-term revegetation success. It would not be advisable to allow livestock grazing on the steep embankments where water erosion is predicted to cause a soil loss of 11.6 tons per acre per year.

Erosion of the retorted shale pile slope could be ameliorated by revisions to the design of the pile. Some combination of design revisions intended to meet the following goals are recommended:

1) Reduce the annual embankment face erosion rate to an acceptable level (below 5 tons per acre per year) by reducing the embankment slope and/or length (i.e., the vertical distance between benches); and

2) Install an impervious, nonerodible cover on the embankment faces, together with runoff energy dissipation basins at the toe of the pile instead of attempting to revegetate the face.

Also, maintenance and control of the retorted shale pile could be extended beyond the point of abandonment of the remainder of project facilities.

4.3.8.5 Ground water

Disturbance to the hydrogeologic regime during the construction, operation, and abandonment phases of the Pacific Project would be unavoidable; however, if the degree of disturbance is minimized, the associated ground-water impacts would also be minimized. Disturbance to the existing ground-water regime can be reduced by avoiding areas where the water table is at or close to the ground surface. During mining, dewatering and/or depressurization of the Mahogany Zone may affect discharge from springs and seeps along the valley walls and in the areas overlying the mine. A ground-water monitoring program should be implemented to evaluate and quantify the effects of dewatering/depressurization on the ground-water regime. For example, an alternative water supply could be required to mitigate the resultant impacts if mine dewatering/depressurization activities adversely impact springs or seeps used for stock watering purposes.

The retorted shale disposal site and other waste handling, storage, and disposal sites are areas that would have a high potential for contaminating ground-water and surface-water quality. Conservatism in the design and construction of the storage and disposal facilities for liquid and solid wastes would help to minimize the potential for adverse impacts. Of importance is the design of the liner and leachate collection system for all waste handling, storage, and disposal facilities. It is anticipated that the existing alluvial materials in upper Deer Park Gulch would not have sufficient permeability to accommodate all ground-water inflow and leachate generation within the retorted shale pile in the absence of evapotranspiration. If this is shown to be the case, an underdrainage system would be installed for the proposed retorted shale disposal area in upper Deer Park Gulch.

A comprehensive ground-water monitoring program should be implemented prior to the start of construction and continued at least throughout the operational phase. If degradation of ground-water quality is detected, appropriate mitigative action should be undertaken. Depending on the specific circumstances, this could entail elimination of sources, implementation of a program of containment by means of a hydraulic or physical barrier (e.g., slurry wall or grout curtain), and removal of the contaminants by one or several pumping wells. Treatment and/or disposal of the pumped waters would depend on the nature and concentration of contaminants involved.

4.3.8.6 Surface water

The eventual degradation of surface-water quality because of contact with exposed retorted shale could be significantly reduced by erosion control measures discussed in Section 4.3.8.4.

4.3.8.7 Aquatic ecology

Impacts associated with increased fishing pressure created by the project could be mitigated by increasing the number of fish in the area through creation of additional habitat or by stocking more fish. In order to mitigate effects of increased fishing pressure associated with the construction work force, approximately 126,000 fish would have to be stocked annually; about 228,200 fish would be needed annually during project operation.

Placement of special fishing regulations on Northwater Creek, Mitchell Creek, Carr Creek, and JQS Gulch could be used to control overharvesting of Colorado River cutthroat trout. The regulations would need to control harvest and could include: reduced creel limits, restrictive size limits, catch and release streams, or closing the stream to all fishing.

Designing the intake according to BACT would mitigate most of the fish impingement impacts. The incorporation of fish protection devices on the intake would further reduce fish impingement impacts. Intake screens with small openings would mitigate a portion of the entrainment impacts.

4.3.8.8 Vegetation

Mitigation for the destruction and disturbance of vegetation is included in the proposed action in the form of a detailed reclamation plan for all disturbed areas. These areas would be planted with species adapted to the region and would be expected to eventually support stable and productive plant communities.

Further mitigation is recommended for special-status species. All potentially disturbed areas not surveyed for these plant species should be surveyed, and impact to individuals of these species should be avoided to the extent practicable. Also, it is recommended that areas known to support special-status species either be avoided or, as an alternative, regional botanists be permitted to collect specimens and seeds from the species to be destroyed for inclusion in herbarium collections and for further study.

4.3.8.9 Wildlife

Possible procedures for mitigating the impacts of project development on wildlife include: siting options, buffer zones, seasonal timing of construction, wildlife-oriented construction features, established road and off-road vehicle restrictions, improvement of existing habitat, recreational restrictions, and wildlife-oriented reclamation.

Wildlife-oriented construction features could include scheduling construction activities to avoid critical big game habitats during key periods of time (e.g., fawning), minimizing fencing so as to not exclude wildlife except from hazardous areas, and using electrocution-proof transmission towers to protect perching raptors.

Vehicle speed limit restrictions on established roads and the use of mass transportation vehicles for project personnel would reduce the number of road kills. Best available technology could be employed to minimize road kills of big game if road kill frequency exceeds 10 per mile per year (the figure recommended by the USF&WS); this might include fencing and construction of big game passageways. Off-road vehicle use restrictions would reduce stress to wildlife, particularly during critical periods in wildlife life cycles such as raptor nesting periods and winter/early spring use of big game feeding areas.

Improvement of habitat beyond the area of disturbance through chaining, brush beating, clear-cutting or selective thinning of forests, nitrogen fertilization, control of grazing pressure or addition of water sources would be a potential option to improve its carrying capacity and allow it to accommodate some wildlife displaced from the area of disturbance.

Control of recreational activities such as hunting and snowmobiling would reduce stress to wildlife. A firearm policy could be implemented to control use of firearms on the project site and to discourage their possession while commuting to and from work. Wildlife protection education could be promoted as part of employee orientation.

Revegetation programs could use shrubs and other plants of importance to wildlife as part of the seed or live-planting mix to enhance wildlife food and cover. Roadway shoulders and borrow ditches should be reseeded with unpalatable vegetation to lessen attraction of big game to these reseeded areas.

In consultation with the Colorado Division of Wildlife and the USF&WS, and in recognition of funding limitations, Pacific could develop an in-house wildlife monitoring program to include, where needed and appropriate, such studies as habitat condition and trend, big game population distribution and movements, and nesting raptor distribution and status.

In addition to the above, the following policies could be adopted:

- No activity should occur within a 0.5 mile buffer zone of any occupied or active raptor nest except as approved by USF&WS and CDW.
- No destruction of raptor nests should occur except as specifically permitted by USF&WS and CDW.
- Pacific should contribute to development of a regional wildlife management plan.
- Reclamation for wildlife should be a principal priority in the final decommissioning of the Pacific Project.
- Restore at a minimum premining level of interspersion of shrub, grassland, and forest cover in consultation with BLM, USF&WS, and CDW.

4.3.8.10 Cultural resources

Whenever possible and feasible, cultural resources should be avoided by construction and related activities. If areas designated for construction have not been inventoried for cultural resources, it is recommended that site file searches and field surveys be undertaken in advance of construction and as directed by the BLM and the Colorado State Historic Preservation Officer (SHPO). If avoidance of known sites is not possible during construction, it is suggested that Pacific consult with the SHPO to determine the most satisfactory means of mitigating damage. These procedures would ensure adequate development of mitigation measures for direct and indirect adverse effects on cultural resources.

4.3.8.11 Visual resources

It is suggested that, where possible and practical, linear excavations for pipelines be located in low visibility areas. They should also be sited to follow natural landform patterns rather than crossing them in unnatural patterns. Where clearing of vegetation is necessary, the edges of clearings should be made irregular so as to avoid the appearance of straight lines and unnatural angles or patterns. Clearing additional vegetation beyond that necessary should be considered in order to create a more natural appearance which borrows from natural landscapes.

It is suggested that transmission line conductors be nonspecular and insulators be a dark color rather than light or transparent to reduce the prominence of these new facilities on the landscape.

The following measures are recommended for application during the design of all facilities.

- All metal structures should be painted with a dull finish, neutral color compatible with the surroundings. Color choices might be selected in coordination with the BLM VRM coordinator.

- All facilities should be designed and located to the form and line of the landscape, as much as practicable, considering, in particular, minimizing visibility from sensitive viewpoints.

4.3.8.12 Noise

Facilities should be designed to comply with OSHA noise requirements; no further mitigative measures are recommended.

4.3.8.13 Land use and recreation

No mitigative measures are recommended.

4.3.8.14 Socioeconomics

Several mitigation measures have been assumed as part of the socioeconomic impact analysis. These include Pacific's proposed construction camp and commitment to encourage employee location in areas that can best accommodate growth (e.g., Battlement Mesa). These measures, as proposed by Pacific, would be part of the Pacific Project's socioeconomic impact mitigation policy which would be based on the following principles:

- The level of assistance will need to be cognizant of the uncertainty of the industry. Local governments, in particular, must be careful to protect themselves against the possibility of premature shutdown. Two strategies are relevant. First, it might be advisable for local governments to require guarantees with respect to obligations which are necessitated by a project and which are only able to be sustained if the project proceeds as scheduled. Second, local governments must make optimal use of short-term, flexible solutions to deliver service needs, rather than longer-term solutions which run the risk of being inappropriately sized.

- Existing impact mitigation funding mechanisms should be used to the maximum extent possible to assist communities impacted by the project, but it will be necessary for affected entities to fully explore other mechanisms available to them and to use those mechanisms to the extent possible to address their current needs and expected impacts.

- A time lag between the financial impact on communities and the receipt of additional tax revenues from the project may cause temporary front-end financing problems for those communities. Impact mitigation programs should be designed to alleviate these revenue-timing problems with the recognition that such assistance should be temporary and provided only until the impacted entity can reasonably be expected to carry forth alone with its responsibilities.

- Temporary facilities and services should be used, to the extent possible, to handle impacts caused by temporary population peaks, as exemplified by the current plans for a construction camp. Permanent facilities and service-levels should be based on permanent population growth.

- Pacific will not alleviate the impacts caused by other sources of growth or existing deficiencies in current facilities or services. When existing residents benefit from new facilities or improved service levels, they should bear a proportionate share of the cost.

- Assistance provided by Pacific should be handled in such a manner as to ensure such assistance is used to mitigate identified and specified needs. Assistance should be on a modular basis; i.e., socioeconomic commitments should coincide with identifiable project stages, wherever possible.

In addition to the primary funding mechanisms noted above, various financing mechanisms are available to provide mitigation assistance. These mechanisms, such as prepaid taxes and connection fees, bonding and other forms of assistance are currently being reviewed by Pacific. The specific application of any one of these can be determined only after a review of the specific mitigation action, after consideration of other funding sources that may be involved, and after a review of the economic conditions at the time of construction.

Pacific is committed to working cooperatively with state, local, and private entities to address the potential impacts of the project. The level and form of assistance, however, cannot be determined at this time. Pacific intends to continue to work with affected entities to develop specific mitigation programs and to then tailor the assistance in a way that is responsive to the needs and consistent with sound business practices.

Pacific has made a commitment to undertake the following measures to mitigate socioeconomic impacts in the area of housing, government finance and community infrastructure, and human services.

Housing

- Pacific proposes to build a construction camp accommodating up to 680 workers. This camp would be located near the project in Garfield County.
- Pacific has made, and will continue to make available, information on employment levels, its construction schedule, and the type, quality, and price of units that may be desired by its employees.
- Pacific will consider the following techniques if and when it is necessary to stimulate housing construction to house Pacific's workers:
  - Providing guarantees to developers;
  - Guaranteeing occupancy of a specific number of units for a certain number of years in mobile home parks, subdivisions, and apartments;
  - Providing construction financing to developers;
  - Depositing capital in local banks to improve the availability of financing; and
  - Providing land or improved lots to developers.

Government finance and community infrastructure

- Pacific will encourage local governments and service districts to put utilities on an enterprise fund basis so the system costs are paid for by revenues generated from users.
- Before any commitment is made to contribute to new capital facilities, Pacific would work with the local government concerned to make sure that there is a long-term, stable source of revenues to cover induced operating and maintenance costs associated with the new facility.
- Fiscal analysis shows that Pacific's incremental growth would create a cumulative surplus in both counties. This surplus would be more than sufficient to cover all of the incremental public costs attributable to

the project. Revenue sharing between the counties and municipalities, therefore, would appear to be one key to overcoming any mismatch of funds.

- State law allows the use of severance tax credits, in a prepayment formula, to mitigate the impacts of growth. This severance tax credit arrangement uses the Operator's Local Affairs Discretionary Impact Assistance Fund. This option will be explored to provide financing to those municipalities and other units of government that face revenue shortfalls related to the Pacific Project. If acceptable by the state and local governments, and Pacific, a formal agreement among the parties will be required.

- Other options for financial assistance that are available to the Pacific Project should Pacific choose to use them are as follows:

  - Technical assistance to pursue matching state or Federal funds;

  - Prepayment of property taxes;

  - Bond programs in which Pacific guarantees debt service payments for the first few years until the tax base is established;

  - Lease-back arrangements where Pacific builds facilities and leases them back to local government, possibly with a purchase option once the tax base to support the facility is established; and

  - Technical assistance to provide "in-kind" assistance.

Human services

- The need for specific human service programs is often difficult to assess ahead of time. Thus, Pacific's approach would be to work with existing human service coordinating organizations to determine the extent of Pacific's impact and the most effective methods of alleviating any difficulties.

- Pacific plans to include recreation facilities as part of the construction camp complex. A formal recreation program may also be organized if conditions warrant it.

4.3.8.15 Transportation

Measures that could be considered to mitigate possible impacts on the transportation systems in the area include:

- upgrading and widening of bridges
- road construction and improvements
- rail crossing upgrades
- bus transportation or some other form of mass transit for workers
- shift scheduling to reduce congestion

These measures could be implemented through working arrangements with the relevant jurisdiction or transportation authorities.

4.3.8.16 Summary of impacts and mitigation

Table 4.3-25 summarizes potential impacts and design control or potential mitigation measures for the Pacific Project.

4.4 ENVIRONMENTAL COMPARISON OF ALTERNATIVES

The Pacific Project components having one or more reasonable alternatives (e.g., plant site location, retort technology, hazardous waste disposal, etc.) are listed in Table 4.1-8.

An interdisciplinary evaluation and comparison of reasonable alternatives was performed through the coordination and integration of discipline-specific analyses and concerns. Each component was evaluated independently of the others; thus, conclusions regarding alternatives for one component did not affect the evaluation of alternatives for other components. The procedure followed was a modified Delphi process. This process was used because it facilitated the orderly, defensible assessment and comparison of alternatives by the large group of principal investigators, each of whom is an expert in a specific environmental discipline.

4.4.1 Procedure followed

Based on descriptions of alternatives (including the proposed action) and discipline-specific issues (e.g., impacts on wildlife), each principal investigator developed a set of criteria (e.g., number of acres of habitat or winter range affected) to methodically and rigorously assess the impacts attendant to each alternative. In most instances, principal investigators established more than one criterion to rate alternatives. Where multiple criteria were developed, principal investigators assigned weightings to each criterion. The weighting was used to define the relative importance of each criterion in establishing an overall rating of the alternative by that discipline. An intradisciplinary score was then assigned to each alternative by the principal investigator according to the criteria and weightings he had established. A complete discussion of the criteria used for each discipline and the weighting system used for each criterion is included in the Impact Analysis Guide (IAG) prepared for this EIS (Dames & Moore, 1983a).

The Delphi procedure involved a meeting of all principal investigators for the project who collectively determined the weight to be assigned each discipline being considered for a particular component.

Table 4.3-25. Summary of potential impacts and mitigation

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Air quality	Construction	Fugitive dust	Water spray
	Malfunctioning air pollution control equipment	Increased emissions	Shut down emitting facility
	Exposure of untreated wastewater	Increased aromatic nitrogen compounds and organic pollutants	Contain wastewater in covered tanks
	Operation	Degradation of air quality and/or visibility	Low NO_x burners with ammonia injection, covered conveyors, baghouses, venturi scrubbers, wet scrubbers, water sprays, cyclones, flue gas desulfurization, floating roof tanks, pressurized spheres, maintenance program (see 4-91 for details)
	Facility abandonment	Fugitive dust	Reclamation and revegetation
Topography, geology, and mineral resources	Operation	Changes in topography	Recontouring and reclamation
		Geological impacts	Avoiding unstable ground, grouting areas near faults, using barriers in rockfall areas, installing drainages in landslide areas
	Abandonment	Subsidence	None
Paleontology	Operation	Loss of resource	Monitoring/salvage surveys
Soils	Construction/operation - plant siting only	1314 acres disturbed	Topsoil stripping and stockpiling; protection of piles by establishing vegetative cover
	Abandonment	Erosion of retorted shale pile	Regrading contours, use non-erodible cover for face of pile or reduce pile erosion to 5 tons/acre/year
Ground water	Construction	Interception of aquifers	Avoidance
	Mining	Dewatering/depressurization of Mahogany Zone	Install ground water monitoring program, supply alternative water sources
	Retorted shale disposal	Degradation of water quality	Compacted shale liner and underdrainage
	Mine closure	Degradation of water quality in springs and seeps	None
Surface water	Construction/operation sand and gravel	Surface water degradation	Desiltation pond
	Operation pipelines, road crossings, transportation	Surface water degradation	Spill prevention, control, and countermeasure plan; pipeline monitoring equipment, inventory control
	Retorted shale pile	Surface water degradation	Redesign embankment face, channel water away from embankment face, install cover over face, diversion of runoff around disposal pile

Table 4.3-25 (continued)

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Surface water (continued)	Plant operation	Water quality degradation	Runoff control system
	Depletion of Colorado River water	Increased salinity	None
	Oil spills	Stream water degradation	None
	Abandonment Shale disposal pile erosion	Water quality degradation	Surface compaction, cover installed over face, revegetation
Aquatic ecology	Construction	Increase in fishing of 31,440 fishing trips per year	Stocking with 125,700 trout annually
		Overharvest of Colorado River cutthroat trout	Placement of special fishing regulations to control harvest
	Operation	Increase in fishing of 57,150 fishing trips per year	Stocking with 228,200 trout annually
		Overharvest of Colorado River cutthroat trout	Placement of special fishing regulations to control harvest
	Operation of intake structure	Entrainment or impingement of larval fish	Design of intake structure, to to less than .5 ft/sec, location of intake structure
Vegetation	Construction/operation	Elimination of 731 acres of existing limited important plant species, elimination of 214 acres of important plant species	Reclamation and revegetation
		Loss of individual plants of some special-status species	Avoidance, or transplanting
Wildlife	Construction Overlap of critical wildlife periods	Loss of wildlife species	Seasonal timing of construction
	Traffic	Road kills	Vehicle speed limit, mass transportation, seeding roadside with unpalatable grass
	Operation Plant site location	Habitat loss	Habitat recovery and replacement plan[a]
	Retorted shale disposal	Habitat loss	Habitat recovery and replacement plan[a]
	Linear disturbance	Interference with deer migration routes	Help develop regional wildlife management plan
	Linear disturbance	Habitat loss Also see pages 4-89 and 90	Habitat recovery and replacement plan
	Operation - general	Interference with wildlife	Minimize fencing, electrocution-proof transmission towers, offroad vehicle restrictions, institute company firearm policy, employee education program--no activity allowed within 0.5 mile of raptor nests, do not allow destruction of raptor nests

Table 4.3-25 (continued)

Affected environment	Action creating impact	Potential impact	Design control or potential mitigation
Cultural resources	Construction	Loss of minor historic sites	Avoidance or excavation and recordation
Visual resources	Construction/operation of access road	Visual contrast would exceed VRM Class II guidelines	Reclamation and revegetation of cuts and fills, end hauling, rerouting, use of low-visibility materials
	Construction/operation of pipelines/utility corridors	Visual contrast would exceed VRM Class II guidelines	Routing of pipelines in out-of-sight areas and areas of deep or readily revegetated soils, clearing additional vegetation to avoid straight lines
	Construction/operation of retorting facilities	Visual contrast would exceed VRM Class II guidelines	Neutral colors used on buildings and structures, design and locate structures to blend with form and line
	Abandonment	Remaining visual impact of access road	Continued maintenance
Noise	Construction/operation	Limited instances of noise in excess of 100 dBA at property line	Meet OSHA noise requirements
Land use and recreation	Construction/operation	Convert 1200 acres of rangeland and 100 acres of cultivated land to industrial use	To be determined by county permitting process; reclamation plan includes returning areas to their original use
		Conversion of 1347 acres of agricultural land to urban commercial/residential use	To be determined by county permitting process; reclamation plan includes returning to their original use
		Change of Scott Gulch from roaded natural ROS class to semiurban class	To be determined by county permitting process; reclamation plan includes returning to their original use
	Construction/operation	Increase of activity days of recreation use in region	Stock up to 228,200 fish annually
Socioeconomics	Construction, operation, abandonment	See 4.3.1.14	See 4.3.5.14
Transportation	Construction/operation	See 4.3.1.15	See 4.3.5.15

[a]Committed mitigation.

4.4.2 Description of Delphi process

The Delphi session was an interactive iterative group process and involved the accomplishment of several tasks at the session. These tasks included:

A. Definition of Impact Issues
B. Importance Ratio Assignment*
C. Statistical Analysis and Review*
D. Group Discussion*
E. Group Stability
*Repeated in each round.

4.4.2.1 Definition of impact issues

Once the group of principal investigators was assembled, a definition of each of the impact issues (including criteria) was presented for the alternatives of a given component (step 1). Each issue was discussed until the group felt it had a common understanding of the impact and its components. This did not mean that the group necessarily accepted the issue or criteria breakdown, rather it meant that the participants had achieved a basic understanding of the impact, so that subsequent steps might proceed on the assumption that all participants were operating from a common information base. Each participant was able to comment on the validity of each issue by assigning values during the assessment process.

4.4.2.2 Importance ratio assignment

At the conclusion of issue definition, each participant was provided with materials for importance ratio assignment. The participants then assigned an importance ratio to each impact issue (step 2). The importance ratio defined how many times more or less important one issue was with respect to another issue. The importance ratio did not reflect the absolute importance of an issue in isolation, but rather the "exchange rate" between issues. If, for example, one issue was assigned an importance ratio of "3" and a second issue was assigned a "1," then it could be said that the difference between alternatives with respect to the first issue was three times more important than the difference between alternatives with respect to the second issue.

The process of assigning importance ratios began by assigning the least important issue relative to the alternatives of a given component a base value of 1. The most important issue was then selected from the remaining issues, and a value assigned to it according to how many times more important it was than the least important one. The participant was not limited to selection of a single least- or most-important issue. Certain issues could be equally important or equally unimportant. Some issues might be completely irrelevant, for which a weight of 0 was used; or a participant might reserve judgment, in which case a weight of NR (No Response) was assigned.

The importance ratios assigned to the most-important and least-important issues defined the limits of importance ratios for all remaining issues. To complete the assignment of importance ratios, each remaining issue was assigned a value greater than the least important issue. The value of each intermediate issue was compared to one that had higher importance and to one that had lower importance. This helped to ensure that the intermediate values were correctly positioned in terms of relative relationship to other issues.

After importance ratios were developed for all issues, each participant tested or refined his scheme by successively comparing and questioning the importance ratios of the next least important and the next most important issues. For example, was wildlife really twice as important as ground water and air quality, and was recreation less important than wildlife but more important than ground water and air quality? This process was repeated until the participant was satisfied with the relationship that had been established among all the issues.

Once all participants had concluded the importance ratio assignment activity, the Delphi moderator initiated a statistical summary of the results.

4.4.2.3 Statistical analysis

The next task was to compile the results of all participants' importance ratios and perform a statistical analysis. (Each importance ratio scheme was initially normalized to permit other computations, step 3.) Worksheets were then returned with an entry showing the average values of the group for each issue (step 4). Other statistics on the importance ratios were computed, including the mean, mode, and standard deviation (to indicate convergence or divergence) as a test of the process and for use by the moderator. As the Delphi process was composed of several rounds of value assignments, the statistical summary was cumulative. By having successive columns for each round, each participant was aware of how the group values were changing throughout the Delphi process.

4.4.2.4 Group discussion

The group discussion (step 5) was conducted in two parts. First, each participant was allowed to present views or arguments concerning each issue, giving him the opportunity to try to persuade the other members of the group to change a specific importance ratio. Participants presented arguments without rebuttal from the group.

Once each participant had been given the opportunity to speak, an open discussion was held. During this discussion, the moderator exercised control over the group and discouraged participants from arguing on points that had already been presented. New ideas and new points about a particular issue of concern were encouraged.

Once all participants were given a chance to speak, the value-assigning process was repeated. Each participant assigned new values based on what had occurred during the previous round (step 6). The statistics were computed again and reported to the group (step 7). After review of the group statistics, each individual was aware of how the group value had changed and would then develop additional arguments or restate previous arguments in an attempt to persuade the group to move a value in a desired direction (step 9). The group discussion was reconvened, and the entire process was repeated (steps 10-12).

4.4.2.5 Achieving group stability

The first round of the procedure was considered to be primarily a learning round. Each individual, who was usually conversant with only some of the impact issues, learned about the other issues.

During subsequent rounds, as the participants began to learn more, new ideas occurred to them, new thoughts about the relative importance of issues were presented, and a greater exploration or a more comprehensive view of each potential impact was achieved. After the process was repeated several times, with the moderator continually monitoring several key statistical indicators, the group average opinion stabilized.

One of two types of stability occurred for each issue: consensus or polarization. Consensus occurred when, after several rounds, there was a small standard deviation. This was a result of everybody assigning close to the same value to an issue round after round. Polarization occurred when the group average stayed the same over several rounds, but the standard deviation remained high. In this case, one faction of the group had consistently assigned a high value to the issue in question, while another faction had consistently assigned a low value.

In the case of polarization, the Delphi moderator sought to examine those issues for which polarization had occurred to determine if the issue had been properly defined. More thorough discussion of this issue would, in most cases, after reassessment, result in a consensus. In other cases, the group would conclude that there was honest disagreements resulting from different points of view and the group opinion was recognized as the final judgement of the group.

Upon achieving a stabilized group opinion or importance ratio for each issue, the Delphi session was complete, and the final group averages were considered to be the collective group judgment concerning the importance of each of the issues of concern. These importance ratios were then applied as weightings in comparing project alternatives.

4.4.3 Results

Table 4.4-1 indicates individual scores for each alternative by discipline. These individual discipline scores were obtained by multiplying two factors: the intradisciplinary score assigned that alternative by the principal investigator; and the interdisciplinary weighting assigned to each discipline during the Delphi meeting of the principal investigators.

The individual discipline scores were totaled for each alternative to provide a final score for that alternative. These final scores were ranked for the alternatives of a particular component to identify the "best" or "least adverse"

Table 4.4-1. Environmental evaluation of alternatives

Component/ alternative	Climate and air quality	Topography and geology	Paleontology	Soils	Ground water	Surface water	Aquatic ecology	Vegetation	Wildlife	Cultural resources	Visual resources	Noise	Land use and recreation	Transportation	Total[a]
Plant Site Location															
Deer Park/Scott Gulch	3.4	3.4	NA	3.2	1.7	2.7	NA	2.1	1.8	1.1	NA	0.3	1.1	NA	20.8
Deer Park Gulch	1.7	3.4	NA	3.2	1.7	2.7	NA	1.8	2.0	1.1	NA	1.0	1.1	NA	19.7
Mesa Top	3.4	3.7	NA	3.5	2.1	3.0	NA	1.8	5.6	1.1	NA	1.6	2.6	NA	28.4
Hydrotreating Site Location															
Main Plant Site	1.3	0.7	NA	1.3	0.8	1.3	0.6	0.8	1.2	0.8	1.0	0.8	1.2	NA	11.8
Merchant Hydrotreater	1.3	1.3	NA	2.2	0.8	1.5	1.0	0.8	2.0	0.8	0.4	1.4	0.5	NA	14.0
Solid Waste Disposal[b] (Hazardous)															
Offsite Contract Disposal	0.5	1.6	1.2	4.9	1.4	5.4	NA	2.7	2.7	1.4	NA	NA	1.4	NA	23.2
Reprocessing	0.5	1.6	1.2	4.9	7.2	5.9	NA	2.2	2.7	1.4	NA	NA	1.1	NA	28.7
Onsite Landfill	0.5	1.2	1.2	2.3	2.0	4.5	NA	1.6	2.7	1.4	NA	NA	1.1	NA	18.5
Solid Waste Disposal[c] (Nonhazardous)															
Onsite Landfill	0.5	1.1	1.2	2.3	2.0	4.5	NA	1.6	2.7	1.4	NA	NA	1.2	NA	18.5
Offsite Contract Disposal	0.5	1.6	1.2	4.9	2.0	5.4	NA	2.7	2.7	1.4	NA	NA	1.4	NA	23.8
Retorted Shale Disposal															
Deer Park Gulch	1.1	2.7	0.7	3.3	2.0	4.2	NA	2.5	1.8	1.3	0.8	NA	1.2	NA	21.6
Mine Backfilling	1.1	5.2	0.9	8.3	2.3	6.0	NA	3.1	6.2	1.3	0.8	NA	1.2	NA	36.4
Mesa Top/Head-of-Hollow Fill	1.1	3.4	0.7	3.3	2.6	5.1	NA	3.1	5.8	1.3	1.0	NA	1.0	NA	28.4
Water Supply															
Federal Reservoir	NA	NA	NA	NA	NA	26.1	6.8	NA	NA	NA	NA	NA	24.7	NA	57.6
Private Reservoir	NA	NA	NA	NA	NA	26.1	6.8	NA	NA	NA	NA	NA	24.7	NA	57.6
GCC Reservoir	NA	NA	NA	NA	NA	24.4	6.8	NA	NA	NA	NA	NA	24.7	NA	55.9
Retort Technology															
Superior and TOSCO II	5.8	NA	NA	6.0	7.6	8.9	NA	4.3	4.6	NA	NA	NA	NA	NA	37.2
Superior	5.8	NA	NA	7.2	7.6	8.9	NA	4.3	4.6	NA	NA	NA	NA	NA	38.4
Union	5.8	NA	NA	7.2	7.6	8.9	NA	4.3	4.6	NA	NA	NA	NA	NA	38.4
Paraho	5.8	NA	NA	7.2	7.6	8.9	NA	4.3	4.6	NA	NA	NA	NA	NA	38.4
Others	5.8	NA	NA	7.2	7.6	8.9	NA	4.3	4.6	NA	NA	NA	NA	NA	38.4
Upgrading Technology[d]															
Two-stage, Fixed-bed															NA
Single-stage, Fixed-bed															NA
Ebullated Bed															NA
Electric Transmission Line Corridor															
Roan Creek Corridor (same as CCSOP)	NA	1.1	1.3	3.4	0.7	2.5	NA	2.3	2.1	1.9	1.9	NA	1.4	NA	18.6
LaSal Corridor (same as CCSOP)	NA	1.1	1.3	3.4	0.7	3.1	NA	2.3	3.2	1.9	4.1	NA	1.4	NA	22.5

Table 4.4-1 (continued)

Component/ alternative	Climate and air quality	Topography and geology	Paleontology	Soils	Ground water	Surface water	Aquatic ecology	Vegetation	Wildlife	Cultural resources	Visual resources	Noise	Land use and recreation	Transportation	Total[a]
Product Oil Pipeline Corridor[e]															
Tie-in at SOPS Terminal															NA
Tie-in at LaSal Pipeline															NA
Mining Methods															
Room-and-Pillar	NA	32.6	6.9	NA	21.9	11.9	NA	NA	NA	NA	NA	NA	NA	NA	73.3
Chamber-and-Pillar	NA	32.6	6.9	NA	21.9	11.9	NA	NA	NA	NA	NA	NA	NA	NA	73.3
Sublevel Stoping	NA	15.8	6.9	NA	21.9	9.5	NA	NA	NA	NA	NA	NA	NA	NA	54.1
Vertical Crater Retreat	NA	15.8	6.9	NA	16.6	9.5	NA	NA	NA	NA	NA	NA	NA	NA	48.8
Long Wall	NA	15.8	6.9	NA	21.9	9.5	NA	NA	NA	NA	NA	NA	NA	NA	54.1
Electrical Power Supply															
Transmission from Offsite Source	4.0	2.9	1.2	3.6	0.6	4.1	3.3	2.6	2.6	1.4	1.4	NA	2.8	NA	30.5
Onsite Generation	4.0	2.3	1.2	2.1	0.6	3.7	2.0	1.6	1.6	1.4	4.1	NA	2.2	NA	26.8
Materials Transportation															
Truck	0.8	1.0	NA	1.0	0.4	0.8	0.7	0.8	0.9	1.3	0.6	1.2	0.8	4.6	14.9
Railroad	0.8	1.0	NA	1.8	0.4	0.8	0.9	1.1	4.3	1.6	0.7	2.1	1.6	4.6	21.7
Mesa Top Access Road Location[f]															
Cliff Route	1.7	1.7	1.2	3.8	NA	2.5	NA	5.0	4.0	3.5	3.0	4.0	3.5	NA	33.9
Conn Creek Route	1.7	1.7	1.2	3.8	NA	2.5	NA	4.1	4.0	3.5	4.0	5.0	3.0	NA	34.5
Water Diversion Facility[f]															
Pacific Intake	NA	NA	NA	NA	NA	24.4	6.8	NA	NA	NA	NA	NA	NA	NA	30.2
GCC Intake	NA	NA	NA	NA	NA	24.4	4.0	NA	NA	NA	NA	NA	NA	NA	28.4

[a]The highest score indicates the most environmentally preferred alternative.
[b]Includes both oily sludges and spent catalysts as no environmental distinction could be made between these relative to potential impacts.
[c]Includes both biological sludge and garbage and scrap as no environmental distinction could be made between these relative to potential impacts.
[d]No environmental differences could be discerned among the three alternatives.
[e]Alternatives are discussed in BLM (1983b), which is incorporated by reference in this document.
[f]These alternatives were evaluated subsequent to the Delphi process. Baseline descriptions of the environment, comparisons with similar project components, and logical deductions were used to develop numerical ratings.

alternative. The highest score was best; the lowest score was worst. Disciplines that would not be affected by particular components are indicated in Table 4.4-1 as being not applicable (NA).

The absolute point values of the final scores given in Table 4.4-1 are important only in comparing alternatives within a given component; no conclusions can be reached by comparing the scores for alternatives of different components. The following paragraphs discuss the evaluation of alternatives by component.

4.4.3.1 Plant site location

The Mesa Top alternative was considered preferable from an overall environmental standpoint. No major changes in existing topography would be required. The depth to ground water is greater than 50 ft. There would be good dispersion of noise (L_{eq} levels are predicted to be no more than 5 dBA). No important or unique wildlife habitat would be disturbed. Locating the facility at the relatively remote mesa-top site was considered preferable from the viewpoint of land use and recreation compared to the locations adjacent to the Roan Creek Valley. Finally, the preference for this alternative was particularly strong relative to wildlife. Regionally, summer range (e.g., the mesa top) is less limiting to big game populations than is winter range (e.g., Deer Park and Scott gulches).

Other than from the standpoint of air quality and dispersion of emissions, there would only be minor environmental differences between consolidation of facilities in Deer Park Gulch, as opposed to dividing them between Deer Park and Scott gulches (the proposed action). In both instances, the plant location would: (1) be in an area of unstable geologic material; (2) require control of surface runoff and sediment through diversion ditches and catchment basins; (3) be in an area where depth to ground water is 20 ft; and (4) cause significant changes in the hydraulic regime.

The consolidation of all facilities in Deer Park Gulch would result in significant exceedances of Ambient Air Quality Standards; for instance, it is estimated that the 24-hour PSD increment would be exceeded by over 400 percent. The presence of special-status plant species in Deer Park Gulch makes consolidation there less preferable than the proposed action.

The proposed action (Deer Park Gulch/Scott Gulch) would disturb mule deer and elk winter range in Scott Gulch.

4.4.3.2 Hydrotreating site location

Since a merchant hydrotreater site is not identified, impacts of that alternative cannot be assessed comparably to those of the proposed action. However, it was considered that the proposed hydrotreating location in Scott Gulch would be less favorable than a merchant hydrotreater alternative at some unspecified location. Using a merchant hydrotreater could reduce Pacific Project water requirements, which could reduce the potential for impingement and entrainment of aquatic organisms. This alternative would also reduce onsite noise at the plant site; L_{eq} levels are predicted to be no more than 5 dBA. However, finding a location for the merchant hydrotreater alternative that would involve less impact than the plant site from a visual resources, land use, and recreation standpoint was considered to be unlikely. In addition, a significant negative factor weighting against the merchant hydrotreater alternative would be the need for an additional raw shale oil pipeline (of some unknown length) to connect retorting facilities with the hydrotreater, a situation that portends to have additional environmental impacts, including a minor potential for contamination of drainages during raw shale oil transport because of a pipeline failure.

In addition to the above, the main plant site would be in a rockfall area and would impact up to 4 acres of big game winter range.

4.4.3.3 Solid waste disposal (hazardous)

No distinction could be made between potential environmental impacts of oily sludge disposal and those of spent catalysts disposal (see Table 4.1-7). Therefore, these were grouped together when alternatives were compared.

No offsite hazardous waste disposal facility is identified, thus impacts of that alternative cannot be assesed comparably to those of onsite disposal. In comparing alternatives, however, it was assumed that the offsite facility would already be in existence and operating in accordance with current legal requirements. The reprocessing alternative for hazardous waste was considered preferable, from an environmental standpoint, with the offsite contract disposal alternative next most desirable. Disposal in an onsite landfill was considered worst because of the unstable geologic conditions in the area, the disturbance of existing soils and vegetation in the area of the landfill, and the potential for contaminant leakage to alluvial aquifers and surface waters. Offsite contract disposal would preclude essentially any adverse impacts associated with the disposal of hazardous wastes on the project area but could entail risks to the environment from transportation accidents.

Reprocessing was considered best from both ground water and surface water viewpoints as it would probably be completed in tankage and with mechanical equipment which would minimize leakage and potential contamination of water. This consideration was judged to be the most important issue.

4.4.3.4 Solid waste disposal (nonhazardous)

No distinction could be made between potential environmental impacts of garbage and scrap disposal and those of biological sludge disposal (see Table 4.1-8). Therefore, these were grouped together when alternatives were compared.

Assuming that disposal would be in an existing approved facility, offsite contract disposal of nonhazardous wastes (the proposed action) is considered more environmentally acceptable than disposal in an onsite landfill. The onsite landfill would be established in an area known to be geologically unstable and would unavoidably disturb existing soils and plant communities. Additionally, components of the nonhazardous waste could be absorbed by the surrounding soils eventually contacting alluvial aquifers and surface waters.

Offsite contract disposal would preclude essentially any adverse impacts related to nonhazardous waste disposal from occurring within the project area. Although, the closest of the three currently permitted sanitary landfills in Garfield County is 5 miles west of Rifle, approximately 50 miles from the Pacific Project site, impacts on transportation were not considered to be significant enough to differentiate impacts of alternatives.

4.4.3.5 Retorted shale disposal

Assuming that surface disturbance would be reduced, disposal of retorted shale by mine backfilling was considered environmentally preferable to disposal on the mesa top (head-of-hollow fill) or in Deer Park Gulch. However, because mine design and development constraints would only allow half of the retorted shale to be disposed by mine backfilling, the area of surface disturbance may be about the same as for the proposed action (Deer Park Gulch). Preventing degradation of water quality could be more difficult with mine backfilling than with surface disposal because of the likely presence of ground water in the mine zone. Mine backfilling would possibly reduce geologic subsidence.

The surface disposal alternatives would involve major changes in the existing topographic configurations of the mesa top and Deer Park Gulch areas and disposal would be on unstable geologic material. Surface disposal at either site would disturb surface soils; achieving maximum reclamation would require costly earthwork, moisture control, and seedbed preparation.

Retorted shale disposal in Deer Park Gulch would potentially affect critical habitat for mule deer and elk while the associated noise would degrade the quality of raptor nesting habitat along nearby headwall cliffs. It would significantly alter the hydraulic and hydrologic regime of the area and there would be a potential for erosion on the retorted shale embankment face which could result in degradation of water quality. Thus, disposal in Deer Park Gulch was considered to be the worst of the three alternatives from the viewpoints of ground water and surface water.

Mesa top/head-of-hollow fill was preferred over disposal in Deer Park Gulch. It would have less of an affect on the hydraulic and hydrologic regime and would not disturb any important or unique plant or wildlife habitat.

4.4.3.6 Water storage and supply

With the understanding that fluctuations in reservoir water level would remain within the historic range, the use of existing Federal or private upstream reservoirs for storage of the project's water supply was considered to be slightly more preferable to using the GCC Reservoir. Use of water stored in the Federal and private reservoirs, which are located on tributaries upstream from DeBeque, would possibly augment low flows of the tributary downstream of the reservoir and the reach of the Colorado River from the tributary mouth to the project's intake structure. Although it is not expected to have a significant affect on aquatic habitats, augmentation of low flows could improve water quality in this reach of the Colorado River. Use of water from Federal and private reservoirs in the upper basin would, otherwise, not significantly affect the existing environment.

The GCC reservoir is addressed in BLM (1983b). Use of that reservoir as a water supply for the Pacific Project would create minor additional impacts on the hydraulic and hydrologic regime of the drainage.

4.4.3.7 Retort technology

The potential for reclaiming the retorted shale produced from the various retort technologies was the major consideration for determining environmental acceptability. The Superior Retorting Process and TOSCO II combination was considered somewhat less desirable than Superior alone, Union, Paraho, and other technologies from an environmental perspective. Retorted shale from the TOSCO II process would include approximately 10 percent fine (<0.25 inch) material which, in large quantities, would be more susceptible to erosion than the larger "clinker" retorted shale which results from the Superior, Union, and Paraho technologies. No other environmental differences were perceived among the various alternatives.

4.4.3.8 Upgrading technology

The three alternatives for upgrading technology differ from one another primarily from an operational standpoint.

The two-stage fixed-bed hydrotreating process consumes the least hydrogen and is a more established process, particularly for oil shale. The disadvantage of the two-stage process as compared to the single-stage process is that additional equipment is required for the first hydrotreating stage and there are more complex operating requirements.

The single-stage fixed-bed process is the simplest process configuration and is the most straightforward unit to operate. A disadvantage is that it requires a higher overall hydrogen makeup than the other two alternatives. Another disadvantage is that the periodic switching of guard reactors is performed at high pressure.

The major advantage of the ebullated bed process is that of eliminating hot spots and maldistribution problems that are associated with fixed-catalyst beds. The process also permits onstream catalyst replacement in small batches. Disadvantages are that catalyst makeup requirements are higher and a large, high-pressure, high-temperature ebullating pump is needed.

No significant environmental differences could be discerned among the three alternatives. Consequently, an environmental comparison was considered to be not applicable.

4.4.3.9 Electric transmission line

Use of the LaSal utility corridor for the project's electric transmission line routing would be more environmentally acceptable than using the Roan Creek corridor. The LaSal corridor would meet BLM's visual resource management (VRM) objectives and would not be as visible to general viewers of the landscape. No important or unique habitats would be disturbed.

The Roan Creek corridor would exceed BLM objectives in a VRM Class III area and would be moderately visible. Additionally, the Roan Creek corridor passes through mule deer and elk critical winter range and peregrine falcon hunting and nesting habitat. Furthermore, development of the Roan Creek corridor could adversely affect a receiving stream through the disturbance and erosion of associated soils.

4.4.3.10 Product oil pipeline corridor

The alternatives of a pipeline tie-in at the SOPS terminal or at the LaSal terminal are discussed in BLM (1983b), which is incorporated by reference in this document.

4.4.3.11 Mining methods

The mining methods considered most desirable, from an environmental standpoint, are the room-and-pillar and the chamber-and-pillar methods; no environmental differences could be discerned between these. These methods would result in higher resource recovery rates than the remaining alternatives. There would only be minor quantities of unrecoverable oil shale above and below the Mine Zone as opposed to major quantities with the other three methods. There would also be less probability for subsidence and alteration of existing stream channels and erosion patterns with the room-and-pillar and the chamber-and-pillar methods.

The vertical crater retreat is considered least desirable primarily because of increased potentials for ground-water contamination, for encountering ground water of significant quantities, and for impacts on communications of surface and ground water.

The long-wall and sublevel stoping methods were judged to be comparable to one another. From a ground water viewpoint, these methods were considered to be more favorable than the vertical crater retreat method.

4.4.3.12 Electrical power supply

It was assumed that the offsite source of power would be an existing facility. Therefore, the most environmentally acceptable alternative for the project's electrical power supply would be the acquisition and transmission of power from an unknown existing offsite source.

Essentially the only environmental advantage of onsite power generation would be a reduction in visual impacts associated with the offsite transmission lines. The environmental disadvantages of onsite generation would include the need for establishing a power plant which would disturb additional surface, affecting soils, vegetation, and wildlife habitat. It would also require additional water for cooling, thereby increasing the quantity of water needed from the Colorado River. The additional water withdrawal would increase the potential for impingement and entrainment of aquatic organisms and would further reduce flows downstream during at least portions of the year.

4.4.3.13 Material transportation

Although some trucks would still be used, the use of a railroad to transport most materials from the main plant along Clear Creek to DeBeque, was considered most acceptable from an environmental standpoint. L_{eq} noise levels for train transport are predicted to be no more than 5 dBA and the railroad would be highly compatible with existing and planned land uses, and with land use management and policies. The additional surface disturbance for a rail spur would be of soils with good reclamation potential (see Section 4.2.4).

The use of trucks alone for this purpose would involve approximately 45 20-ton trucks traveling from the main plant facility to DeBeque and back daily while railroad transportation would involve only one unit train every 1 to 2 days. The potential for accidental spills, wildlife road kills, and noise persistence along Clear Creek would increase with the use of trucks only. L_{eq} noise levels are predicted to be between Colorado standards and 5 dBA less than standards. Existing roads would require upgrading which would include additional rights-of-way acquisition to accommodate the 20-ton truck traffic for both alternatives. The railroad would also require rights-of-way.

4.4.3.14 Mesa-top access road location

The Conn Creek route alternative for accessing the Mesa Top facilities was considered to be environmentally slightly more preferable than the proposed Cliff route. Both corridors are near known locations of sensitive plant species. The Conn Creek route would disturb approximately 0.5 mile of valley grassland, which is considered to be a sensitive vegetation type, and would cross bottomlands along Conn Creek, which could impact land use patterns. However, the visual and noise impacts associated with the Conn Creek corridor would be less than those associated with the Cliff route because of the Cliff route's proximity to the Clear Creek road and topographic features. The noise and visual impacts were considered to be slightly more important when evaluating the two alternatives. Therefore, the overall preference was for the Conn Creek route.

4.4.3.15 Water intake facility

Use of the GCC water intake for the Pacific Project water supply source was considered less desirable than the construction of a separate structure. The added intake demand on the GCC structure would increase intake velocities to approximately 2.0 cubic feet per second. This velocity, as opposed to the 0.5 cubic foot per second velocity of the Pacific intake, would greatly increase the probability of aquatic organisms becoming impinged or entrained. The same quantity of water would be withdrawn from the Colorado River regardless of the water diversion facility. Therefore, based on the increased potential for impingement and entrainment of aquatic organisms, the development of a separate intake structure was preferred.

4.4.4 Bureau of Land Management's preferred alternative

The Council on Environmental Quality (CEQ) Regulations state in Section 1502.14(e) that the lead agency must "Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternatives in the final statement unless another law prohibits the expression of such a preference."

Additional guidance is provided to agencies in the CEQ's March 16, 1981 memo, entitled, "Questions and Answers about the NEPA Regulations." The agency preferred alternative is explained as "The alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors. The concept of the "agency's preferred alternative," is different from the "environmentally preferable alternative," although in some cases one alternative may be both. It is identified so that agencies and the public can understand the lead agency's orientation." BLM's selection of the preferred alternative reflects their mandate as described in the Federal Land Policy and Management Act of 1976. Consideration has been given to agency mission, national policy, technical issues and the physical and human environments. The preferred alternative does not dictate final agency action.

The following is BLM's preferred alternative for the Pacific Project.

- Plant Site Location
  Deer Park/Scott Gulch

- Hydrotreating Site Location
  Main Plant Site

- Solid Waste Disposal (hazardous)
  Reprocessing

- Solid Waste Disposal (nonhazardous)
  Offsite Contract Disposal

- Retorted Shale Disposal
  Deer Park Gulch

- Water Supply
  Federal Reservoir

- <u>Retort Technology</u>
  Superior and TOSCO II

- <u>Upgrading Technology</u>
  Two-stage, Fixed-bed

- <u>Electric Transmission Line Corridor</u>
  Roan Creek Corridor (same as CCSOP)

- <u>Product Oil Pipeline Corridor</u>
  Tie-in at SOPS Terminal

- <u>Mining Methods</u>
  Room-and-Pillar

- <u>Electrical Power Supply</u>
  Onsite Generation

- <u>Materials Transportation</u>
  Railroad

- <u>Mesa Top Access Road Location</u>
  Conn Creek Route

- <u>Water Diversion Facility</u>
  Pacific Intake

5 Cumulative Impacts

Section 1508.7 of the CEQ Regulations defines cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions . . . ." This chapter assumes major development of shale oil projects, and that the impacts of the Mobil Project and the Pacific Project would be combined with those of other proposed projects in the region.

The future of oil shale development is controversial because of the fluctuating price of oil and unproven technological developments. Because of this uncertainty, the BLM chose to include within a high-development scenario future oil shale developments which would be situated within the probable environmental impact area of the Mobil and Pacific projects, and for which there was sufficient information available from EISs to evaluate the impacts.

Specifically, the cumulative impact analysis assumes that there would be concurrent development of the Mobil Project (100,000 bpd), the Pacific Project (100,000 bpd), Union Oil Company's Phase II (90,000 bpd) Parachute Creek Oil Shale Project, Chevron Shale Oil Company's Clear Creek Shale Oil Project (100,000 bpd), the Exxon Colony Shale Oil Project (47,000 bpd), and the Colorado-Ute Electric Association's Southwest Electrical Generation Project (Units 1 and 2); the latter is assumed to be built and operational because of the need that there would be for additional electrical energy. Because regional air quality is influenced by more distant developments as well, the cumulative impact assessment for air quality assumes sources of emissions in addition to those listed (see Figure 5.1-1).

In the following sections, cumulative impacts are addressed by discipline in the same order as in Chapters 3 and 4. Cumulative effects are discussed in terms of being additive, synergistic, or reductional. In each case, the planning and environmental information used for other shale oil projects was that contained in draft or final EIS documents; BLM file information was used for the Southwest Electrical Generation Project. Because of different methodologies, levels of detail, etc., all information was not sufficiently comparable to permit summation of impacts and detailed analyses of cumulative effects. Thus, conclusions reflect professional judgment based on that information which was available for each discipline.

The time period covered is from the present to the year 2009. The assumed schedules for the Mobil Project and the Pacific Project are as described in Chapter 3 and Chapter 4, respectively. The assumed schedules for other projects are as in the latest approved CITF BAS file.

The "No-Action" scenario assumes the existing environmental conditions of the region except that socioeconomic impact assessments assume "No-Action" growth projections through the year 2009, as discussed in Sections 3.3.1.14 and 4.3.1.14.

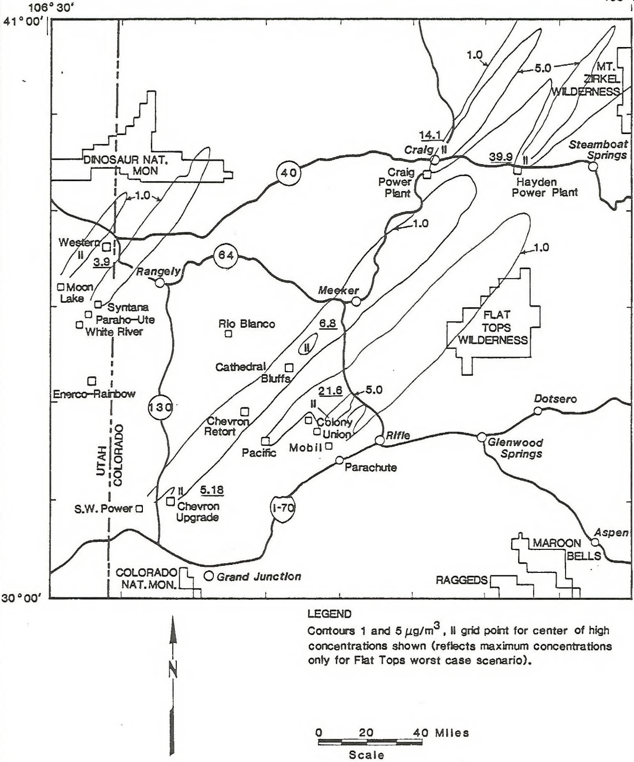


Figure 5.1-1. Predicted SO^2 ground-level concentrations ($\mu g/m^3$) for TAPAS model 24-hour worst-case scenario for Flat Tops wilderness area

5.1 CLIMATE AND AIR QUALITY

Complex I and TAPAS models were employed for cumulative impact evaluations, as described in Sections 3.3.1.1 and 4.3.1.1. Cumulative effects were evaluated for nearby and more distant Class I areas based on the high-development scenario which assumed emissions from operation of the Mobil, Pacific, Union Phase II, Chevron, and Colony shale oil projects, and the Southwest power project. In addition, since air quality is affected by broad, regional factors, the assessment of impacts using TAPAS (for assumptions, see Dames & Moore, 1984) also considered emissions from other western Colorado and eastern Utah projects, including the Cathedral Bluffs, Rio Blanco, Enercor-Rainbow, Paraho-Ute, Syntana, Western, and White River shale oil projects, and the Hayden, Craig, and Moonlake power projects. The projected worst-case emission scenarios for the Mobil and Pacific projects were used in these evaluations.

"Worst-case" long-range-transport TAPAS modeling was centered on the Flat Tops Wilderness Area, which is the closest Class I area to the Mobil and Pacific projects, and is also downwind of prevailing winds from these projects and most other regional sources. The Mount Zirkel Wilderness Area, although more distant, is downwind from Mobil, Pacific, and a large number of other regional sources; thus, it was also evaluated using the TAPAS model.

There is some uncertainty in the results of any atmospheric dispersion modeling. Therefore, the possibility exists that increments or standards may be exceeded, which could result in the denial of permits for some of the oil shale projects (or at least later phases of the projects). Moreover, various air quality models predict different levels of long-range impacts. Modeling efforts for a PSD permit, for example, may be more conservative than modeling done solely for NEPA purposes.

Results from the TAPAS and Complex I models for Class I areas are shown in Table 5.1-1. There were no predicted exceedances of the PSD increments or NAAQS. Figure 5.1-1 shows predicted ground-level concentrations of SO_2 for the worst-case Flat Tops Wilderness Area scenario. As previously discussed in Section 3.3.1.1, TAPAS trajectories are steered to the south of the Flat Tops Wilderness Area for winds with a slightly more westerly component; also, such scenarios show less persistency. Consequently, Table 5.1-1 and Figure 5.1-1 reflect the highest concentrations predicted by the TAPAS model based on the 18 months of data collected for the Mobil Project (Mobil, 1983b). Complex I, on the other hand, reflects a worst-case 24-hour concentration with the plume centerline moving directly at the Flat Tops Wilderness Area receptors.

Maximum SO_2 24-hour concentrations projected for the Flat Tops ranged from 1.78 $\mu g/m^3$ (TAPAS) to 3.14 $\mu g/m^3$ (Complex I), or from 36 percent to 63 percent of the increment. The SO_2 3-hour Complex I value was 12.87 $\mu g/m^3$, or 51 percent of the increment; the annual Complex I value was 0.85 $\mu g/m^3$, or 42 percent of the increment. Particulate matter 24-hour concentrations ranged from 0.5 $\mu g/m^3$ (TAPAS) to 1.88 $\mu g/m^3$ (Complex I) or from 5 to 19 percent of the Class I increment. The annual particulate matter Class I value was predicted to be 0.54 $\mu g/m^3$, or 11 percent of the annual allowance. The cumulative NO_x annual concentration was predicted to be 4.9 $\mu g/m^3$, or 5 percent of the NO_2 NAAQS.

The TAPAS model projected a maximum 24-hour SO_2 concentration at the Mount Zirkel Wilderness Area of 2.65 $\mu g/m^3$ or 53 percent of the increment; the maximum

Table 5.1-1. Maximum predicted cumulative SO_2 and particulate matter (PM) concentrations in regional Class I areas ($\mu g/m^3$)

FLAT TOPS WILDERNESS AREA

Pollutant	Averaging time	Complex I Concentration	Complex I Percent Class I increment	TAPAS Concentration	TAPAS Percent Class I increment
SO_2	Annual	0.85	42	--	--
	24-hour	3.14	63	1.78	36
	3-hour	12.87	51	--	--
TSP	Annual	0.54	11	--	--
	24-hour	1.88	19	0.5	5

COLORADO NATIONAL MONUMENT[a]

Pollutant	Averaging time	Complex I Concentration	Complex I Percent Class I increment
SO_2	Annual	0.35	18
	24-hour	2.92	58
	3-hour	8.86	35
TSP	Annual	0.24	5
	24-hour	1.89	19

DINOSAUR NATIONAL MONUMENT[a]

Pollutant	Averaging time	Complex I Concentration	Complex I Percent Class I increment
SO_2	Annual	0.23	12
	24-hour	1.59	32
	3-hour	5.78	23
TSP	Annual	0.16	3
	24-hour	1.53	15

MOUNT ZIRKEL WILDERNESS AREA

Pollutant	Averaging time	TAPAS Concentration	TAPAS Percent Class I increment
SO_2	24-hour	2.65	53
TSP	24-hour	0.39	4

[a]Colorado National Monument and Dinosaur National Monument are State Category I areas; SO2 increments are identical to those for PSD Class I areas.

projected particulate matter 24-hour concentration was 0.39 $\mu g/m^3$ or 4 percent of the increment. Projected emissions from the Hayden power plant contributed largely to the SO_2 levels.

The Complex I model was used to assess cumulative impacts on other sensitive (Class I and Category I) areas. Results from this model are considered highly conservative, because in the actual worst-case scenario identified transport would be influenced by complex topography and diverse wind variations along the trajectories, and pollutants would be unlikely to arrive at sensitive receptors as predicted. Modeling results indicate that the Mobil and Pacific projects would have small effects on the air quality of the other sensitive areas. Complex I results for cumulative impacts on the Colorado National Monument and Dinosaur National Monument are shown in Table 5.1-1. These predictions indicate no exceedances of any Category I SO_2 or Class II TSP incremental allowances (see Dames & Moore, 1984).

Plumes modeled for many of the regional power plant and oil shale sources would not affect Flat Tops Wilderness Area receptors under the worst-case meteorology assumed. For example, with southwest winds, the plumes from the Western, Syntana, Paraho-Ute, and White River facilities in Utah move directly toward the Dinosaur National Monument (Figure 5.1-1). On the other hand, on days when emissions from these facilities might reach the Flat Tops Wilderness Area (more westerly winds), the southern Piceance Basin oil shale facility emissions would be likely to move south of the Flat Tops.

Results (Table 5.1-2) from high-development scenario cumulative impact modeling for the immediate vicinity of the Mobil Project, using Complex I (Dames & Moore, 1984), indicate approximately 3 to 7 percent increases over direct Mobil concentrations alone for various PSD criteria pollutant levels. All predicted maximum concentrations would be below the NAAQS and PSD increments. The highest cumulative ground-level concentrations from all sources would occur at the property line of the Pacific Project. Results from modeling of high-development scenario cumulative impacts produced essentially the same results within 5 km of the Pacific Project as for the Pacific Project alone (Table 4.3-4). This is because the Pacific emission sources would be located at relatively low elevations in Clear Creek valley, Deer Park Gulch, and Scott Gulch; maximum concentrations predicted by the model were almost entirely from Pacific operations in these sheltered valleys as shown in Table 5.1-2. Other than for particulates, the values in Table 5.1-2 are below NAAQS and PSD increments. Pacific did additional modeling after the DEIS was completed using additional meteorological data and a revised emissions scenario which showed the PSD Class II increments for particulates may be exceeded near the Pacific Project site. Concentrations predicted by Pacific's additional modeling are reflected in Table 5.1-2 since it is reasonable to assume that the particulate Class II increments would be exceeded.

High-development scenario cumulative impacts were also modeled using Complex I for Colorado River Valley towns and other sensitive regional receptors. Results are shown in Table 5.1-3. Maximum incremental increases in the concentrations at the towns were about 3 percent of the PSD Class II incremental allowances. Maximum concentration increases at the Grand Hogback were somewhat higher but remained less than 12 percent of the SO_2 Class II increments, and 15 percent of the TSP Class II increment.

Table 5.1-2. Maximum predicted SO_2, particulate matter (PM), and NO_x concentrations in Class II areas near Mobil and Pacific projects resulting from high-development scenario sources ($\mu g/m^3$)

Pollutant	Averaging time	Near Mobil	Percentage PSD	Near Pacific	Percentage PSD
SO_2	Annual	9.3	47	17.9	89
	24-hour	41.1	45	82.0	90
	3-hour	272.2	53	438.3	86
TSP[a]	Annual	8.3	44	20.4	107
	24-hour	26.9	73	48.1	130
NO_x	Annual	67.8	68[b]	91.8	92[b]

[a]Pacific updated modeling results (Table 4.3-4) indicate the PSD Class II increment near the Pacific Project may be exceeded.
[b]Percent NO_2 NAAQS.

5.1.1 Acid deposition

Deposition of elemental sulfur from cumulative SO_2 emissions at Class I/ Category I areas were estimated using TAPAS and Complex I models. Estimated deposition velocities were used to determine the total wet and dry sulfur deposition rates (Dames & Moore, 1984). Results were as follows:

Sensitive area	Total wet and dry sulfur deposition (kg/HA-yr)
Flat Tops Wilderness Area	0.42 to 2.68[a]
Colorado National Monument	1.10
Dinosaur National Monument	0.72
Mount Zirkel Wilderness Area	0.62

[a]Range using TAPAS and Complex I, respectively.

These rates are about 2 to 10 percent of the postulated 13 kg/HA-yr threshold impact value described in Section 3.3.1.1.

Turk and Adams (1982) surveyed 27 lakes in the Flat Tops Wilderness Area to measure the lakes' sensitivities to acidification. The most sensitive lake measured was Ned Wilson Lake at 11,120 feet elevation, which had a measured alkalinity of 70 µeq/L. The sulfur and nitrogen deposition rates stated above would result in a pH change in Ned Wilson Lake of from -0.03 using the TAPAS results, to -0.31 using the Complex I results. As previously discussed, the TAPAS results are expected to be more realistic.

Table 5.1-3. Maximum predicted incremental concentration increases in micrograms per cubic meter for cumulative high-development point source scenario impacts at sensitive Class II regional receptors

	SO_2			PM		NO_x	CO	
Receptor	3-hour average[a]	24-hour average[a]	Annual average	24-hour average[a]	Annual average	Annual average	1-hour average[a]	8-hour average[a]
DeBeque	7.19	1.39	0.15	0.83	0.11	0.77	28.67	4.73
Parachute	11.96	2.23	0.24	1.35	0.15	1.27	35.14	5.06
Rifle	5.95	0.96	0.12	0.82	0.08	0.62	29.90	4.36
Grand Junction	3.94	1.13	0.10	0.88	0.09	0.48	24.27	3.59
Grand Mesa	5.02	1.59	0.19	1.23	0.13	0.82	31.51	7.26
Grand Hogback	39.22	8.70	2.37	5.52	1.50	9.66	200.58	31.88

[a]Second-highest concentration because NAAQS allow one exceedance per year of the short-term standards.

5.1.2 Secondary impacts

This section presents the estimated air quality impacts from secondary growth emission sources that would be associated with the cumulative high-development scenario. Secondary growth impacts were focused on the following representative locations in the Colorado River Valley: Rifle, DeBeque, Parachute, and Grand Junction. Projected emissions were based on population growth projections presented in Section 5.14.5 and emission inventories established in a 1982 report on air quality impacts of oil shale and related growth in western Colorado (PEDCo, 1982). Projected growth emissions were modeled using a box model to simulate the worst case meteorological conditions of a severe inversion (mixing depth 100 m) combined with very light winds (1 m/sec).

Results, which are provided in Table 5.1-4, indicate modest increases of SO_2, NO_x, and particulate matter at all locations. Since these concentrations are predicted from emission rates and do not include background, these results are useful only as a tool for understanding how air quality might change in a relative sense. Actual concentrations may be higher, particularly for TSP as it includes the measurement of reentrained dust as well as direct emissions.

Table 5.1-4. Estimated high-development scenario secondary pollutant impacts at representative Colorado River Valley locations (24-hour average concentrations expressed in $\mu g/m^3$)

Town	1980[a]	No action[b]	High-development scenario
Rifle			
SO_2	2	3	9
NO_x	14	28	88
PM	49	62	123
DeBeque			
SO_2	2	2	2
NO_x	16	16	28
PM	34	35	47
Parachute			
SO_2	1	2	4
NO_x	20	29	44
PM	92	102	116
Grand Junction			
SO_2	11	14	18
NO_x	103	132	177
PM	122	152	197

[a]Calculated from 1980 emissions.

[b]Based on projected population increases through 1999 for Rifle, DeBeque, and Parachute, and through 2009 for Grand Junction without regional oil shale development (see Sections 3.3.1.14 and 4.3.1.14).

5.2 TOPOGRAPHY, GEOLOGY, AND MINERAL RESOURCES

Impacts of the high-development scenario would be site-specific and additive. A total of about 10 square miles would undergo considerable change in topography, especially as a result of surface disposal of retorted shale.

There would also be significant depletion of mineral resources. At the end of a 20-year period, a total of about 3 billion barrels of oil will have been produced, causing the depletion of about 2 percent of the higher grade oil shale resource of the Mahogany Zone in the Piceance Basin. However, the production rate of 437,000 bpd of shale oil would replace more than 10 percent of the oil imports now required by the United States. Construction of oil shale project facilities, as well as other industrial and municipal construction as a result of oil shale development, would use significant quantities of sand and gravel deposits of the Colorado River in this region. Electric power and energy demands associated with this oil shale development would increase production, and add to the depletion, of coal and natural gas resources in northwestern Colorado.

5.3 PALEONTOLOGY

Impacts on any paleontological resources would be site-specific and additive. Paleontological losses would be proportional to the volume of oil shale containing paleontological values extracted by mining. The covering of some areas with retorted shale, water impoundments, and other surface facilities may preserve some paleontological resources by isolation. This effect would also be site-specific and additive.

5.4 SOILS

Impacts of the high-development scenario on soils would be site-specific for each project and additive in total. Offsite impacts would be minor and consist of slight increases in depositions from wind and water erosion of affected areas. The cumulative effect is not expected to be major.

5.5 GROUND WATER

Cumulative impacts on ground water would result largely from mine dewatering/depressurization operations where the respective 'cones' of influence overlap. With the exception of the Mobil and Union 90 projects, the proposed oil shale developments are effectively isolated hydrologically from other projects by intervening drainages and deep canyons. Therefore, the cumulative impacts on ground-water quantities will be insignificant. In general, the impacts caused by oil shale developments and the Southwest Power Project would be independent and not cumulative.

Project-specific impacts on ground-water quality have the potential of occurring in combinations (e.g., if accidental releases should occur in a common drainage or corridor). Whether these cumulative impacts would be synergistic, reductional, or additive would depend upon the interaction of various constituents but, in general, the impacts would be expected to be additive.

5.6 SURFACE WATER

5.6.1 Surface-water quantity

Annual withdrawals from the Colorado River of about 21,000 acre-feet for Pacific, 16,000 acre-feet for Mobil, 25,000 acre-feet for the Clear Creek Shale Oil Project, and similar quantities for the Union, Southwest, and Colony Oil Shale projects are expected to result in streamflow depletion of the river. Preliminary rough estimates indicate that Colorado River flow could be depleted by 10 percent or more. The construction of a reservoir on Roan Creek would block a major portion of the annual flows of Roan Creek and the river's tributaries from reaching the Colorado River, which could further reduce its annual flows by about 4 percent. This would result in a total Colorado River streamflow depletion of 14 percent or more. A portion of the above-mentioned depletions, particularly in the river reach between the mouth of Elk Creek and Mahaffey Ranch, would be made up by controlled releases from the Main Elk Creek Reservoir. The stream depletion during low-flow periods would be further reduced by the fact that most of the withdrawals would be limited to high-flow periods and most of the releases from the proposed reservoirs would be made during low-flow periods.

5.6.2 Surface-water quality

5.6.2.1 Spills

All five of the oil shale projects under review would use pipeline transport of product oil, with tie-ins to either the LaSal or SOPS pipelines. This transport method would result in relatively low risks of surface water quality degradation because of oil spills compared with other transport means. The combined risks of all of the projects would be reductional, since two common major carrier pipelines are proposed for transport to a major market area. Spill risks would be minimized if only one of the major carrier pipelines (LaSal or SOPS) is constructed.

Cumulative spill risks because of rail and truck transport of blasting materials, fuels, and by-products would be additive. Because of the combined transport of materials for all five oil shale projects, there would be a moderate risk of short-term surface water quality impacts on Clear, Roan, and Parachute creeks, and on the Colorado River during the common operating period of the five projects.

5.6.2.2 Tributary water quality impacts

Cumulative water quality impacts on Colorado River tributary streams associated with land disturbance, handling of solid and liquid wastes, fuels and by-products, and retorted shale disposal would generally be additive for the projects situated in the same drainage basins. Impacts would occur on Parachute Creek from the Colony, Union, and Mobil projects, while Clear and Roan creeks would be impacted by the Pacific and Clear Creek projects. The full effect of the three Parachute Creek projects would be exerted on a 4-mile segment of Parachute Creek below Wheeler Gulch. The full effect of combined water quality impacts of the Clear Creek and Pacific projects would occur on 3 miles of Clear Creek to its confluence with Roan Creek, and 15 miles of Roan Creek to the Colorado River at DeBeque.

The cumulative impacts of the shale projects on tributary water quality would also be affected by variations in the scheduling of the projects. While impact analyses for individual projects have generally dealt with effects of the maximum construction, operation, and post-reclamation period configurations and rates of activity, different sequences and schedules of activity levels and project phases would, in some cases, result in ameliorated cumulative impacts.

Increases in sediment loading, total dissolved solids (TDS) and specific chemical species because of land disturbance during construction activities would occur in both the Parachute and Roan Creek drainages through about the year 2005. However, not all the projects would be at peak construction levels and areas of disturbance at the same time. Also, irrigation withdrawals and return flows along the drainages would tend to seasonally reduce the combined effects of the projects. Natural stream siltation processes may also reduce the combined effects of suspended sediment loading increases from the projects.

Increases in TDS and specific trace metals and organics could potentially occur because of leaching of retorted shale, leaching of solid and liquid waste disposal areas, and from fuel and by-product tank leakage. Such increases would generally be additive except where reduced by irrigation, as described above. The cumulative impacts on tributary surface-water quality because of failure of containment systems cannot be quantified since the rates of leakage and leachate migration to streams are unknown, but could involve a wide range of pollutants including organics, TDS, and metals.

Eventual water pollution from erosion and leaching of the retorted shale embankments is, likewise, difficult to quantify. Depending on the rates of pollutant migration from the reclaimed shale piles, cumulative impacts on stream segments could potentially range from no significant impact to major degradation of water quality.

5.6.2.3 Colorado River water quality impacts

Impacts to Colorado River water quality because of the combined effects of the five oil shale projects would converge at the mouth of Roan Creek near DeBeque, Colorado. Despite the influence of tributary siltation and irrigation, there would be a slight increase in Colorado River sediment loading during the period up to 2005, when the projects are under construction.

Cumulative impacts of the five shale projects plus the Colorado-Ute Southwest power plant on salinity in the lower Colorado River Basin would be additive. However, the varying schedules on which the shale projects would achieve and maintain peak shale oil production rates and water demands would limit the period of maximum impacts to the years 2007 through 2015.

Nominal Colorado River and tributary water withdrawals for the projects would be as follows:

- Mobil - 22.6 cfs.
- Pacific - 32 cfs.
- Clear Creek - 33 cfs (BLM, 1983).
- Union - 19 cfs (Union, 1982).
- Exxon-Colony - 12.5 cfs (BLM, undated).
- Colorado-Ute Southwest power plant - 12 cfs (Burns and McDonnell, 1982).

The combined increase in TDS at Imperial Dam (on the lower Colorado River border of southern California and Arizona) because of these water withdrawals is estimated to be approximately 5.0 to 5.5 mg/l, using the U.S. Department of the Interior (1983) model equation as a basis. This increase would constitute about 0.6 percent of the salinity standard of 879 mg/l at Imperial Dam and would have an annual value (1982 dollars) of about $2.8 million (Colorado River Basin Salinity Control Forum, 1981).

Long-term stream pollution after reclamation because of ground water contact with and surface runoff erosion of retorted shale embankments should be of low to moderate intensity on the Colorado River. The net effect could be a long-term increase in parameters such as TDS, sulfate, fluoride, boron, molybdenum, and zinc. These increases could potentially impair uses of river water downstream of DeBeque.

During heavy snowmelt and precipitation runoff events, when erosion of reclaimed retorted shale embankments would be most intense, the loadings of pollutants on the Colorado River could be high. However, all shale oil projects would have run-on and runoff controls for process facilities and processed shale disposal areas. Moreover, general high runoff conditions on the Colorado River, such as during the major spring snowmelt, would cushion the impact of these pollutant loadings from the Roan and Parachute creek drainages.

The most severe impact on the Colorado River because of reclaimed retorted shale embankments could occur when heavy late summer thunderstorms cause high runoff and erosion rates in the Roan and Parachute creek drainages while Colorado River flow is relatively low. In this case, high pollutant loadings from the tributaries could cause significant increases in the concentrations of pollutants in the river. The severity of this impact would be limited by the generally isolated nature of these storms. It is unlikely that high precipitation and runoff would occur concurrently on all the retorted shale embankments.

5.7 AQUATIC ECOLOGY

Consideration was given to cumulative effects of habitat reductions resulting from increased water withdrawal from the Colorado River system, air emissions (acid precipitation), and increased fishing pressure.

Water withdrawal for the high-development scenario is discussed in Section 5.6. It is projected that annual water withdrawal could exceed 14 percent of the average annual flow of the Colorado River. Water withdrawals during low flow periods would have the largest detrimental impacts on downstream aquatic habitat. Water withdrawal operational plans for the various projects are presently not adequately defined to allow water withdrawals during low flow periods to be projected. Therefore, impacts can be expected during low flow periods, but the exact impacts on downstream aquatic habitat cannot be projected. Of special concern are flows required to maintain essential habitat for Federally listed threatened and endangered fishes in downstream reaches of the Colorado River. Important downstream riverine areas within the National Park system (e.g., Canyonland and Grand Canyon national parks, and Glen Canyon and Lake Mead national recreation areas) could be altered as a result of reduced flows.

Air emission modeling indicates that with all six projects in operation and with worst case conditions, total acid deposition (sulfur + nitrogen) would be less than 5 kg/ha-yr in either the Grand Mesa or Flat Tops Wilderness Areas. Acid deposition of less than 13 kg/ha-yr is not likely to impact even the most sensitive aquatic ecosystems (Environment Reporter, 1983). Therefore, even under the high-development scenario, acid precipitation should not adversely impact aquatic resources.

The development of the six projects is expected to increase the population of the area by more than 70,000 people (Section 5.14.4), resulting in an estimated increase in fishing pressure of about 624,000 trips annually. If the CDW's goal of 2.3 fish per fishing trip is achieved, an additional 1.4 million fish would be harvested annually. The aquatic resources of the area are presently harvested at or above production capacity and, therefore, cannot produce additional fish. If stocking is used to prevent overharvesting of the fishery resource, approximately 2 million additional fish would need to be stocked in the region annually to achieve the CDW goal. Streams containing Colorado River cutthroat trout would probably need to be closed to fishing if the species is to be protected.

5.8 VEGETATION

Impacts of the high-development scenario on vegetation would be site-specific and additive. Special-status species would be avoided when possible and impacts on them would only be moderate. Losses of important plant communities would be limited and losses of limited importance communities would not be extensive. Impacts on plant metabolic processes by cumulative air quality effects are expected to be negligible.

5.9 WILDLIFE

Cumulative impacts on wildlife resulting from the high-development scenario would be largely additive. Habitat loss resulting from each project would reduce the regional carrying capacity for all species of wildlife. This loss can be at least partially expressed by the simple measure of acreage removed from productivity. Whether impacts to wide ranging species (e.g., big game and raptors) would be additive or synergistic is not certain. Conceivably, one facility could displace a portion of a wildlife population to nearby areas, whereas multiple facilities could eliminate the habitat that is capable of supporting increased wildlife densities. Another cumulative effect on wildlife would occur from the projected curvilinear increase in human population as a result of additional facilities. More people in the region would result in more recreation, more offsite disturbances, increased possibilities for accidental forest and range fires, increased road kills, etc. Because of increased revenues (e.g., from taxes and hunting licenses), more funds could be made available for wildlife education, law enforcement, recreation, and the purchase of lands for the preservation of critical wildlife habitats.

5.10 CULTURAL RESOURCES

The potentially affected cultural resources are predominantly archaeological sites associated with prehistoric aboriginal and historic Euro-American use of this portion of west-central Colorado; no significant historic aboriginal sites have been identified. The cultural resources provide opportunities for research and interpretation because of their temporal depth and regional extension.

The significance of cumulative impacts would be relative to an enhancement of knowledge about prehistoric and historic societies (beneficial impact) or degradation of the special scientific qualities and opportunities that the resources provide (adverse impact). Such impacts would be more "indirect" because they would not concern direct modifications of specific resources, but rather generalized modifications to a body of resources (i.e., cultural resources in west-central Colorado). Actions that would produce these indirect impacts would be cumulative increases in population in the region, increased recreation on public lands, and a cumulative increase in the attention invested in these resources by public agencies, in anticipation of, and in response to, the several proposed actions.

5.11 VISUAL RESOURCES

Cumulative visual impacts become significant when the overall character of the landscape begins to change. Four categories of landscape character have been identified in the study region: natural-dominated scenic, natural-dominated common, manmade-dominated, and man-natural mix.

Sensitive viewpoints of the various projects would include those from Interstate 70, the Parachute Creek Road, the Roan Creek Road, the River Road, and the communities of DeBeque, Parachute, Battlement Mesa, and Morrisania. The lands seen from these viewpoints are primarily of a scenic-natural character within which occur some areas of man-natural mix character. In addition, the communities themselves and the Union upgrading facility represent isolated man-dominated areas.

With the high-development scenario, the overall visual character of the region would unavoidably change. Overall, the scenic-natural character would begin to change to a man-natural mix. Because of the scale and dominance of scenic-natural features, however, only isolated areas, such as within the proximity of retorting and upgrading facilities, would become man-dominated.

The Roan and Parachute Creek valleys, which would contain concentrated utility corridors and from which the primary project facilities would be most directly seen, would likely be most affected. The visual change, as seen from the roads through these valleys would be a significant adverse impact with the area becoming man-natural mix with some man-dominated areas.

Various projects would be seen intermittently from Interstate 70 for a distance of approximately 20 miles. Only from a 7-mile segment of Interstate 70 in the Parachute area, however, would the view be close enough to be considered as an overall change from natural-scenic and man-natural mix to a greater proportion of man-natural mix and some man-dominated areas. This would also be the case for the River Road, Morrisania, Battlement Mesa, and Parachute. The overall visual impact in this area would be a significant adverse effect.

5.12 NOISE

Since the oil shale developments in the Piceance Basin/Roan Plateau area would all be separated by many miles, there would be no cumulative noise impact in the region. Some increase in noise would be experienced in the communities of Rifle, Parachute, and DeBeque; however, this should be generally low and no more than that experienced by other small towns in Colorado during recent growth periods.

5.13 LAND USE AND RECREATION

5.13.1 Land use

The high-development scenario would have a major influence on existing land use within Mesa and Garfield counties. Total direct surface disturbance related to the high development scenario would be approximately 43,300 acres. Nearly all of this disturbance would be of lands currently used as rangeland, and to a lesser extent, cultivated lands which are located along valley bottoms in the Roan and Parachute Creek drainages.

Secondary land-use impacts associated with increased population would also be significant. These projected changes are shown in Table 5.13-1. A total of approximately 9600 acres of new development would be required to support cumulative population increases, including about 4800 acres each in Mesa County and in Garfield County.

Within Garfield County, nearly half of the projected development is expected to occur at Battlement Mesa. The Rifle vicinity would receive the next largest amount (25 percent), and the remainder would be spread out between Carbondale, Glenwood Springs, New Castle, Parachute, Silt, and unincorporated areas within the county. The projected distribution of new development in Mesa County is as follows: unincorporated areas (45 percent); Grand Junction (35 percent); and Palisade, Fruita, and DeBeque (estimated to be 6, 9, and 5 percent, respectively).

The magnitude of projected land-use requirements would have a significant effect on the existing land-use pattern in the project region. Probably the most notable effect would be increased development pressure on cultivated lands, including prime farmlands and orchards in the Grand Junction-Palisade vicinity.

Table 5.13-1. Expected land-use requirements (acres) associated with the cumulative increase in population[a]

Year 2009	Garfield County	Mesa County	Total (Mesa and Garfield)
Residential[b]	3048	3088	6136
Commercial[c]	48	47	95
Industrial[d]	352	344	696
Public facilities[e]	1342	1339	2681
Total	4790	4818	9608

[a]Based on population projections described in Section 5.14.4.

[b]Assumes housing type mix as follows: 55 percent single family, 30 percent multifamily, and 15 percent mobile home. Standards used for land requirements were: single family (3.5 units per acre), multifamily (20 units per acre), mobile homes (6 units per acre).

[c]Based on a standard of 15 acres per 1000 population.

[d]Based on a standard of 11 acres per 1000 population.

[e]Based on a standard of 12 acres per 1000 population for community facilities and a standard of 25 percent of total developed area for streets.

5.13.2 Recreation

Even though a large area would be influenced by construction and operation of projects, direct impacts of the high development scenario would not be significant because of a predominantly private ownership pattern and low levels of existing recreational use. Secondary impacts, however, would be significant. The expected increased demands for activities within Mesa and Garfield counties are listed in Table 5.13-2. As shown in the table, use in most activities would increase substantially.

The impacts associated with increased usage would depend on the response that agencies and the private sector are able to make. For those activities that are facility-oriented (e.g., downhill skiing, developed camping), no significant impacts would result if required facilities are developed in sequence with increased population. Those activities for which it is difficult to expand available resources (e.g., wilderness, fishing, hunting) would probably experience a decline in quality and increased restrictions on use.

Table 5.13-2. Projected activity days (cumulative) in selected activities resulting from project-related population increases, Mesa and Garfield counties

	Camping (developed)	Camping (Back-country)	Fishing	Hunting	Downhill skiing	Snow-mobiling	Four-wheeling	Lake boating
1980[a]	423,300	526,300	904,900	551,300	316,200	157,100	1,015,200	464,000
1992	560,558	889,303	1,529,340	931,492	534,235	251,532	1,540,231	784,564

[a]1980 baseline use levels taken from Mobil (1982a).

Note: Increased activity days were estimated by applying participation percentage and participation rate factors from 1981 Colorado State Comprehensive Outdoor Recreation Plan (SCORP) to estimated project-related population increases. (See Section 5.14 for population projections.)

5.14 SOCIOECONOMICS

The purpose of this section is to provide a qualitative assessment of the Mobil and Pacific impacts in a high-development scenario. Enough planning has been done so that a preliminary and qualitative consideration of the socioeconomic impacts of this scenario can be undertaken. However, it must be emphasized that broad assumptions were made for the inclusion of energy projects and, importantly, there is no fixed start up date for some of the projects. The high-development scenario would produce many times the effects of an individual project and would cause changes of kind, as well as of degree in the socioeconomic environment. The socioeconomic categories considered in assessing cumulative impacts are: employment, income, purchases, population, housing, public facilities and services, fiscal conditions, and the social structure. The high-development scenario serves as an alternative condition for considering the Mobil and Pacific projects.

5.14.1 High-development scenario: employment and income

5.14.1.1 Basic employment and income

The peak construction work force for the high-development scenario, based on planning estimates of worker demand and schedules, could exceed 17,000 by 1992. For the full operation scenario, onsite employment is estimated to exceed 16,000. Since all the projects would overlap in construction and operation schedules, peak employment (1992) could exceed 24,000 for both categories. A total of the direct basic employment, labor income, and purchases, as reported for the multiple projects is shown in Table 5.14-1.

Direct wages and salaries, using CITF wage rates ($34,400 for construction and $32,612 for operation) could peak at over $820 million and produce $545 million per year during operation.

5.14.1.2 Total employment and income

Employment, income, and purchases, coming directly from the basic activities of the high-development scenario would produce significant effects on the study area (Garfield and Mesa counties) economies. The additive total from the available reports suggests that at peak employment in 1992, the total number of basic and nonbasic jobs generated might be expected to exceed 44,000, an increase of 81 percent over the No-Action projections of 54,439. Total labor income under such a scenario could exceed $1 billion by 1987 and reach $1.9 billion in 1998, more than doubling the No-Action case projections of $975 million. During operations, the employment impacts could be almost 34,500 basic and nonbasic jobs; the annual labor income impacts would exceed $800 million.

Table 5.14-1. Cumulative projects construction and operations; direct employment, purchases, and income

Year	Employment			Purchases	Income
	Construction	Operation	Total	($000)	($000)
1980	42	8	50	2,019	10,652
1981	786	35	821	37,781	28,180
1982	900	90	990	16,208	33,895
1983	225	25	250	4,458	8,555
1984	225	25	250	5,403	8,555
1985	1,745	25	1,770	25,735	60,843
1986	3,915	25	3,940	45,504	132,051
1987	6,082	668	6,750	70,002	231,006
1988	10,006	1,490	11,496	229,079	392,798
1989	11,930	2,898	14,828	307,449	504,902
1990	12,140	3,723	15,863	309,863	539,030
1991	14,590	4,838	19,428	362,324	659,673
1992	17,770	6,412	24,182	412,020	820,396
1993	14,705	8,740	23,445	395,620	790,881
1994	11,760	10,404	22,164	411,660	743,839
1995	10,780	11,525	22,305	416,285	746,685
1996	10,062	12,275	22,337	395,337	746,445
1997	9,000	13,573	22,573	318,434	752,243
1998	7,717	14,501	22,218	333,399	738,371
1999	6,540	14,890	21,430	450,214	710,569
2000	4,870	15,617	20,487	444,030	676,830
2001	3,315	16,495	19,810	389,475	651,971
2002	40	16,735	16,775	367,405	547,138
2003	55	16,735	16,790	359,425	547,654
2004	10	16,735	16,745	359,425	546,106
2005	--	16,735	16,735	359,425	545,762
2006	--	16,735	16,735	359,425	545,762
2007	--	16,735	16,735	359,425	545,762
2008	--	16,735	16,735	359,425	545,762
2009	--	16,735	16,735	359,425	545,762
	159,210[a] (36.9%)	272,162[b] (63.1%)	431,372	$8,265,679	$14,358,078

[a]Total construction wages would be $5.5 billion figured at $34,400 per year in 1982 dollars. This would account for 47.1 percent of the total labor income.

[b]Total operations wages for the period would be $6.1 billion figured at $32,612 per year in 1982 dollars. This is 52.9 percent of the total labor income.

Source: Mountain West Research - Southwest, Inc., 1983. Projections for Chevron, Union Phase II, Mobil and Pacific are based on EIS documents. Colony and Southwest descriptions are those in the CITF data base prior to the shutdown of these two projects. A start date of 1987 was assigned for the Colony and the Southwest projects.

5.14.1.3 Qualifications on data for high-development scenario

The simple addition of projections from these six project descriptions probably understates the economic impacts that would accrue with the levels of direct basic employment, income, and purchases outlined here. For one thing, the total labor income would more than double the current levels and this could produce significant expansion in the capacity of the local economy. As a consequence, the nonbasic effects could rise substantially as a greater proportion of the spending would be captured in the study area. The multi-project case may create a new geographical distribution of nonbasic effects because of changes in local market capacities and locations. For example, the forecasts for employment and income in Garfield County could change significantly if the Rifle-Parachute-Battlement Mesa area were to develop as a viable market center alternative to Grand Junction. Also, each project individually assumes a certain interaction with the local economy (e.g., access to the labor force), which could only supply its surplus capacity once. Moreover, demand for workers could force rescheduling of construction and produce an entirely different magnitude and duration of effects for the multi-project scenario. Bottlenecks could develop not only for labor supply, but for many other components of the local economy. In addition, there could be a shift in the number of immigrating workers with families who would fill the available jobs since the high-development scenario might attract more long-term or permanent employees. Finally, the demand for workers could bid up wages in all sectors, thus, increasing both the basic and nonbasic income response.

5.14.2 Mobil and Pacific impacts, employment and income

5.14.2.1 Basic employment and income

The basic employment, income, and purchases are shown in Sections 3.3.1.14 and 4.3.1.14 for Mobil and Pacific, respectively. The maximum employment for Mobil is projected for 1999 when they would have 5860 engaged in construction and operations. This would be 27.3 percent of the 21,430 estimated for the high-development scenario in the same year. During the peak year for the high-development scenario (1992) Mobil would have 3090 (12.8 percent) of the 24,182 basic employees working on all projects. The Mobil proportion of the operations employment would be 20.4 percent or 3410 of the high-development total of 16,735.

Employment for Pacific in 1992, the peak year in the high-development scenario, is projected to be 3380 or 14 percent. During operation, Pacific expects to employ 3365 workers, 20 percent of the high-development total.

Basic income from wages would follow the pattern of basic employment since all projects are assigned the same wage rates for construction and operations personnel.

Purchases by Mobil would peak in 1999 at $189 million, about 42 percent of the $450 million estimated for the high development scenario that year. During operation, Mobil expects to spend about $104 million annually, about 29 percent of the high-development total.

The Pacific purchases peak in 1995 at about $73 million, 17.5 percent of the purchases for the high-development scenario that year. The operational purchases were estimated by Pacific at about $68 million, 19 percent of the high-development total.

5.14.2.2 Mobil and Pacific total employment and income in the high-development scenario

Mobil's peak employment impacts (basic and nonbasic) were estimated to be 11,720 in 1999. For 1992, they were estimated to be 5238 or 12 percent of the high-development scenario. This suggests that the proportions of total employment and income impacts because of Mobil would be about the same proportions as these for basic employment and income. The same would be true for Pacific, because its proportions of total employment and income impacts would parallel those outlined for basic employment and income.

5.14.2.3 Summary

This qualitative evaluation suggests that Mobil could account for from 12 to 27 percent of the employment and income impacts during the high-development scenario. In terms of local purchases, the Mobil effect could reach over 40 percent.

The estimates for Pacific are lower; its employment share could range from 14 to 20 percent. The proportion of local purchases was estimated at less than 20 percent of the high-development scenario.

5.14.3 Allocation of employment by residence

The allocation of employment to counties, cities, towns, communities, and unincorporated areas is based upon the location of the project and the capabilities of the receiving areas. The reserve capacity of these areas would only be available once, and development at the multi-project level may require new allocation formulas. The distribution proposed for the Mobil and Pacific projects would probably have to be re-evaluated for a high-development scenario.

5.14.4 Population

5.14.4.1 Population impacts of the high-development scenario

The No-Action alternative projects a small, steady increase in population for the study area. The total would be expected to rise to about 120,000 by the early 1990s, and to about 125,000 by the year 2009 (see "No-Action" projections in Sections 3.3.1.14 and 4.3.1.14). The population impacts implied by the high-development scenario, based on the available reports, would be substantial. By the mid 1990s, population additions to the study area would be more than

70,000 persons, a 60 percent increase over the No-Action alternative. Applying the allocation formulas used by the reports, population growth in some communities would be very rapid. Battlement Mesa could become a city of over 20,000, more than 30 times its size under the No-Action alternative. Rifle could almost triple in size by the 1990s, growing to more than 14,000. Parachute, which had 331 people at the time of the 1980 U.S. Census, could top 3000. The total population for Garfield County could increase by over 150 percent, rising from 26,000 for the No-Action alternative to over 65,000 for the multi-project scenario. DeBeque, in Mesa County, could increase from 375 for the No-Action case to over 2200 during the 1990s, more than a five-fold increase.

5.14.4.2 Qualifications on population projections for the high-development scenario

While the population increases by community would be reasonable for each individual project (e.g., Mobil projects an increase of 65 people or 17 percent for DeBeque at peak employment in 1999), the accumulation of impacts by adding projects from four individual analyses becomes problematic. It may not be reasonable to use the same logic that projects a 65-person increase for DeBeque from the Mobil Project and apply it to the multi-project scenario. An increase of 1700 for DeBeque may not be logical under any circumstances, especially since Battlement Mesa is located near and is designed to accommodate 25,000 with the possiblility of doubling even that number. In other words, the cities, towns, and communities may have practical thresholds which would resist higher levels of population increase. If so, perhaps a new and distinct allocation scheme should apply once those thresholds are reached. Involved in this line of reasoning are important implications for evaluating population, housing, facilities, services, and fiscal impacts. One consequence could be the development of new market centers which would change even further the distribution of nonbasic employment and income.

5.14.5 Mobil and Pacific impacts, population

The estimated population impacts for Mobil and Pacific were distributed to communities; however, this distribution in a high-development scenario becomes very doubtful. Also, the population effects may be understated since in-migration could be higher because of the fact that a smaller proportion of workers to meet the demand would come from the local work force.

Mobil's peak population impacts would occur in 1999 at 14,771 (see Table 3.3-14). This would be 21.6 percent of the population impacts for the high-development scenario. Maximum population impacts for the high-development scenario would occur in 1992 and 1993 at more than 71,000. Mobil's share of those impacts would be 7 to 10 percent. During operations, the Mobil Project would account for about 17 percent of the high-development population impacts.

The Pacific population impacts (see Table 4.3-19) were projected to reach 5319 at the peak year (1992) for the high-development scenario, about 7.5 percent of the total impacts. During operation, the estimated impact on population of the Pacific Project would be 11 to 16 percent of the total impacts for a high-development scenario.

In summary, the Mobil and Pacific projects each would be expected to account for between 7 and 20 percent of the population impacts for a high-development scenario during construction. During operations, each project would contribute about 11 to 17 percent of the total impacts.

5.14.6 Housing

Projections of housing demand, by number of units and type, are based on the population figures. Therefore, many of the considerations that come into play for population with the high-development scenario also apply to housing. The allocation assumptions of housing demand may very well change significantly with the higher levels of development. One important factor could be the ability of local areas to use their public services to support new housing development, or their willingness to establish the necessary capacity. Garfield County could be expected to add the assessed valuation of the oil shale projects to their tax base, and this source of revenues may be used to provide the capital needed for infrastructure development, including support for new housing. Other communities may decide to support pro-growth policies, while still others may want to limit or resist housing expansion. Communities with limited revenues may not be able to support the housing demand implied by the distribution of effects which results from adding up the estimates for a high-development scenario.

The magnitude and duration of the high-development scenario may also attract a more permanent construction work force. This could affect the housing mix, for example, creating a greater demand for single family residences. The assumptions about the housing mix (single family, multifamily, and mobile home) might change as compared to the individual project case. Overall, however, the population forecasts for a high-development scenario implies additional demand for up to 32,000 housing units, about a 60 percent increase over the No-Action alternative in 1992.

5.14.7 Mobil and Pacific impacts, housing

The maximum additional housing demand with the Mobil Project could be over 5000 units or about a 10 percent increase over the No-Action alternative. This number of units would be about 15 percent of the total impacts with a high-development scenario. Pacific's impact on housing demand could reach 9 percent of the high-development scenario impacts during construction and up to 14 percent during operation.

Since an accurate allocation of housing by community or type of unit cannot be made for the high-development scenario, the Mobil and Pacific impacts in that context cannot be estimated.

5.14.8 Public facilities and services

Most of the studies done for individual oil shale projects have found some surplus capacity in public facilities and services. This is especially true of work done since the shutdown of the Colony Shale Oil Project in mid-1982. Because of the demand from the Colony project, and in anticipation of continued need, significant capacity additions were made or scheduled. The schools and other public improvements and facilities at Battlement Mesa are a prime example of existing surplus capacity.

Assessments of probable impacts for individual projects have concluded that there would be relatively modest impacts on public facilities and services because of the in-place capacity. At the same time, the increased demand for each project would basically exhaust what is available. The immensely greater demands of the high-development scenario would exhaust the in-place capacity in many locations and require large new capital expenditures.

In effect, the impacts on public facilities and services cannot be determined by adding together the impacts as reported in several reports and EISs because a surplus capacity that is only available once is used numerous times. Thus, to merely add the impacts from several individual cases would seriously understate the situation for a multi-project scenario. Once the capacity of public facilities and services is exhausted, all additional demand would require capital expenditures to meet the new levels of need. Significant capital expenditures would apply to most of the projection period for the high-development scenario.

The revenue and expenditure flows could be seriously out of balance at certain times during the high-development scenario for many jurisdictions. The rise in demand, as shown for individual projects, often does not produce enough revenues to balance expenditures in the earlier phases. The additional property taxes, severance taxes, and sales taxes collected because of the increased level of development would be major sources for meeting the increased expenditure demands. However, Garfield County is allocated most of the increase in property taxes. Therefore, the utility of this tax to meet increased demand is limited. Severance taxes do not apply to construction periods and, therefore, often lag years behind the time when they are critically needed by local jurisdictions. Sales taxes rise with increased income and spending, but are not capable of supporting massive capital expenditures, not even in Mesa County where the sales tax is most effectively applied. Moreover, the difference between sales tax rates in Garfield and Mesa counties may encourage commercial and industrial development in Garfield County, which would further diminish the Mesa County revenues.

Finally, there is the possibility that the state may legislate a different distribution of potential revenues than what is currently in place. For example, the increased value of property in Garfield County assessed for property taxes would rise rapidly and would probably be many times the expenditure requirements. It might be necessary to devise some method for allocating a portion of these potential tax revenues to jurisdictions that would experience negative fiscal impacts. Consideration of this possibility would require a major effort by numerous state and local agencies. It should probably begin with an analysis of how other states have responded to similar problems.

5.14.9 Mobil and Pacific impacts, public facilities and services/fiscal

The uncertainties of the public sector during a high-development scenario make definition of the Mobil or Pacific impacts in that context impossible. Based on the overall estimates for employment, income, purchases, population, and housing, it would be likely that each individual project could account for between 5 and 25 percent of the total impacts for a high-development scenario.

5.14.10 Social structure

The outline of the current social structures of south-central Garfield and Mesa counties is presented in Section 2.14.7. The important functional groups were identified and described. In Sections 3.3.1.14 and 4.3.1.14, the individual project effects that might change the groups and their patterns of interaction were discussed. The level of effects which would be expected to result from each project individually, was assessed as producing major changes in the Garfield County social structure and moderate changes in Mesa County. The spatial distribution of population would concentrate the impacts in the Rifle-Parachute-Battlement Mesa area. These changes were large enough, and scheduled to take place over a long enough period of time, so that significant impacts would result in the social structure. In Mesa County, the larger base and the smaller levels of effects would create important changes, but not at the level expected in Garfield County.

The size and intensity of change that would be likely to result in all areas (e.g., employment, demographic, etc.) would be significant. The newcomers under this scenario would put tremendous pressure on the existing social structure. The implications for the existing social groups are not clear. Moreover, there exists little basis for assessing how these newcomers might evolve their own, perhaps dominant, social presence.

When the vast majority of the members of a social structure are newly arrived, the local traditions of interaction may not apply and little cohesiveness might exist in terms of religious, ethnic, or social values; such a social structure may lack the components often considered necessary to a stable and fulfilling society. Under these conditions, it would not be a question of assessing how the existing social structure would integrate immigrants, nor how the newcomers would interact to create an expanded social structure. Rather, the assessment would deal with understanding and describing the evolution of a new social structure. The evaluation of this possibility would require a different perspective on social change than the one that is appropriate for assessing a single oil shale project.

5.14.11 Mobil and Pacific impacts, social structure

The social impacts from either the Mobil or the Pacific Project cannot be defined in the context of the high-development scenario. The attempt to specify these impacts would require a workable description of the social structure for the high-development scenario itself.

5.15 TRANSPORTATION

The cumulative effects of the six projects would add pressure on the existing transportation systems and would result in congestion and delay along some of the road segments. Accidents and the frequency of necessary road repair would increase. The highway segments that would be most significantly impacted include segments "B" through "E," which correspond to the portions of the interstate between Grand Junction and Glenwood Springs (see Figure 3.3-11). Significant congestions and delays would most likely occur in the vicinity of DeBeque, Parachute, Rifle, and Grand Junction.

Significant impacts on the rail transportation system could also occur under the cumulative scenario. Shipment of by-products, ammonia and local shipments of synthetic crude oil (syncrude) would most likely necessitate upgrading the rail transportation to accommodate the increase in traffic. The air transportation facilities would also have to be expanded to accommodate the increases in population that are projected for the high-development scenario. An industry pipeline for shipment of the syncrude would be needed to move the product to market.

If the LaSal product pipeline were developed, its planned capacity of 100,000 bpd would have to be increased to meet the needs of the high-development scenario.

6 Consultation and Coordination

This document has been prepared through consultation and coordination with the following governmental jurisdictions or entities.

Federal Agencies

U.S. Bureau of Land Management
- Colorado State Office
- Grand Junction District
- Craig District

U.S. National Park Service
- Denver
- Fruita

U.S. Environmental Protection Agency
- Denver
- Cincinnati, Ohio

U.S. Fish and Wildlife Service
- Denver
- Grand Junction
- Salt Lake City, Utah

U.S. Army Corps of Engineers
- Grand Junction
- Sacramento, California

U.S. Forest Service
- Denver

U.S. Department of Energy
- Casper, Wyoming
- Washington, D.C.

U.S. Soil Conservation Service
- Colorado State Office
- Grand Junction
- Glenwood Springs

State Agencies

State of Colorado
- Department of Natural Resources
- Mined Land Reclamation Board
- Division of Wildlife
- Geological Survey
- Division of Water Resources
- Water Conservation Board
- Soil Conservation Board
- Department of Health

Department of Highways
Department of Agriculture
Department of Regulatory Agencies
State Historic Preservation Office
Office of Energy Conservation
Governor's Office

County Agencies

Garfield County
Impact Coordinator
Planning Director

Mesa County
County Planner
County Administrator

Towns and Communities

Grand Junction
City Manager

Rifle
Mayor's Office

New Castle
Planning Department

Glenwood Springs
City Planner

Parachute
Town Manager

Palisade
Mayor's Office

Silt
Town Planner

DeBeque
Mayor's Office

In addition to the points of coordination discussed in Section 1, Purpose and Need, two other ongoing coordinative activities have been constructive in preparing this document. First, the Pacific Shale Project has been working through the Colorado Department of Natural Resources' Joint Review Process (CJRP) since early in 1981. CJRP is a useful mechanism for the transfer of information regarding the project to interested parties. The following is a record of the major project-related activities occurring through CJRP since 1981:

5 March 1981	Governor Lamm accepted the Pacific Shale Project as a participant in the Joint Review Process.

10 June 1982	An interagency meeting organized by the CJRP was held for the purpose of informing Federal, state, and local agencies about the project. Agency representatives were invited to comment on the environmental baseline monitoring plan.
22 February 1983	CJRP organized an interagency meeting to discuss new aspects of project design and the plans for the joint Mobil/Pacific EIS.
	A public information meeting was held in Denver for the purpose of disclosing the plans to prepare a joint Mobil/Pacific EIS.
1-3 March 1983	Public information meetings were held in DeBeque, Grand Junction, and Rifle to discuss the project with the general public.
7 June 1983	A CJRP Pacific Team informational meeting was held in DeBeque to review the progress and schedule of events associated with preparation of the EIS.
28 September 1983	A CJRP Pacific Team informational meeting was held in Grand Junction to review the progress and schedule of events associated with preparation of the EIS.

Second, a series of three socioeconomic planning meetings was held in Parachute on 18 May 1983, 7 June 1983, and 29 June 1983 for the purpose of discussing the approach, assumptions, and results of the socioeconomic impact modeling with local planning officials. Representatives from Mesa County, Garfield County, and the towns/communities of Parachute, Rifle, Silt, and New Castle attended.

7 List of Preparers

The Mobil-Pacific EIS was written and produced through a multidisciplinary team led by Dames & Moore under the technical direction of the U.S. Bureau of Land Management. Listed below are all BLM and Dames & Moore personnel involved in production of the FEIS, their qualifications, and responsibilities. The affiliations of Dames & Moore team members not directly employed by Dames & Moore are indicated in parentheses.

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8 Glossary of Terms

ABOVEGROUND RETORTING - Extraction of oil from oil shale which has been mined and brought to surface facilities.

ACTIVE NEST - A raptor nest currently in use or which has been used for nesting in at least one of three preceding years.

ACRE-FOOT - A volume which is 1 acre in area and 1 foot deep (325,853 gallons).

ADDITIVE IMPACTS - Descriptive term used when total combined impact is equal to the sum of the individual impacts.

"A" GROOVE - A sequence of low grade oil shale that marks the upper limit of the Mahogany Zone.

AIR BASINS - Areas of weak dispersion which result from obstructed wind flow such as mountain ranges.

ALLOTMENT - An area of land (pasture) on which an operator grazes a specified number of livestock for a set period.

ALLUVIAL FAN - A gently sloping mass of loose rock material, shaped like an open fan, deposited by a stream where it enters from a narrow mountain valley upon a plain or broad valley.

ALLUVIAL SOIL - Soil developing from depositions of present-day rivers or rivers of recent geologic time. Materials may be sorted or semisorted but no horizons have developed.

AMBIENT AIR QUALITY - The air contaminant concentrations in an outdoor atmosphere to which the general public has access.

ANCILLARY FACILITIES - Support structures needed for the operation or maintenance of a project.

ANIMAL UNIT MONTH (AUM) - The forage consumed by one cow/calf pair (calf 6 months of age or younger) in 1 month. Used to determine stocking rates.

ANTHROPOGENIC - Relating to or resulting from human activity.

ANTICLINE - A fold in the underground rock structure that is convex upward. Its core contains the stratigraphically older rocks.

AQUIFER - A subsurface formation containing sufficient saturated permeable material to yield significant quantities of water.

AREA OF INFLUENCE - The geographical area within which significant impacts of a project may occur; it is the affected area. The area of influence may vary among disciplines and, within a discipline, may be different for direct and indirect impacts or for various subjects within that discipline.

ARTESIAN - Ground water which rises above its aquifer because of hydrostatic pressure.

ATMOSPHERIC DISPERSION MODEL - A mathematical simulation of atmospheric transport and dispersion used to predict pollutant concentrations.

AVIFAUNA - Bird species of a region.

A-WEIGHTED SOUND LEVELS - A method of measuring sound intensity that simulates an individual's sound perception.

BACKGROUND CONCENTRATION - The pollutant concentration for an area without the proposed action.

BAGHOUSE - A stationary source pollution control system used to filter emissions with a designed efficiency over 99 percent.

BARREL OF OIL - Forty-two U.S. gallons.

BASELINE - Information collected prior to project initiation which is used to predict environmental impacts.

BEDROCK - Rock, usually solid, that underlies soil or other unconsolidated surficial material.

BIG 3 - A series of three closely spaced, persistent, rich oil-shale beds about 200 to 250 feet above the Mahogany Zone.

BIOTA - Plant and animal life of an area.

CALENDAR DAY - A period of time equal in length to that of a day in the calendar conventionally in use (i.e., there are 365 days in the year or, when a February 29 is included, 366 days).

CARRYING CAPACITY - The maximum number of animals which can utilize an area without incurring damage or deleterious effects upon the vegetation or other resources of an area.

CHARACTERISTIC LANDSCAPE - The landscape most representative of an area being viewed.

CHIMNEY DRAIN - A vertical structure constructed within retorted shale or waste disposal piles which serves as a drain.

CLIMATE - Weather conditions for a specific area over a period of several years, usually decades.

COLLUVIUM - Rock fragments, sand, and soil that accumulate on steep slopes or at the foot of hills.

COMPONENT - A constituent part of the overall project such as the mine and mining method, access road, retorting facility and process, processed shale disposal site and method, product pipeline, water supply and pipeline or power supply.

CONFINED AQUIFER - An aquifer bounded above and below by relatively impermeable beds.

CRITICAL AREA - An area of habitat essential to the survival of a species at some time during its life cycle.

CULTURAL MODIFICATION - Any anthropogenic change in a landscape which results in visual contrast with the natural character in terms of line, form, color, or texture.

CUMULATIVE IMPACT - A net impact on the environment of a high-development oil shale scenario that includes the Parachute Shale Oil Project (Mobil Project), Pacific Shale Project (Pacific Project), and other projects in the general vicinity (see high-development scenario).

DE-ASHER - The process vessels used to remove shale fines from raw shale oil. Raw shale oil containing the fines is heated and mixed with water before entering the de-asher. The de-asher contains an electrostatic precipitator to separate the shale oil and water containing the water-wet solids. The water effluent from the de-asher is sent to a clarifier for solids removal. The clarified effluent water is sent to biological treatment, and the fines sludge is disposed as solid waste.

DECIBEL (dB) - A unit used to express power or intensity ratios in electrical and acoustical technology.

DELPHI CRITERIA - A set of mutually exclusive categories (e.g., <50 acres disturbed, >50 acres disturbed) developed for the Delphi technique by the principal investigator to rate the relative importance of a particular issue when comparing alternatives.

DELPHI ISSUE - As used in the Delphi technique, a discipline-specific impact (e.g., adverse affect on vegetation) that would result from construction, operation, or abandonment of a project component.

DELPHI TECHNIQUE - An interactive, iterative group process of decision-making. The process involves issue definition, importance ratio assignment, statistical analysis and review, group discussion and, finally, group stability with regard to the decision. This technique was used to assist in the interdisciplinary evaluation and comparison of alternatives.

DELPHI WEIGHTING - Used in the Delphi technique when the principal investigator established more than one criterion to rate alternatives. The weighting was used to define the relative importance of each criterion in establishing the overall rating for the issue. The sum of all weights must be 1.00. For example, assume that the following weightings were assigned:

Criterion	Weighting
A	.60
B	.10
C	.30

They would mean that the principal investigator felt that criterion A was twice as important as C in evaluating the impacts of various alternatives.

DEMOGRAPHIC - Relating to the statistical evaluation of human populations, particularly with respect to size, density, distribution, and vital statistics.

DIP - Angle at which a stratum, bed, or vein is inclined from the horizontal.

DIRECT (PRIMARY) IMPACTS - Impacts that result directly from implementation of a project activity, with no intermediary between the project activity and the environmental component. Direct impacts may result from either construction or operational activities and include effects such as removal or vegetation, loss of soil, loss of wildlife in the affected area, air emissions, and reduced water quality within the affected area.

DIRECT RETORTING - Direct heating of shale by combustion of carbon, air, and gas within the retort. Used to extract oil.

DISPERSION POTENTIAL - Ability of the atmosphere to dilute or disperse air pollutants by normal ventilation.

DIURNAL - In meteorology, one complete day/night cycle; in wildlife biology, just the day portion of the cycle.

END HAULING - As used here, the removal and transportation of excavated materials to a suitable disposal location.

ENDANGERED SPECIES - A species which is in danger of extinction throughout all or in a significant part of its range.

ENDEMIC - Naturally occurring species within a specific area whose distribution is limited to that area or region.

FAULT - A surface or zone of rock fracture along which there has been movement.

FAUNA - Animals or animal life of a region.

FLOODPLAIN - Lowland or relatively flat areas that are subject to a 1 percent or greater probability of flooding in any given year (i.e., a 100-year or more common flood).

FLORA - Plants or plant life of a region.

FORB - An herbaceous plant which is not a grass, sedge, or rush.

FORMATION - Primary unit of stratigraphic mapping or description.

FUGITIVE DUST - Particulate matter which becomes airborne because of wind and/or man's activities during construction, transportation, or cultivation.

GAME FISH - Any fish species taken in the pursuit of food or sport for which seasons and bag limits have been set.

GEOLOGY - The study of the physical forces that act on the planet Earth, the chemistry of its constituent minerals, and the biology of its past inhabitants.

GREEN RIVER FORMATION - Sedimentary rocks deposited about 50 million years ago in northwestern Colorado, eastern Utah, and southern Wyoming that contain rich oil shale.

GROUND WATER - Water below the land surface, generally in a zone of saturation.

HABITAT - The location and conditions under which a plant or animal species lives.

HERBACEOUS - Green leafy material associated with plants other than trees, shrubs, mosses, or lichens.

HIGH-DEVELOPMENT SCENARIO - Simultaneous development of the Parachute Shale Oil Project (Mobil Project), Pacific Shale Project (Pacific Project), Union Oil Shale Company Phase II (90,000 bpd) Parachute Creek Oil Shale Project (Union Phase II Project), Chevron Clear Creek Shale Oil Project (100,000 bpd), Colony Shale Oil Project (47,000 bpd), and Colorado-Ute Electric Association Southwest Electrical Generation Project (Units 1 and 2).

HYDROCARBONS - A class of chemical compounds consisting primarily but not exclusively of carbon and hydrogen.

INDIGENOUS - Native to an area, growing or living in the area naturally.

INDIRECT (SECONDARY) IMPACTS - Impacts that occur as a result of the direct impacts of a project on the environment, but at a later time or greater distance. In some disciplines, there may not be a clear distinction between direct and indirect impacts. The term "indirect impact" is primarily applied in socioeconomics. For example, the spending produced directly by the construction and operation of a project will be a direct beneficial impact on the county or community in which the money is spent; however, the growth-inducing effect of the increased spending will be an indirect (secondary) impact.

INDIRECT RETORTING - Method by which heat is produced from gases outside the retort, then transferred to the shale for oil extraction.

IN SITU RETORTING - Any method by which oil-bearing shale is heated in place (underground) to remove oil without mining.

INTERDISCIPLINARY IMPACTS - Impacts that require analysis by two or more environmental disciplines because they involve the interaction of two or more environmental factors. As an example, the potential effects of atmospheric emissions on aquatic ecosystems may require analyses of changes in air quality, analyses of air quality effects on water quality, and analyses of water quality effects on aquatic biota.

INTERFACE - A common boundary, contact between two independent entities; in the case of oil shale, the boundary between soil and native rock or shale.

INTRADISCIPLINARY IMPACTS - Impacts that are restricted in scope to environmental factor(s) within a single discipline and are analyzed only by that discipline.

INVERSION - Departure from normal cooling of air with rise in altitude, typically warm air overlaying cool air.

IRREVERSIBLE - Incapable of being reversed; once initiated, use, direction, or condition would continue.

IRRETRIEVABLE - Essentially irrecoverable; not reasonably retrievable; once used, not readily replaceable.

JOINT (Geology) - A surface of fracture or parting in a rock, without displacement.

JOINT FREQUENCY DISTRIBUTION - Meteorological data describing concurrent frequencies of occurrence of defined wind directions, wind speeds, and atmospheric stabilities.

KEROGEN - Solid organic material in oil shale that may be converted to oil through the application of heat.

LEACHING - The removal of soluble constituents in a rock by percolation of water.

LEK - An area where grouse conduct courtship rituals and displays.

LITHIC SITES - Sites historically relevant to man's production of tools.

LONG-TERM IMPACTS - Project effects on the environment which persist beyond the operational life of the project.

LOW-DEVELOPMENT - A scenario wherein there would be simultaneous development of the existing Phase I (10,000 bpd) Parachute Creek Oil Shale Project (Union Phase I Project), and either the Parachute Shale Oil Project (Mobil Project) or the Pacific Shale Project (Pacific Project).

MAHOGANY ZONE - The uppermost and most widespread rich oil shale unit in the Green River Formation of Colorado and Utah. Some 1-foot beds in the zone may yield more than 70 gallons of oil per ton.

MATRIX - A rectangular array of project components (rows) and environmental disciplines (columns) used to record and compare suitability ratings assigned to various project alternatives.

MEMBER - A subordinate part of a geologic formation.

MITIGATION - Any activity that, when implemented, reduces the severity of a predicted impact. The BLM EIS Analysis Handbook defines mitigation as:

- avoiding an impact by not taking or approving an action;

- limiting the degree or magnitude of the action or its implementation;

- compensating for the impact by replacing or providing substitute resources, environs, or habitat;
- rectifying the impact by rehabilitation, restoration, or repair of the affected environment;
- reducing or eliminating the impact over some stated time period.

The BLM Handbook states, "Mitigation does not include efforts or measures which are part of the designed proposed action or project through regulation, law, or policy." The mandated activities should be described in the Proposed Action and Alternatives chapter of the EIS and only referred to in subsequent sections.

MIXING HEIGHT - Height above ground below which air becomes well-mixed due to turbulence.

MODELING - Simulation of an observable situation through mathematics or physical representation.

MODIFIED IN SITU RETORTING (MIS) - Removal of a portion of the shale deposit through underground mining followed by fracturing of the remaining shale and removal of its oil by heating in place.

NAHCOLITE - A sodium bicarbonate mineral of potential economic value associated with the Green River Oil Shale in the Piceance Basin.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) - The established national standards for absolute limits of pollutant concentrations.

NONATTAINMENT AREA - A designated area where NAAQS standards are not met for a specific pollutant.

NONPOINT SOURCE - Pollution arising from a broad area rather than a specific point.

OFF-ROAD VEHICLE (ORV) - Vehicles capable of traveling over areas not crossed by a road. This includes four-wheel drive, trail bikes, three-wheelers, snowmobiles.

OIL SHALE - Layered sedimentary rock containing kerogen from which shale oil can be removed by heating.

OPEN PIT MINING - Process by which oil shale and overlying strata are drilled, blasted, and removed.

PASQUILL STABILITY CLASSES - Categories which represent meteorologic stability conditions based on cloud cover, and surface wind speed and directional variability.

PASSERINE - Order and class of perching song birds.

PEDIMENT - A broad, gently sloping erosion surface at the base of an abrupt and receding mountain front in arid or semiarid regions.

PERCHED GROUND WATER - A local zone of saturation above and separated from the main water table by unsaturated impervious material.

PERMEABILITY - The ease with which liquids or gases penetrate or pass through a solid material. Technically, it is the volume of fluid that will flow through a unit area under a unit hydraulic gradient, measured in centimeters per second or equivalent units.

PETROGLYPH - Carving or inscription on rock, usually of historic origin.

pH - Acidity/alkalinity rating based upon hydrogen ion concentration (pH = 7 is neutral).

PHYSIOGRAPHIC PROVINCE - A region with similar geologic structure and climate, and a unified geomorphic history.

PICEANCE CREEK BASIN - An area (1500 square miles) in Garfield and Rio Blanco counties of northwestern Colorado containing vast oil shale deposits.

PIEZOMETRIC SURFACE - That surface represented by the static water-level in wells tapping a confined aquifer.

PLANT COVER - Percent of an area covered by foliar or basal extent of plant material.

POINT SOURCE - Source of pollution emission which can be identified as a single point.

POLLUTION - Contamination of water, air, or soil by noxious substances.

POST-OPERATIONAL IMPACT - An impact that persists after a project has been abandoned.

PREVAILING WIND - Compass direction from which the wind most often blows.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD) - A regulatory program enacted by Congress in the 1977 Clean Air Act Amendments which limits the amount of incremental SO_2 and total suspended particulate air quality degradation allowed in classified (I, II, and III) areas.

PRIME FARMLAND - Arable land which has an adequate and dependable water supply, favorable temperature and growing season, few rocks and suitable acidity or alkalinity levels with acceptable salt and sodium contents. Criteria are established by the U.S. Soil Conservation Service.

PRINCIPAL INVESTIGATOR - The senior technical expert who was responsible for all work in a given discipline (e.g., Principal Investigator for cultural resources).

PROBABLE MAXIMUM FLOOD - The hypothetical flood (peak discharge, volume, and hydrograph shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of probable maximum precipitation (PMP) and other hydrologic factors favorable for maximum flood runoff such as sequential storms and snowmelt.

PROBABLE MAXIMUM PRECIPITATION - The estimated depth for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance.

PROJECT PHASES - Stages in the life of a project, including construction, operation, and abandonment.

PYROLYSIS - Use of heat to break chemical bonds.

RANGE SITE - A distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community.

RAPTOR - Bird of prey with sharp talons and strongly curved beaks (owls, eagles, hawks, falcons).

REASONABLE - Not extreme or excessive, based on sound judgment.

REDUCED IMPACT - A descriptive term applied to cumulative impacts when the total combined impact is less than the sum of the individual impacts.

REFINING - Process (chemical or physical) by which crude petroleum is separated into desired end-products such as gasoline and heating oil.

RESIDUAL IMPACTS - Those impacts which follow project shutdown, decommissioning, and abandonment.

RETORT - Vessel or structure used to remove oil from shale by heating.

RETORTED SHALE - Material remaining once oil and gas have been extracted from oil shale; characteristics depend upon type of retorting process.

RIPARIAN - Associated with or located on the banks of a river or stream, usually plant or animal life.

SALINE SOIL - Soil in which high soluble salt concentrations restrict plant growth.

SCENIC QUALITY CLASS - Value assigned to a scenic quality rating unit indicating its relative visual importance to other units within its physiographic region.

SECONDARY IMPACTS - See indirect impacts.

SEDIMENTARY - Formed by the deposition of sediment.

SEISMIC - Pertaining to a vibration of the Earth, including those that are artificially induced.

SENSITIVE SPECIES - Those species which are not yet listed but are undergoing status review for possible listing as being threatened or endangered, species which are rare or infrequent and have small and widely dispersed ranges, or species which require conservation because of declining numbers.

SHALE OIL - Liquid oil produced from the heating of oil shale (also known as raw oil).

SHORT-TERM IMPACT - An impact that will not persist beyond the life of the project; i.e., the environment would only be affected during the construction and operation phases of the project.

SIGNIFICANCE - Significance of actions will be judged in accordance with use of this term in NEPA. Accordingly, it will be judged in several contexts such as society as a whole, the affected region, the affected interests, and the locality. Consideration will be given to both short- and long-term effects. Finally, significance will be judged in terms of intensity (severity) of impact.

SODICITY - Concentration of exchangeable sodium ions.

SOIL HORIZON - Layer of soil generally parallel to the surface with characteristics differentiating it from adjacent layers.

SOIL PROFILE - Vertical section through the soil surface including all soil horizons, organic layers, and parent materials.

SPAWN - A simultaneous deposition of eggs and sperm by fish or a collective term used for eggs and sperm of fish.

STABILITY CLASSES - Scheme by which vertical mixing of the atmosphere is characterized. "Unstable" refers to good atmospheric mixing while "Stable" refers to poor vertical mixing.

STRATIGRAPHY - The study of the origin, composition, distribution, and succession of strata.

STREAM DAY - An operating day; e.g., the Pacific Project assumed that there would be 328 operating days per year.

SYNCLINE - A fold in the rock structure that is concave upward. An elongated basinal fold.

SYNERGISTIC IMPACT - A descriptive term applied to cumulative impacts when the total combined impact is greater than the sum of the individual impacts.

SYNOPTIC - Pertaining to weather or atmospheric conditions over a broad area, involving high and low pressure systems.

SYNTHETIC CRUDE OIL - A product made by adding hydrogen to crude shale oil, comparable with the best grades of conventional crude oil.

TALUS - A mass of various size, angular, rock fragments lying below a cliff from which they are derived.

THREATENED SPECIES - A species which could become endangered within the foreseeable future.

TOPOGRAPHY - The physical surface features of the Earth, either natural or modified by man.

TOPSOIL - Surface soil layer usually well-suited to supporting plant life.

TOTAL SUSPENDED PARTICULATES - A measurement of the particulate matter which is suspended in the atmosphere.

TRANSMISSIVITY, HYDRAULIC - A measure of the ability of an aquifer to transmit water equal to the product of the permeability and the thickness of the aquifer, expressed in gallons per day.

TUFFACEOUS - Sedimentary material that consists of more than 50 percent volcanic airborne debris.

UNCONFINED AQUIFER - An aquifer that is not confined by impermeable beds. The upper surface is called the water table.

VEGETATION TYPES - A grouping of plant species which has a characteristic physical appearance (morphology) and a consistent composition, generally named after the dominant members of the group.

VISIBILITY - The degree of clearness of the atmosphere, commonly measured by distance to which objects may be seen.

VISITOR DAY - A period of time (12 hours) during which one or more persons use an area of land or water for recreational purposes.

VISUAL RESOURCE MANAGEMENT (VRM) - The design, planning, and implementation of programs to provide acceptable levels of visual impacts for all BLM resource management activities.

WATER TABLE - The upper surface of an unconfined aquifer.

WET ADIABATIC LAPSE RATE - Standard rate at which moist air decreases in temperature with increase in altitude (at constant density, pressure).

WILDERNESS EXPERIENCE - An encounter with nature in its primeval state. This type of experience occurs in an area where opportunities for solitude and primitive, unconfined types of recreation are prevalent and where man is only a visitor appreciating the works of nature's forces.

WIND ROSE - A graphic representation of wind direction and wind speed, the arms of which indicate the strength (length) of the wind and the direction from which the wind blows.

WINTER RANGE - The area where certain individuals of a wildlife species congregate over an average five winters out of ten during the period of mid-December to mid-March.

WORST CASE - This term is applied to an impact assessment based upon the most severe conditions thought to be possible.

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