DRAFT

Environmental Impact Statement
Clear Creek Shale Oil Project

U.S. Department of the Interior

Bureau of Land Management

ERRATA

1. P. 2-52; Table 2.4-1

   Aquatic Ecology: FII-50 "Res" value should be -1.5

   Energy: PA-100 "Res" value should be -0.1

2. P. 2-53; first paragraph, first line "the FII-50 and FII-100 alternatives" should read "the FII-50 alternative".

3. P. 2-70; Table 2.4-7 The value for Aquatic Ecology under the Colorado River at Parachute diversion point should be -2.6.

4. P. 2-79; Table 2.4-10 Visual Resources impact ratings: Rangely B should be -1.0; Roan Creek to Clear Creek Overland should be -1.3; Big Salt Wash Straight Line (Tunnel) should be -1.0.

5. P. 2-83; Table 2.4-11 Visual Resource impact ratings: Worker Transport, Bus should be -0.7.

6. P. 3-10, Table 3.2-6 Colorado Standards should read 235 for O_3 Primary and Secondary Standards.

7. P. 4-5; Table 4.2-3 PM is equivalent to TSP. Also applicable to other tables in Section 4.2.

8. P. 4-45, first full paragraph, 6th line Date of revegetation should read 1989 to 1990.

9. P. 4-65, Section 4.5.3.3., first line should read, "Stove/Buniger canyons and other sites may....".

10. P. 4-70, Section 4.7.2, second line from bottom of page should read "... reservoir would be likely at least once...".

11. P. 4-94, Section 4.8.5, third paragraph, second line should read, "Passage of up to 450 haul trucks per day...".

12. P. 4-161, Section 4.14.1, first paragraph, second line should read "... who is responsible for ...".

DRAFT
Environmental Impact Statement
Clear Creek Shale Oil Project

Prepared by:

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

with the assistance of:

Camp Dresser and McKee Inc.

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

February 25, 1983

NOTICE

This is the Draft Environmental Impact Statement (DEIS) for the Clear Creek Oil Shale Project. Your review and comments on the adequacy of the DEIS are invited. Please direct your written comments to the Chevron EIS Team Leader, BLM, 764 Horizon Drive, Grand Junction, Colorado 81501. Also use this address when requesting further information on the materials referenced in the DEIS.

Public meetings on the DEIS will be held at 7:30 P.M. at the following locations:

April 4, 1983	Grand Junction - BLM Office, 764 Horizon Drive
April 5, 1983	DeBeque - DeBeque School, Minter Avenue
April 6, 1983	Rifle - Rifle High School Auditorium, 1353 Prefontaine
April 7, 1983	Denver - Ramada Inn Foothills, Winchester Room, 11595 W. 6th Avenue

Written comments received by May 3, 1983, and comments presented at the public meetings, will be fully considered and evaluated in preparation of the Final Environmental Impact Statement (FEIS). Those comments that pertain to the adequacy of the impact assessment, or present new data, will be addressed in the FEIS.

If changes in the FEIS in response to comments are minor, the FEIS will include only those changes and will not be a reprint of the entire DEIS. For this reason, reviewers are requested to retain their copy of the DEIS for use in conjunction with the FEIS volume.

District Manager

Clear Creek Shale Oil Project
Environmental Impact Statement

(X) Draft ( ) Final

Lead Agency

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

Cooperating Agencies

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

Abstract

This EIS assesses the environmental impacts of an oil shale project proposed for the Roan Creek drainage in west-central Colorado. The project includes a combination underground/surface mine; retort and upgrading facilities; a water system; two storage reservoirs; and support facilities. Alternatives to the Proposed Action consist of three different project configurations with all of the ancillary facilities and No Action. Based on the issues and concerns identified during the scoping process the EIS focuses on the impacts to socioeconomics, water quality, air quality, and cumulative impacts.

EIS Contact

Comments on this EIS should be directed to:

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

Comments Have Been Requested From:

See Attached List

Date By Which Comments Must Be Received

May 3, 1983

Comments Have Been Requested From:

Federal Agencies

U.S. Department of Agriculture
Forest Service

U.S. Department of the Army
Corps of Engineers

U.S. Department of Energy

U.S. Department of the Interior
Bureau of Reclamation
Fish and Wildlife Service
Geological Survey
Minerals Management Service
National Park Service
Office of Surface Mining
USDA Soil Conservation Service

U.S. Department of Labor
Mine Safety and Health Administration

U.S. Environmental Protection Agency

Local Agencies

Cities/Towns

Grand Junction
Glenwood Springs
Fruita
Rifle
Palisade
New Castle
Parachute
Silt
De Beque

Counties

Mesa
Garfield
Rio Blanco
Delta

Associated Governments of Northwest Colorado

State Agencies

Colorado

Governor's Office
Department of Agriculture
Department of Education
Department of Employment and Training
Office of Energy Conservation
Department of Health
Department of Highways
Historic Preservation Office
Department of Local Affairs
Commerce and Development
Local Government
Department of Natural Resources
Geological Survey
Land Commissioners
Mined Land Reclamation
Mines
Natural Areas
Parks and Outdoor Recreation
Soil Conservation Board
Water Conservation Board
Water Resources
Wildlife
Department of Social Services
Public Utilities Commission

Utah

State Clearinghouse

Others

Numerous organizations and individuals expressing interest in the Proposed Action have been sent copies of this document and have been invited to comment.

Clear Creek Shale Oil Project
Draft Environmental Impact Statement
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Summary

Proposed Action

Description

Chevron Shale Oil Company and Conoco Shale Oil Inc. propose to develop their upper Clear Creek oil shale property in northwest Colorado to produce 100,000 barrels per day (bpd) of shale oil. The major components of the project would consist of an underground and open pit mine; retorting and upgrading of shale oil; spent shale disposal in upper Clear Creek canyon and in the open pit mine; a reservoir in Roan Creek and water diversion facilities on the Colorado River near De Beque; an access road and service corridor along Roan Creek from De Beque to Clear Creek mesa; a water pipeline and service corridor from Fruita to Clear Creek mesa along Big Salt Wash; a water diversion facility on the Colorado River between Fruita and Loma; a reservoir near Garvey Gulch along the Big Salt Wash service corridor; a syncrude pipeline to Parachute Creek; peak employment of 9,000 people; and a railroad spur and rail yard west of De Beque.

Analysis and Conclusions

Adverse impacts have been identified on all environmental components during project construction; the most significant would be impacts to surface water, recreation, transportation, vegetation, soils, and wildlife.

During the operations phase most impacts would be reduced due to less construction activity, a smaller work force, and initiation of rehabilitation. Impacts on ground water would occur during operations due to increased water withdrawals. Adverse impacts on recreation would occur during construction, but would change to beneficial impacts during the operations phase. Lower adverse impacts on the transportation systems would occur during operations due to the reduction of transportation needs for supplies and the work force. Aquatic ecology would be affected more during operations due to increased water usage. The production of shale oil would be a beneficial impact on the energy balance for the project and also a beneficial use of the resource.

The Grand Valley area of Mesa County would receive the greatest share of population and economic growth; the Battlement Mesa/Parachute area would also show significant growth. Garfield County would receive the better part of the direct tax benefits. Some municipalities could have difficulty financing public services.

Other Major Alternative Project Configurations Considered

Clear Creek Alternative

Description

This configuration is the same as the Proposed Action with the exception that the Big Salt Wash corridor and reservoir, and the Loma water diversion would not be built.

Analysis and Conclusions

The impacts of this configuration would be essentially the same as for the Proposed Action. Less surface disturbance would occur since the reservoir and service corridor would not be constructed. Therefore, there would be lower impacts on surface water, visual resources, cultural resources, vegetation, soils, wildlife, and the energy balance. The social and economic impacts would be essentially the same as for the Proposed Action.

Fruita I Alternative

Description

This configuration is the same as the Proposed Action except that the upgrading facilities would be located north of Fruita and not on Clear Creek mesa. The Big Salt Wash corridor would contain a power transmission line, the

Loma water system, and a syncrude pipeline to transport the raw shale oil from the retorts on Clear Creek to the upgrading facilities north of Fruita. Spent shale would be disposed of in upper Clear Creek canyon and in the open pit mine.

Analysis and Conclusions

The impacts of this configuration would be slightly higher than the Proposed Action on the following environmental components: surface water, land use, visual resources, vegetation, soils, wildlife, and aquatic ecology. The Grand Valley would receive an even greater share of population and economic growth. Mesa County would receive substantial tax benefits from upgrading facilities located there.

Fruita II Alternative

Description

This configuration is the same as the Proposed Action except that both the retorting and upgrading facilities would be located north of Fruita on Operator-owned property. The production rate of this alternative would be 50,000 bpd. Spent shale would be disposed of in the mountainous area north of the upgrading facility.

Analysis and Conclusions

This configuration would result in slightly higher impacts than the Proposed Action on some environmental components. The components that would have lower impacts are air quality, soils, vegetation, recreation, energy, transportation, and topography. Mesa County would receive over three-quarters of the socioeconomic impacts but these impacts would be considerably less than with the Clear Creek or Fruita I configurations. The rapid buildup and decline of the project work force could create more extreme short-term impacts than the Clear Creek or Fruita I configurations.

50,000-bpd Production Alternatives

Description

All of the major configurations described above have been analyzed at 50,000-bpd as well as the proposed 100,000-bpd production rate. Production at 50,000 bpd would involve mining with underground methods and surface disposal of spent shale. The remaining project components would be as described for the Proposed Action or Fruita I alternatives.

Analysis and Conclusions

In general, the 50,000-bpd alternatives would have fewer impacts due to the smaller facilities, less surface disturbance, and lower air quality emissions. The increase in population would be less than for the Proposed Action. Socioeconomic impacts would be less than their high production counterparts but rapid buildup and decline of the project work force could create more extreme short-term impacts.

Other Major Siting Alternatives

Description

These alternatives consist of alternative sites for various support facilities. Siting alternatives analyzed include:

- Eight product transport corridors
- Seven railroad corridors
- Four road corridors

- Two water supply systems
- Three Colorado River diversion points
- Four Roan Creek reservoir sites
- Five spent shale disposal sites
- Two coal transport systems
- Two worker transport systems

Analysis and Conclusions

- Product transport corridors — The La Sal/Parachute Creek route is preferred for all project configurations if a northern market is chosen for the shale oil. The Fruita to SOPS route is preferred if a southern market is chosen.

- Railroad corridors — Access to the Fruita site via the Dorchester Coal route is preferred. Access to Clear Creek mesa via the De Beque to Clear Creek route is preferred.

- Road corridors — Access to the Fruita site would be the best via 16 Road. Access to Clear Creek mesa via the Roan Creek road is preferred.

- Water supply systems — The Mesa Collection system would have less impacts than the Alluvial Well system. However, both systems would be necessary to supply adequate water.

- Colorado River diversion points — The Parachute diversion point would have the lower impacts.

- Roan Creek reservoirs — The Lower Dry Fork site would have lower impacts of all Roan Creek reservoir sites considered

- Spent shale disposal — The Mesa Valley Fill site on Clear Creek mesa is the preferred site.

- Coal transport systems — The railroad transport system is the most desirable due to the very large number of trucks involved in the truck system.

- Worker transport systems — The bus transport system is the most desirable.

Scoping

Scoping meetings were held in December 1981 in Grand Junction, Rifle, De Beque, and Denver. An agency scoping meeting was also held in Denver in December 1981. This project is being coordinated with the Colorado Joint Review Process and numerous public meetings have been held since September 1981. The main issues that have been identified (in order of importance) are:

- Socioeconomics
- Surface and Ground Water Quality and Quantity
- Air Quality
- Cumulative Impacts
- Land Use and Recreation
- Development Technology
- Transportation
- Solid Waste Generation and Disposal
- Biological Impacts
- Energy

Projects considered with the CCSOP for cumulative impact analysis were selected according to three criteria: (1) an existing project, (2) a project under construction, or (3) a project that has a committment of $100 million or more as of September 1982.

1.0

Purpose and Need

2.0

Proposed Action and Alternatives

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

This chapter describes and compares the Proposed Action and alternatives to the Proposed Action. Based on the information provided in Chapter 3.0, Affected Environment, and Chapter 4.0, Environmental Consequences, Chapter 2.0 (Section 2.4) presents the environmental impacts of the Proposed Action and the alternatives in comparative form. The impacts are presented in relation to the issues in Chapter 1.0, thus providing a clear basis for choice among the varying alternatives by BLM, U.S. Army Corps of Engineers, and the public. In accordance with the Council on Environmental Quality (CEQ) regulations (40 CFR 1502.14 [a-f]) this chapter addresses the following:

- Alternatives eliminated from detailed study and the reasons for elimination (Section 2.2)
- Description of the Proposed Action and reasonable alternatives (Section 2.3)
- The No Action alternative (Section 2.3.5)
- A comparison of environmental impacts of the alternatives considered in detail including the Proposed Action (Section 2.4)
- The BLM's preferred alternative (Section 2.4.11)

2.2 Selection of Alternatives for Detailed Consideration

The U.S. Bureau of Land Management, according to 40 CFR 1505.1(e), identified the Proposed Action as well as a full range of alternatives to the Proposed Action, in order to ensure that all reasonable alternatives were studied in detail in the EIS. The following criteria were applied to this range of alternatives.

- Minimize environmental and socioeconomic impacts
- Maximize the recovery of the oil shale resource
- Maximize engineering efficiency and obtain a logical engineering scheme
- Minimize capital expenditure in a manner consistent with the previous criteria

Documentation of the selection process used is contained in BLM project files. Those alternatives that did not meet the above criteria were eliminated from detailed study within the EIS and the reasons for their elimination were documented. Table 2.2-1 presents the full range of alternatives considered and the reasons for inclusion or elimination from detailed study in the EIS, based on the criteria described above. A more complete discussion of alternatives eliminated from detailed study is provided in Appendix A.

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Resource Property			
Mine Location	Clear Creek Property	Included	Most desirable from an engineering and economic standpoint (All: 50, 100)
	Parachute Creek Property	Eliminated	Currently less desirable from an engineering and economic standpoint

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Major Facility Sites			
Feed Preparation	Clear Creek Property	Included	Reduces transport and increases efficiency (PA: 50, 100; CC: 50, 100; FI: 50, 100)
	Adjacent to Mine	Eliminated	Inefficient for long-term operation
	Near Fruita Retorts	Included	Considered in Fruita II configuration only (FII: 50)
Retort Modules	Clear Creek Mesa	Included	Feasible from economic, engineering, and environmental standpoint (PA: 50, 100; CC: 50, 100; FI: 50, 100)
	Skinner Ridge	Eliminated	Not feasible from economic or engineering standpoint
	No Name/Mud Springs	Eliminated	Same as Skinner Ridge
	North of Fruita	Included	Feasible from engineering and economic standpoint at 50,000-bpd level; considered in Fruita II alternative only (FII: 50)
Upgrading Modules	Clear Creek Mesa	Included	Feasible from economic and engineering standpoint (PA: 50, 100; CC: 50, 100)
	Skinner Ridge	Eliminated	Not feasible from economic or engineering standpoint
	No Name/Mud Springs	Eliminated	Same as Skinner Ridge
	North of Fruita	Included	Feasible from economic, engineering, socioeconomic, and environmental standpoint (FI: 50, 100; FII: 50)
Spent Shale Disposal			
Clear Creek Mesa	Mesa Valley Fill	Included	Area has capacity to hold spent shale; feasible from economic and engineering standpoints (PA: 50, 100; CC: 50, 100; FI: 50, 100)
	North/South Clear Creek Fill	Eliminated	Not enough available area
	Clear Creek Deep Canyon	Eliminated	Not enough available area
	Northeast Corner of Property	Eliminated	Not enough available area
	Underground Mine	Eliminated	Economic, environmental, and safety problems prohibit disposal underground
	Open Pit Disposal	Included	Practical method of shale disposal (PA: 100; CC: 100; FI: 100)
Fruita Locations	Stove/Buniger Canyons	Included	Considered as an alternative to transport of spent shale to the Clear Creek mesa; feasible from engineering and economic standpoints (FII: 50)
	Garvey Canyon	Included	Considered as an alternative; feasible from an engineering/economic standpoint (FII: 50)
	Dry Gulch	Included	Considered as an alternative; feasible from an engineering/economic standpoint (FII: 50)
	Munger Creek	Included	Feasible from an engineering/economic standpoint (FII: 50)

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Infrastructure			
Water Supply/ Primary Sources	Colorado River Near De Beque	Included	Chevron, Conoco and others (GCC Partners) own individual water rights (All: 50, 100)
	Colorado River Near Loma	Included	Chevron owns water rights; feasible water system (PA: 50, 100; FI: 50, 100; FII: 50)
	Colorado River Near Parachute	Included	Feasible alternative source (All: 50, 100)
	Upper Clear Creek	Included	Mesa collection system to control and capture usable water; feasible water system component (All: 50, 100)
	Clear Creek Aquifers	Included	Used to partially satisfy initial water requirements; feasible water system component (All: 50, 100)
	Roan Creek Near De Beque	Included	Feasible from engineering and economic standpoints (All: 50, 100)
	Big Salt Wash Near Loma	Included	Big Salt Wash Reservoir used to store water as a supplemental system (PA: 50, 100; FI: 50, 100; FII: 50)
	Parachute Creek Near Parachute	Included	Feasible from engineering and economic standpoints (All: 50, 100)
	Ruedi Reservoir	Eliminated	Water rates and delivery schedules uncertain at this time (Conoco will have potential water use considered in U.S. Bureau of Recreation EIS)
	Other sources	Eliminated	Other sources uncertain at this time
Water Supply Systems	De Beque System - Diversion Point and Roan Creek Pipeline	Included	Feasible alternative (All: 50, 100)
	De Beque System Reservoir Sites		
	Upper Dry Fork	Included	Proposed reservoir site (All: 50, 100)
	Lower Dry Fork	Included	Feasible alternative, provides adequate storage (All: 50, 100)
	Lower Conn Creek	Included	Feasible alternative, provides adequate storage (All: 50, 100)
	Upper Conn Creek	Included	Feasible alternative, provides adequate storage (All: 50, 100)
	Kimball Creek	Eliminated	Site inundates a significant amount of critical winter range and has unfavorable geologic conditions
	Loma System - Diversion Points and Pipelines		
	Diversion/Route A	Included	Existing depression advantageous for intake (PA: 50, 100; FI: 50, 100; FII: 50)
	Diversion/Route B	Included	Good access to intake site (PA: 50, 100; FI: 50, 100; FII: 50)
	Diversion/Route C	Included	Good site due to location of present gravel pond, easy access (PA: 50, 100; FI: 50, 100; FII: 50)
	Diversion/Route D	Eliminated	Limited space would create a sediment problem
	Diversion/Route E	Eliminated	Poor river hydraulics, limited access, sediment problems
	Diversion/Route F	Eliminated	Poor river hydraulics, poor access

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
	Loma System - Reservoir Sites		
	Big Salt Wash	Included	Adequate storage capacity, good structural competency (PA: 50, 100; FI: 50, 100; FII: 50)
	Ruby Lee Reservoir	Eliminated	Extremely long dam required for adequate storage
	Parachute System	Included	Feasible from an engineering and economic standpoint; see environmental studies for Union Shale Oil (All: 50, 100)
	Clear Creek Mine System	Included	Feasible alternative (All: 50, 100)
	Clear Creek Mesa System	Included	Feasible alternative (All: 50, 100)
	Clear Creek Well System	Included	Feasible alternative (All: 50, 100)
	Ruedi Reservoir	Eliminated	Water rates and delivery schedules uncertain at this time (Conoco will have potential use considered in the U.S. Bureau of Reclamation EIS)
	Other Sources	Eliminated	Other sources uncertain at this time
Water Supply Augmentation Sources and Systems	Finley Ranch Pumping Plant	Included	Potential need for augmentation depending on other systems (PA: 50, 100; CC: 50, 100; FI: 50, 100; FII: 50)
	Roan Creek System	Included	Potential need for augmentation depending on other systems (PA: 50, 100; CC: 50, 100; FI: 50, 100; FII: 50)
Access Roads to Clear Creek Property	Roan Creek Road	Included	Required for primary access to mine and/or plant site (All: 50, 100)
	Big Salt Wash to Clear Creek Property - Echo Lake Route	Included	Required for primary and/or secondary access to mine site; primary access to Fruita plant sites; feasible from engineering and economic standpoints (PA: 50, 100; FI: 50, 100; FII: 50)
	Big Salt Wash, East Gulch to Clear Creek Property - East Gulch Route	Eliminated	Length substantially greater adding additional construction costs and transportation time
	Douglas Pass to Clear Creek Property	Eliminated	Additional distance and unstable geologic conditions
	Piceance Creek Road to Clear Creek Property (East Fawn Creek)	Eliminated	Substantial road construction or upgrading required; too close to proposed limits if open pit mine; not economically feasible
	Piceance Creek Road to Clear Creek Property (Dry Gulch)	Eliminated	Longer distances and slopes require additional operational costs; not economically feasible
	Piceance Creek Road to Clear Creek Property (Hunter Creek)	Eliminated	Longer distances, increased worker commute time, and additional maintenance; not economically feasible

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Access Roads to Fruita Site	Fruita to Plant Site	Included	Necessary access to Fruita plant site; feasible from engineering and economic standpoints (FI: 50, 100; FII: 50)
	Douglas Pass Road to Site - Route A	Eliminated	Additional upgrading required plus additional distance and commute time; not feasible from engineering standpoint
	Douglas Pass Road to Site - Route B	Included	Part of multiple use corridor; feasible from economic and engineering standpoint (FI: 50, 100; FII: 50)
	Douglas Pass Road to Site - Route C	Eliminated	Offers no advantage over other routes
Intertie Pipelines	Big Salt Wash to Clear Creek Property - Echo Lake Route	Included	Part of Fruita I alternative; easiest to construct and along routes of other facilities (FI: 50, 100)
	Big Salt Wash to Clear Creek Property - Deer Creek Route	Included	Feasible alternative from engineering and economic standpoints (FI: 50, 100)
	Big Salt Wash, Deer Creek Straight Line to Clear Creek Property	Eliminated	Construction difficult due to proposed route; impacts maximized; uneconomical
	Roan Creek to Clear Creek Property - Overland Route	Included	Feasible from engineering and economic standpoints (FI: 50, 100)
	Douglas Pass Road to Clear Creek Property	Eliminated	Geological stability problems apparent
Product Transport - From Clear Creek Mesa	La Sal Pipeline Connection Corridor I	Included	Part of system to connect to proposed La Sal pipeline (All: 50, 100)
	La Sal Pipeline Connection Corridor II	Eliminated	Necessary pumping equipment would have to to be located at a point where manned operations would not otherwise exist
	Lisbon (SOPS) Connection	Included	Connection to proposed SOPS system considered viable alternative from economic and engineering standpoints (All: 50, 100)
	Rangely Connection (A)	Included	Practical line to existing terminal facilities - feasible from engineering and economic standpoints (All: 50, 100)
	Rangely Connection (B)	Included	May offer environmental advantages over Rangely A (All: 50, 100)
Product Transport - from Fruita Plant Site Property	Big Salt Wash to Clear Creek - Echo Lake Route	Included	Same corridor as similarly named access road - feasible from economic and engineering standpoints (FI: 50, 100; FII: 50)
	Big Salt Wash to Clear Creek Property - Deer Creek Route	Included	Minor variation of Echo Lake Route; feasible from economic and engineering standpoints (FI: 50, 100; FII: 50)
	Roan Creek to Clear Creek Property - Overland Route	Included	Feasible from economic and engineering standpoints (FI: 50, 100)
	Roan Creek to Clear Creek Property - Tunnel Route	Included	Considered only in conjunction with applicable shale transport railroad (see below); feasible from economic and engineering standpoints (FII: 50)

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
	Big Salt Wash Straight-Line Tunnel to Clear Creek Property	Included	Considered only with applicable shale transport railroad (FII: 50)
	Big Salt Wash West to SOPS Line	Included	Shortest route to SOPS line from Fruita site; feasible from economic and engineering standpoints (FI: 50, 100; FII: 50)
Transmission Line Corridors to Clear Creek Mesa	De Beque, Parachute to Clear Creek Loop	Included	Looped system considered practical to allow a reasonable power source supply (All: 50, 100)
	De Beque Radial	Included	Essentially one-half of loop described above; feasible alternative power source and corridor (All: 50, 100)
	Davis Radial	Included	Essentially one-half of loop described above; feasible alternative power source and corridor (All: 50, 100)
Transmission Line Corridors to Fruita Plant Site	Dorchester Coal Corridor	Included	Practical means of supplying power to Fruita plant site (FI: 50, 100; FII: 50)
	Fruita to Upgrading Plant Site	Included	Practical alternative to supplying power to Fruita plant, particularly in early stages (FI: 50, 100; FII: 50)
	Multiple Use Corridor (Douglas Pass Road)	Included	Minimize impacts by utilizing multiple-use corridor (FI: 50, 100; FII: 50)
Natural Gas Pipeline Corridors	Along product transport pipelines	Included	Use same route as product transport pipelines (All: 50, 100)
Rail Transport Corridors to Clear Creek Property	D&RGW Spur at De Beque	Included	Practical due to proximity to mainline (All: 50, 100)
	D&RGW De Beque to Clear Creek Property	Included	More costly but feasible alternative to mainline spur from economic and engineering standpoints (All: 50, 100)
Rail Transport Corridors to Fruita Plant Site	Rail Corridor Route A (west of Mack)	Eliminated	Reconstruction of part of highway required; no advantages over other alternatives
	Rail Corridor Route B (16 Road)	Included	Part of multiple-use corridor (FI: 50, 100; FII: 50)
	Rail Corridor Route C (Dorchester Coal Route)	Included	Joint usage with proposed Colorado-Ute power plant (FI: 50, 100; FII: 50)
	Rail Corridor Route D (similar to Route C)	Eliminated	Offers no advantage over other routes
	Douglas Pass Road	Included	Joint railroad/road is more efficient (FI: 50, 100; FII: 50)
Shale Transport System to/from Fruita	Railroad to Fruita		
	Tunnel Route	Included	Shorter, more efficient (FII: 50)
	Carr Creek Route	Eliminated	More surface disturbance, difficult engineering
	Roan Creek Route (Tunnel)	Included	Shorter, more efficient (FII: 50)
	Kimball Creek Route	Eliminated	Additional length decreases efficiency
	Conveyor	Eliminated	Costs for construction and operation prohibitive

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Mine Technology			
Mining Methods	Combination Underground and Open Pit Mine	Included	Maximum resource recovery (All: 100)
	All Underground	Included	Feasible under a 50,000-bpd production rate (All: 50)
	All Open Pit Mine	Eliminated	Limits extent of resource recovery
Underground Mine Access	Decline Slope/Vertical Shaft	Included	Proposed method of underground mining; offers lowest capital and operating cost while conforming to the mine plan (All: 50, 100)
	Vertical Shafts	Eliminated	Not ideally suited for transporting large production tonnages from relatively shallow mines; this alternative more costly
	Adit Access	Eliminated	This alternative would require additional men, ore, and materials transport, hence increasing costs
Underground Mining Method	Room-and-Pillar	Included	Underground mining method most amenable to oil shale resource (All: 50, 100)
	Chamber-and-Pillar	Eliminated	Increased cost and safety hazards
	Sublevel stoping	Eliminated	Not amenable to existing oil shale resource
	Sublevel caving	Eliminated	Oil shale not conducive to caving technique; more expensive than proposed method.
	Block caving	Eliminated	Oil shale not conducive to caving technique; more expensive than proposed method.
Process Technology			
Retorting	Chevron STB	Included	Process developed by Chevron and proposed for use (All: 50, 100)
	Lurgi LR	Eliminated	Not as energy efficient as STB
	Paraho DH	Eliminated	Not as energy efficient as STB
	Union B I-H	Eliminated	Not successfully demonstrated at commercial scale
	Tosco II	Eliminated	Not as energy efficient as STB
	Superior	Eliminated	Clear Creek resource does not contain attractive quantities of nahcolite and dawsonite
	In-Situ/Modified In-Situ	Eliminated	Does not achieve adequate recovery for the CCSOP oil shale resource
Upgrading	Hydrotreating	Included	Feasible engineering alternative (All: 50, 100)
	Delayed Coking-Hydrotreating	Eliminated	Product not as suitable for refinery feed stock
	No Upgrading	Eliminated	Transport difficult due to viscosity; not interchangeable with other feedstocks

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Drainage Control - Clear Creek Locations	Clear Creek Through Underground Mine Drain - Mesa Valley Fill	Included	Practical means of controlling surface water; feasible from economic and engineering standpoints (PA: 50, 100; CC: 50, 100; FI: 50, 100)
	Clear Creek Underdrain - Mesa Valley Fill	Included	Practical means of controlling surface water; feasible engineering alternative (PA: 50, 100; CC: 50, 100; FI: 50, 100)
	Willow Creek Through Open Pit North/South Clear Creek	Eliminated	Not used with chosen spent shale alternatives
	Willow Creek Open Channel Diversion to Clear Creek - North/South Clear Creek Fill	Eliminated	Uneconomical; engineering complications
Solid/Hazardous Waste Disposal			
Solid Waste	Landfill in Shale Disposal Area	Included	Utilized developed techniques for disposal of shale; feasible engineering and economic alternative (All: 50, 100)
	Incineration and Landfill	Included	Alternative to landfill in shale disposal area; feasible engineering and economic alternative (All: 50, 100)
	Separate Landfill	Included	Alternative to landfill in shale disposal area; feasible engineering and economic alternative (All: 50, 100)
Hazardous Waste	Off-site Disposal	Included	Feasible engineering and economic alternative (All: 50, 100)
	On-site Disposal	Included	Feasible engineering and economic alternative (All: 50, 100)
Hydrocarbon Liquid Waste Disposal	Recycle	Included	Recycling back into combustor is feasible disposal method (All: 50, 100)
	Incineration	Included	Wastes fed to a thermal incinerator and combusted; feasible method of eliminating wastes (All: 50, 100)
Reclamation Techniques			
Reclamation	Capillary Barrier/Subsoil/ Topsoil with Revegetation	Included	Most reliable method of reclamation (All: 50, 100)
	No Topsoil Cover	Eliminated	Properties of spent shale are not conducive to direct revegetation
Transportation			
Coal Transport	Truck	Included	Feasible from engineering and economic standpoints (All: 100)
	Rail	Included	Feasible from engineering and economic standpoints (All: 100)
Worker Transport	Bus Fleet	Included	Transit system practical and economic for worker transport (All: 50, 100)

Table 2.2-1 ALTERNATIVES CONSIDERED FOR OR ELIMINATED FROM DETAILED STUDY, CLEAR CREEK SHALE OIL PROJECT EIS (Continued)

Project Component	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion/Elimination (Project Configuration)[a]
Power Sources			
Electrical Requirements	Off-site Power (Purchase)	Included	Most practical method of obtaining required power (All: 50, 100)
	Cogeneration	Included	Use of gas and heat from processes feasible for power generation (All: 50, 100)
	Off-site Power (Assist in Power Plant Construction)	Eliminated	Requires additional capital expenditures and planning; future uncertain
	CCSOP Builds Power Plant	Eliminated	Requires additional capital expenditures and planning; future uncertain

[a] Applicable project configurations shown in parentheses.
All = All project configurations
PA = Proposed Action configuration
CC = Clear Creek configuration
FI = Fruita I configuration
FII = Fruita II configuration
50 = 50,000-bpd production rate
100 = 100,000-bpd production rate
(e.g., PA: 50, 100 is Proposed Action at 50,000 and 100,000 bpd rates; CC: 50, 100 is the Clear Creek configuration at 50,000 and 100,000 bpd production rates)

2.3 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.3.1 Introduction and Overview

An oil shale operation consists of five major components.

1. *The mining of oil shale,* typically by underground and/or surface mining methods.

2. *The retorting process,* which extracts the shale oil from marlstone by subjecting the shale to high temperatures.

3. *The upgrading of the shale oil,* using techniques similar to conventional oil refining.

4. *The disposal of spent shale,* mine and plant decommissioning, and subsequent reclamation.

5. *The provision of support services* to the mining, retorting, upgrading, and disposal facilities, including roads, railroads, transmission lines, pipelines, and other facilities. A water supply system is also included.

Consistent with the major components as described above, the Operator has proposed a project to produce 100,000 barrels per day (bpd) of shale oil. The project would last for approximately 90 years and includes:

- A combination surface/underground mine on the Clear Creek property
- Eleven retorting modules on the Clear Creek property

- Four upgrading modules on the Clear Creek property

- Spent shale disposal on Clear Creek mesa and in the open pit mine

- Support facilities such as roads, pipelines, transmission lines, a water system and related facilities

A detailed description of the Operator's Proposed Action is presented in Section 2.3.2.

Based on this initial proposal, over 75 alternatives were identified for detailed study. The detailed analysis and comparison of this complex set of alternatives necessitated special consideration. Therefore, alternatives are addressed in this EIS in the following manner.

- Facility Siting Alternatives — at a 100,000-bpd production rate

- Facility Siting Alternatives — at a 50,000-bpd production rate

- The No Action Alternative

In order to simplify presentation and to allow the reader to identify and compare impacts of the alternatives to the Proposed Action, the alternatives were organized into seven major project configurations by BLM. Each of these major project configurations is described in the following sections.

Facility Siting Alternatives Producing 100,000 bpd

The 100,000-bpd alternative project configurations include facilities such as the mine, retort and upgrading modules, and corridors with support facilities such as pipelines, roads, and railroads. The following three alternative configurations at 100,000 bpd are considered in detail in the EIS:

- *The Proposed Action Configuration* — This configuration is the Operator's Proposed Action and includes mining (surface and underground), feed preparation, retorting (11 modules), and upgrading (4 modules) on Clear Creek mesa. Additionally, a water pipeline and reservoir would be located in the Roan Creek valley, a reservoir in the Big Salt Wash drainage, and a water pipeline from the Loma area to Clear Creek mesa. This project configuration is shown on Figure 2.3-1.

- *Clear Creek Alternative Configuration* — This configuration includes mining (surface and underground), feed preparation, retorting, and upgrading of shale oil on Clear Creek mesa, as above. The number of upgrading and retorting modules would remain the same as for the Proposed Action. A water pipeline and reservoir would only be built in the Roan Creek valley. This configuration does not include the Big Salt Wash reservoir or the Loma pipeline. The locations of the major components of this configuration are shown on Figure 2.3-2.

- *Fruita I Alternative Configuration* — This configuration includes mining (surface and underground), feed preparation, and retorting on Clear Creek mesa, as above. The upgrading plant, however, would be located in the Grand Valley area north of Fruita. The number of retort and upgrading modules would also remain the same as for the Proposed Action. Additional support facilities would be required to service the upgrading facility north of Fruita. This configuration is shown on Figure 2.3-3.

Numerous support facilities are required for each of the above project configurations. Within the discussion for each project configuration the appropriate alternative support facility sites will be presented. Some of the facilities are common to several project configurations. These are described for the first applicable configuration within the text, and are subsequently referenced when the support facility applies to an alternative configuration.

A fourth alternative project configuration, Fruita II, was considered under the 100,000-bpd scenario. The Fruita II configuration differs from the Fruita I configuration in that both the retorting and upgrading modules would be located at the Fruita plant site. A raw shale transport system from Clear Creek mesa to the Grand Valley would also be part of this configuration. The Fruita II configuration at the 100,000-bpd production rate was eliminated from detailed study due to environmental and engineering considerations. The potential for consumption of the Prevention of Significant Deterioration (PSD) increments made the configuration environmentally unacceptable. The economics of transporting large volumes of shale from Clear Creek mesa to the Fruita plant site to produce 100,000 bpd of shale oil was also prohibitive. Therefore, the Fruita II configuration is only considered feasible at a 50,000-bpd production rate.

Facility Siting Alternatives Producing 50,000 bpd

The impacts of each of the project configurations discussed above (Proposed Action, Clear Creek, Fruita I) were also evaluated at the 50,000-bpd production rate. These are described and compared in Section 2.4.3. In addition to these three configurations a fourth configuration — Fruita II, as introduced above — is considered in detail at the 50,000-bpd production rate. This configuration is shown on Figure 2.3-4.

The Fruita II 50,000-bpd configuration involves only underground mining on Clear Creek mesa. The upgrades (4 modules) and retorts (3 modules) would be located on the plant site north of Fruita. A raw shale transport system (railroad) would be necessary to provide feedstock to the retorts. Spent shale disposal would occur in the Grand Valley. A more detailed discussion of the Fruita II configuration is presented in Section 2.3.4.

For the other three project configurations at the 50,000-bpd production rate, all mining would occur underground on Clear Creek mesa with spent shale disposal on the surface of the mesa. Mine life for all alternatives would be approximately 25 years. The support facilities required for any of the project configurations under the 50,000-bpd scenario would be generally the same as those described for the 100,000-bpd scenario. Differences, where they occur, will be noted.

No Action Alternative

The President's Council on Environmental Quality (CEQ) regulations for EIS preparation require (at 40 CFR 1502.14) the No Action alternative to be examined and analyzed. This alternative is described in Section 2.3.5.

2.3.2 Description of the Proposed Action

Under the Operator's Proposed Action, mining, retorting and upgrading would occur on Clear Creek mesa. Ultimate production would be 100,000 bpd of shale oil from an estimated resource of 17.7 billion tons of oil shale. From this reserve, averaging 18.6 gallons per ton (gpt), approximately 7.8 billion barrels of shale oil could be extracted. This configuration is shown on Figure 2.3-1.

2.3.2.1 Project Overview

The Operator proposes to extract oil shale from the Clear Creek property utilizing conventional underground and surface mining techniques. Initial production of the shale oil will commence by developing the underground reserves to recover high grade (31 gpt) oil shale and then developing the surface mine (lower grade oil shale) reserves later. Both techniques will be utilized concurrently until the underground reserves are depleted in 20 years. Surface mining would continue for another 70 years. At maximum production, approximately 275,000 tons per day (tpd) of oil shale would be mined to produce 100,000 bpd of synthetic crude oil. The maximum areal limits of the surface pit and underground mine are shown on Figure 2.3-5.

Oil shale removed from the underground and surface mines would be moved by large high-speed belt conveyors to the processing area. To produce 100,000 bpd of syncrude, it would be necessary to move approximately 275,000 tpd of oil shale from the mines to the crushing and feed preparation areas and then to the retorts. The oil shale would be subjected to primary crushing in the mining area to a nominal 6 inches in size and conveyed by covered belt to the feed preparation area. In the feed preparation area the oil shale would be reduced in size to less

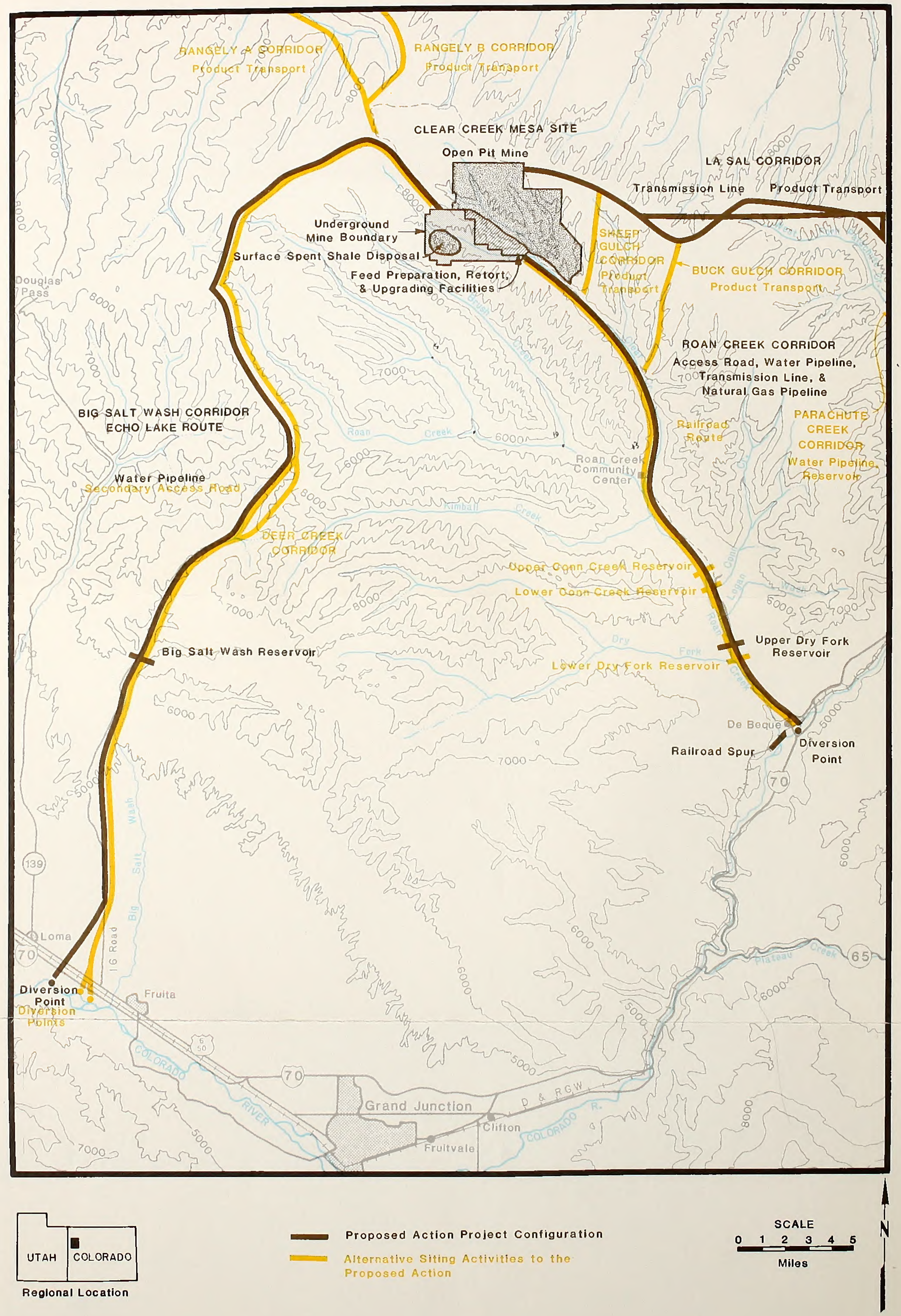


Figure 2.3-1 Proposed Action Project Configuration Showing Alternative Siting Activities to the Proposed Action

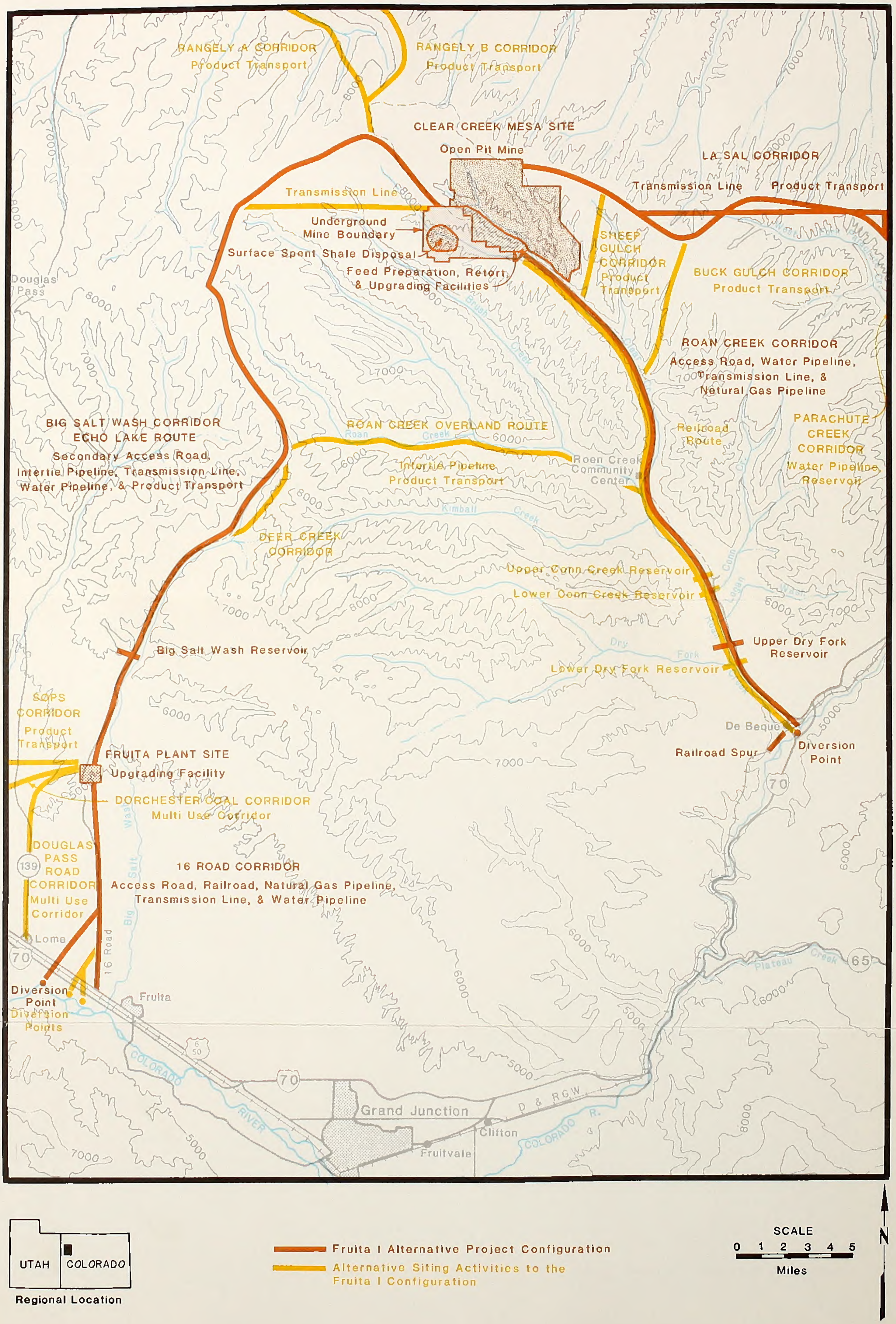


Figure 2.3.3 Fruita I Alternative Project Configuration Showing Alternative Siting Activities to the Fruita I Configuration

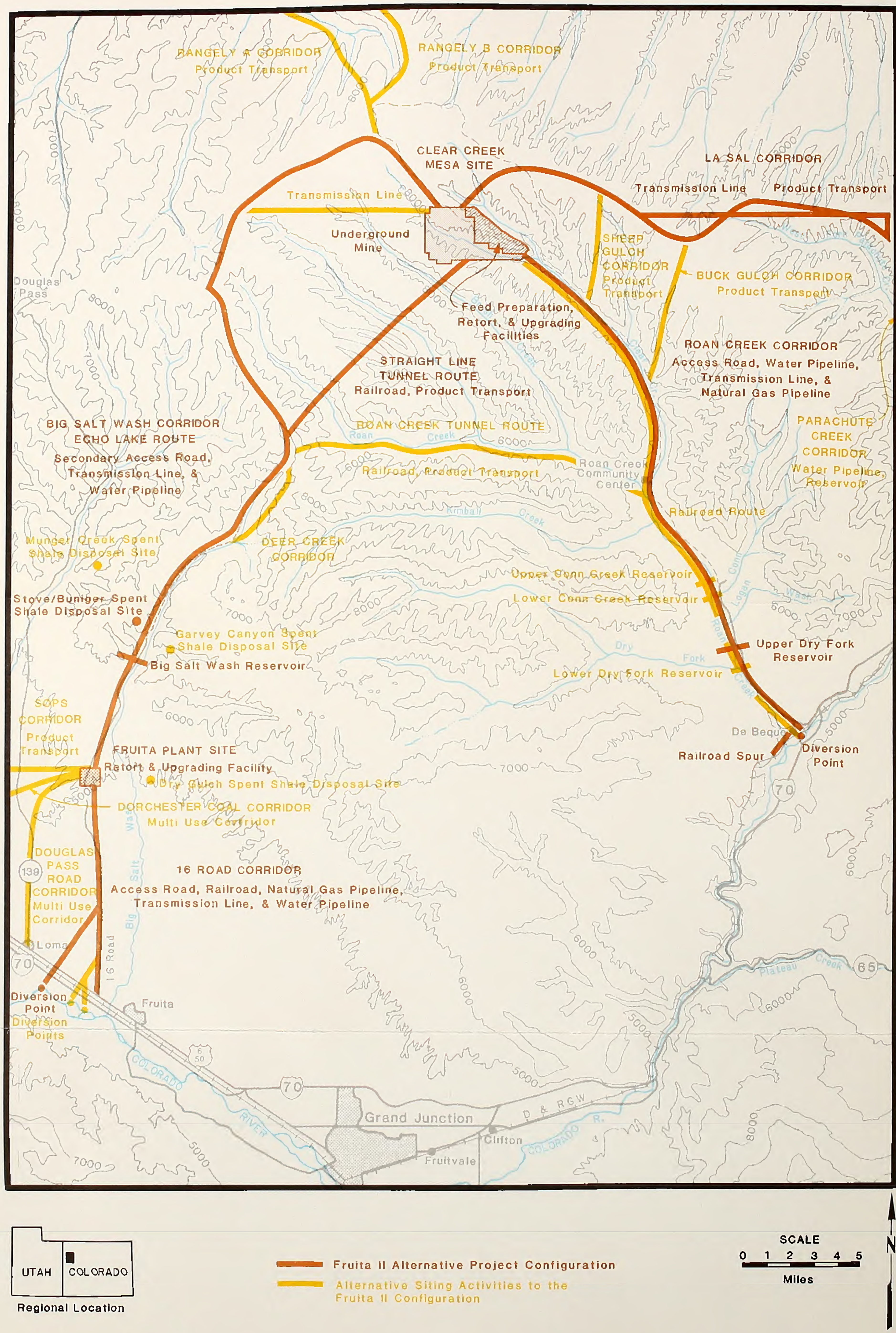


Figure 2.3.4 Fruita II Alternative Project Configuration Showing Alternative Siting Activities to the Fruita II Configuration

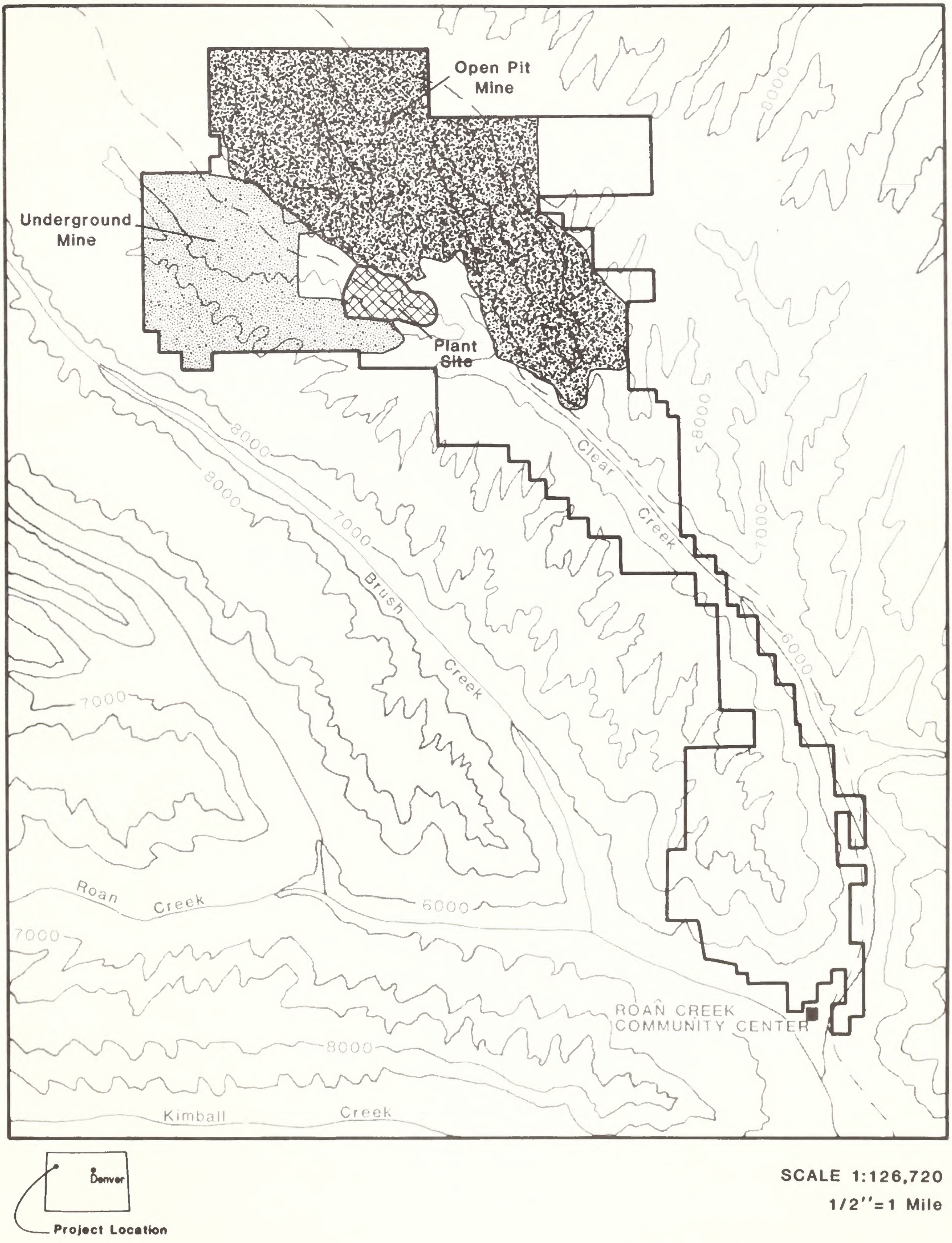


Figure 2.3.5 Limits of Open Pit and Underground Mining

than ¼ inch, then carried in covered high-speed belt conveyors to the retort area for recovery of oil. All oil shale passing to the feed preparation plant, including fines produced in the crushing operation, would be sent to the retorts.

Raw shale oil would be produced by retorting the oil shale using the Chevron Staged Turbulent Bed (STB) Process. The crushed oil shale would be fed to the STB surface retorts where it is heated to over 900°F. The hydrocarbon vapors generated in the retorts condense to form raw shale oil.

The raw shale oil recovered in the retorts would be separated from process gas (generated as a by-product of retorting) and fed by pipeline to the upgrading plant. In the upgrading plant, manufactured hydrogen would be added to the raw oil to remove impurities and produce a refineable crude. The syncrude thus produced by upgrading would be sent by pipeline to existing oil refineries for the manufacture of gasoline, jet fuel, and other petroleum products.

After removal from the retort, the spent shale would be conveyed back to a fill area on the mesa or the surface mine for disposal. If 275,000 tpd of oil shale is fed to the retorts, approximately 275,000 tpd of retorted (spent) shale would be returned to the mine area. Therefore, a total of up to 550,000 tpd of material may be moved between the mines and processing area.

The proposed plant site for the three processing facilities (feed preparation, retorting, and upgrading; Figure 2.3-6) would be located between the open pit mine to the north and the underground mine to the southwest and would occupy approximately 800 acres.

Development of the project is proposed to occur over a period of about 15 years, with site preparation beginning in late 1985. Underground mining would begin in 1989 and surface mining in 1994. Eleven retorts are proposed and would be built in modules to process 25,000 tpd each. The first retort would be built during the period 1986-1989, with the first shale oil produced in 1989. Production of 100,000 bpd would occur in approximately 2007. The base cost for developing these facilities in 1981 dollars is about $5 billion. Assuming that costs would rise over the life of the project, it is estimated that actual total capital costs would be in the range of $6-10 billion.

Details on each of the components of the Proposed Action configuration are presented in the following sections.

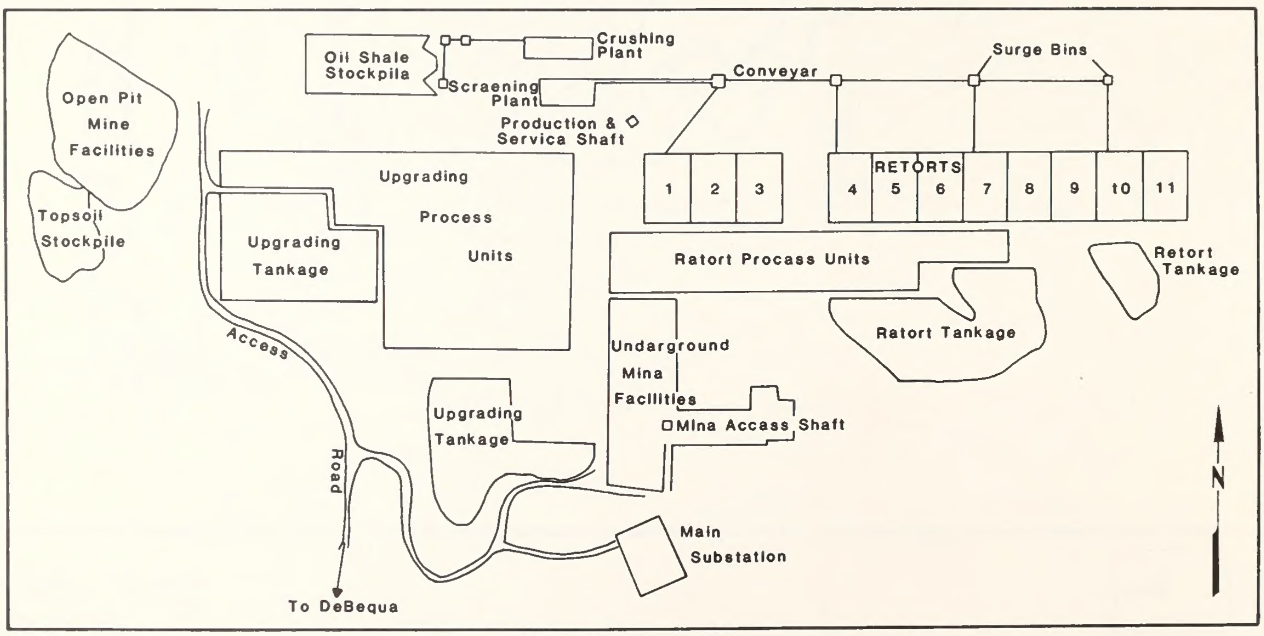


Figure 2.3-6 Plot Plan of Clear Creek Mesa Mine, Retort, and Upgrade Facilities

2.3.2.2 Anticipated Labor Requirements

The CCSOP would employ a significant number of people for construction of the proposed facilities and for operation of the mines and processing plants. Preliminary projections indicate that, at its peak construction year (1994), the CCSOP would require approximately 6,000 construction workers, and approximately 3,000 supervisory and operations personnel. Approximately 5,000 people would be permanently employed after the construction is complete. Table 2.3-1 indicates the expected construction and operation employment. Further detail is provided in Section 4.12, Socioeconomics.

Table 2.3-1 AVERAGE ANNUAL EMPLOYMENT, CLEAR CREEK SHALE OIL PROJECT[a]

	Employment Numbers		
Year	Construction	Operations	Total
1985	1,200	0	1,200
1986	3,125	0	3,125
1987	3,625	500	4,125
1988	4,025	1,000	5,025
1989	2,845	1,480	4,325
1990	1,020	1,480	2,500
1991	3,020	1,480	4,500
1992	5,520	1,480	7,000
1993	6,110	2,390	8,500
1994	5,980	3,020	9,000
1995	5,390	3,610	9,000
1996	5,020	3,980	9,000
1997	4,710	4,290	9,000
1998	3,775	4,555	8,330
1999	2,630	4,670	7,300
2000	2,300	5,000	7,300
2001	2,195	5,105	7,300
2002	0	5,125	5,125
2003	0	5,125	5,125

Source: Morrison-Knudsen (1982).

[a] Proposed Action at 100,000 bpd

2.3.2.3 Proposed Facility Sites and Processes

Underground Mine

A total of 245 million tons of oil shale averaging about 31 gpt of shale oil would be mined underground from the Mahogany Zone at an average depth of 600 feet. The average thickness of the mining zone would be 38 feet, and a minimum extraction of 60 percent (within the mining zone) would be achieved. The underground mine would cover the surface equivalent of 3,600 acres, and would be limited to the southwest corner of the Clear Creek property (Figure 2.3-5). The surface disturbances associated with the underground mine (e.g., access roads) would comprise approximately 15 acres.

After completion of underground mine construction, production would reach 25,000 tpd and would be maintained until commissioning of a second retort approximately 3-4 years later. At that time, the mine would produce approximately 50,000 tpd of oil shale. This level of underground mining would be maintained until about 2007, when underground reserves would be exhausted.

Oil shale would be mined conventionally by the advancing room-and-pillar method (Figure 2.3-7). Mine access would be via decline slope and vertical shaft. Mining would advance about 7,500 feet per year and cover the surface equivalent of 180 acres per year. Topsoil would be removed in areas of surface disturbance and reclamation would occur after decommissioning of surface facilities.

Spent shale disposal during the initial stages of underground mining would occur within Clear Creek canyon at a location somewhat upstream of Clear Creek falls. The open pit mine would be used for disposal when an adequate area for disposal was available. Detailed descriptions of the spent shale disposal systems are provided later in this section.

The underground mine facilities would include minor repair shops, a warehouse, office, and other ancillary facilities. A fleet of service/supply equipment (e.g., maintenance trucks, fire trucks, cranes, and water trucks) would provide support for the mining operation. A general mine office, changehouse, hoist building, and major repair shops would be located on the surface.

The underground mine plan has been designed to comply with all federal and state standards and would provide the necessary control systems for subsidence, water, emissions, and noise.

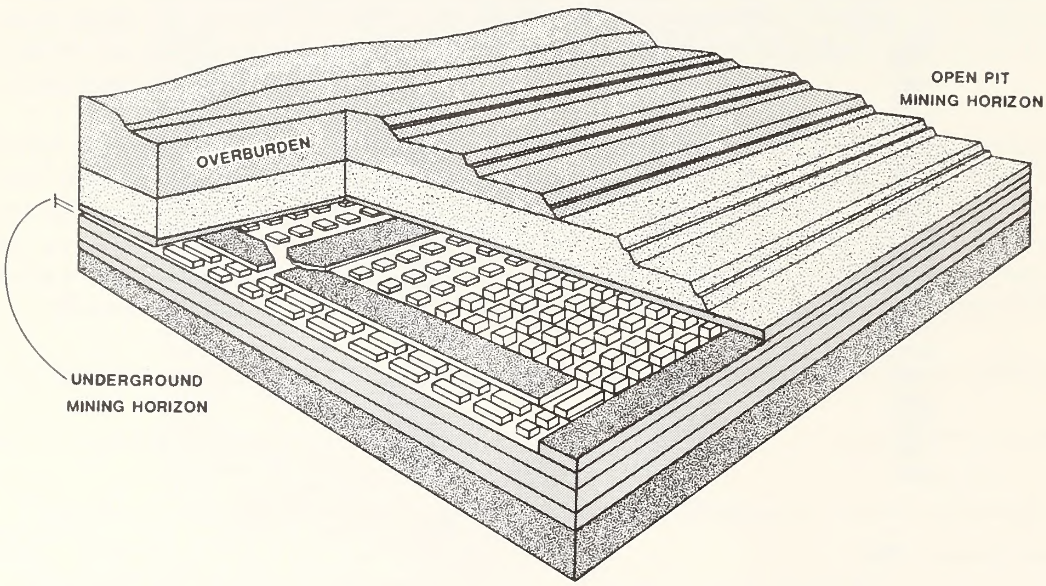


Figure 2.3-7 Conceptual Design of Room and Pillar Mining Technique

Surface Mine

The Operator would use conventional surface mining techniques to extract oil shale from those areas of the Clear Creek property where overburden depths are economically acceptable for maximum resource recovery. Surface mine development would begin with the construction of an access road, support facilities, and drainage control. Construction would commence in 1991. Assembly of the primary mining equipment would also begin in that year and the first oil shale would be mined from the open pit in 1994.

Surface mining would start above the Willow Creek falls where a box cut would be opened parallel to the Willow Creek drainage. The initial box cut would advance north and south at approximately 600 feet per year, hence impacting about 86 acres of land per year (Figure 2.3-8). The mining operation would employ large electric shovels mounted on rubber-tired dozers for support. Waste material and oil shale would be hauled by large diesel-electric rear dump trucks to the waste rock disposal site and primary crushers, respectively.

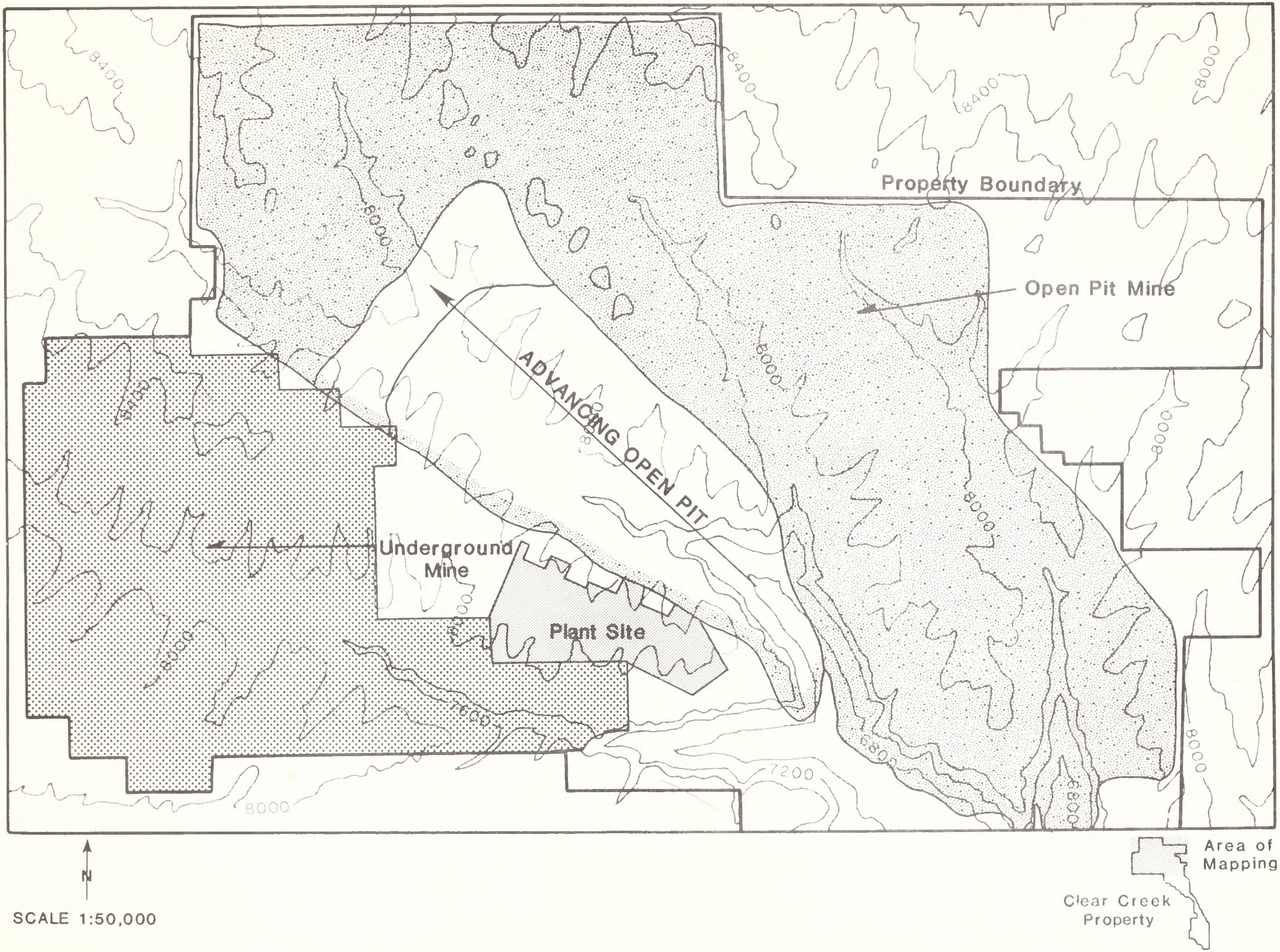


Figure 2.3-8 Open Pit Mine Advancement

In the early years of the mine life, waste rock and overburden would be placed in Willow Creek canyon, which has a capacity of approximately 183 million cubic yards. Upon completion of the Willow Creek canyon fill, overburden would backfill the open pit excavation. Typically, the waste to oil shale ratio (in tons) would be approximately 1:1.

Mining of oil shale from the open pit would progressively increase to a maximum production of approximately 275,000 tpd; this would occur between 2006 and 2007. This production level would continue an additional 70 years until the reserves are depleted.

The control systems for open pit mining are categorized into water, noise, and emissions controls and would meet applicable laws and regulations. Similarly, the mine safety measures implemented would conform to all applicable laws and regulations.

Feed Preparation, Handling, and Storage

Before the mined oil shale is retorted, it would be crushed to a nominal 6-inch size at the mine site and transported by conveyers to the feed preparation area where it would be further reduced in size to less than ¼ inch. The feed preparation area would be located at the plant site north of the retort processing and upgrading facilities and would occupy about 300 acres. Facilities at the feed preparation area would include a high-speed belt conveyer system, a 4,600-ton primary transfer silo, an open oil shale storage area, a crushing plant, a screening plant, and four surge barns (Figure 2.3-6). Control and safety systems would be designed to meet all applicable regulatory requirements.

Retorting

Raw shale oil would be produced by retorting the oil shale in modules above ground in the processing area. The retorts and their support facilities would be located on about 300 acres at the eastern end of the site (Figure 2.3-6). At a production rate of 100,000 bpd of syncrude from lean oil shale, 11 retort modules would be required. These retorts are approximately 350 feet high and would be arranged in an east-west line along the mesa. Retort construction would start near the middle of the site with the first module (Number 1) located nearest the feed preparation plant. The distance between Module 1 and Module 11 would be about 1 mile. Oil shale feed would enter the retorts from the north and retorted (spent) shale would leave the area from the north; therefore, all shale handling would be along the northern edge of the site. Ten hours of emergency storage of crushed oil shale would be provided in four surge barns located north of the retorts. Support facilities including tankage, utilities, and by-product processing would be located south of the retort modules.

The retorting process proposed is Chevron's STB process, shown schematically in Figure 2.3-9. Chevron's STB retorting process is a small-particle retort. The conditions in the retort section can best be described as a staged, moving bed of particles, in which a portion of the particles are "fluidized" during the retorting process. As a result, the gaseous and liquid hydrocarbons (kerogen) are released and are available for further processing. The retorted shale, with essentially all kerogen removed, would be collected at the bottom of the retort and fed to the combustor vessel to burn off residual char, thus producing the heat for retorting. The remainder of the combusted shale would flow to spent shale conditioning. When feeding rich shale to the retort, there would be sufficient char to provide all fuel for combustion. When feeding lean shales, auxiliary fuel, such as coal, would have to be added to the combustor for heat balance. A maximum of 5,500 tpd of coal would be fed to the combusters when feeding lean shale. An additional 1,000 tpd of coal or other hydrocarbon fuel would be used for producing steam, totaling 6,500 tpd of auxiliary coal fuel for the project.

After retorting the hot product gas from the retort section would enter a fractionating tower where the vapors would be quenched. Condensed heavy oil would be removed from the bottom of the tower, then centrifuged to remove residual solids. Heavy oil concentrate would be cooled further and combined with the lighter oil fractions also removed from the fractionator. The resultant product would be sent to storage tanks before transport to the upgrading plant. Overhead vapor leaving the fractionator is partially condensed to recover light oil which would then be blended with other raw shale oils. Non-condensed gas would be sent to the raw gas treating section.

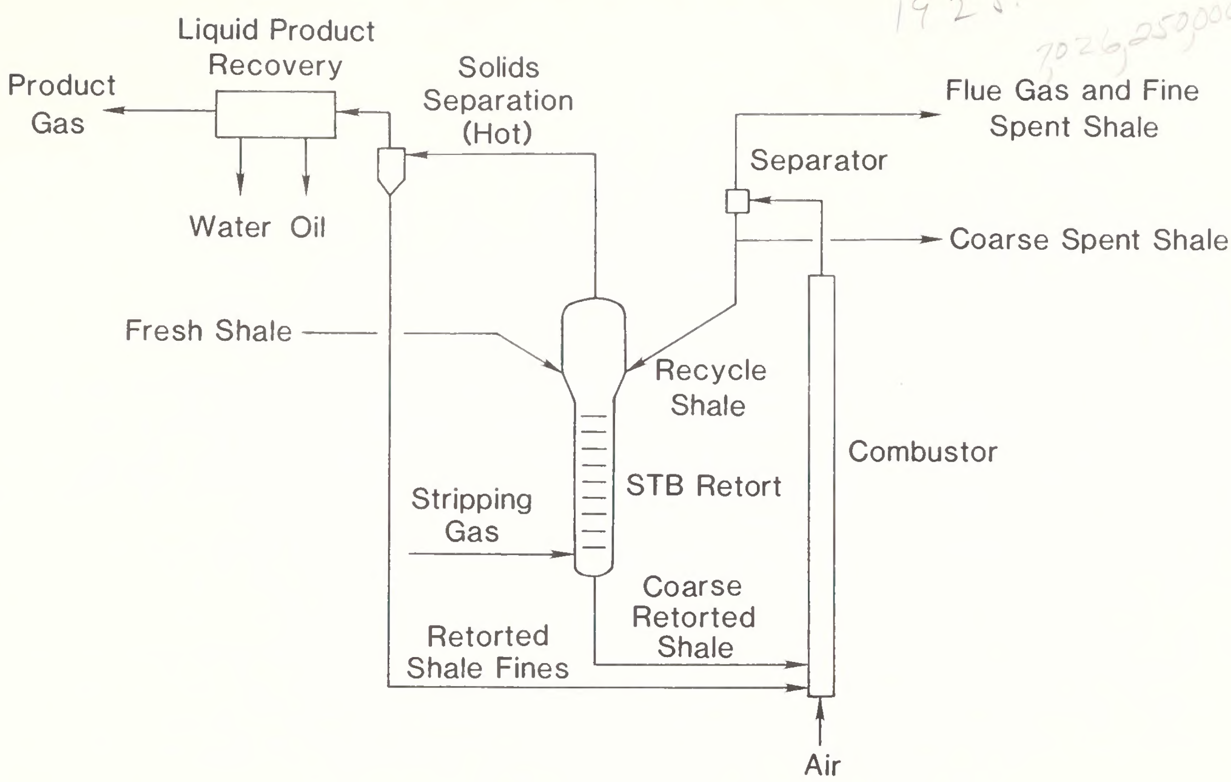


Figure 2.3-9 Flow Diagram of STB Retort

Process water from the retorting operation would contain carbon dioxide, ammonia, and hydrogen sulfide. This process water would be treated to remove these compounds and produce water which would be returned to the spent shale conditioning section to cool and moisturize the spent shale. The water removed from various locations in the retorting area would be sent to an acid gas stripper column where carbon dioxide and hydrogen sulfide would be removed as a vapor. The water leaving the bottom of the acid gas stripper would be sent to an ammonia stripper column for ammonia recovery. The ammonia vapor leaving overhead from this tower would be condensed and purified to produce a saleable liquid ammonia product.

Particulate matter, carbon monoxide, hydrocarbons, nitrogen oxides, and sulfur oxides are expected to constitute the major air pollutants during the retorting process. The sources and rates of emission of these pollutants are presented in Table 2.3-2. Air emission controls for the retorting process are based on the Best Available Control Technology (BACT). Specific control measures are shown on Table 2.3-3.

Upgrading

The upgrading facilities would be located at the western end of the site and would occupy about 200 acres (Figure 2.3-6). The retort and upgrading plants would be connected by a pipeline running east-west through the middle of the site. The upgrading plant would be constructed in four modules with each module capable of producing 25,000 bpd of syncrude. Support facilities for upgrading including tankage, utilities, and by-product processing would be generally located south of the upgrading modules.

Oil shale retorting yields raw shale oil that is viscous and waxy and contains impurities such as nitrogen, sulfur, and arsenic. Upgrading removes elements that foul conventional petroleum refining units and reduces the oil viscosity. Changes attributable to upgrading include the following:

	Raw Shale Oil	Upgraded Shale Oil
API (viscosity rating)	20°	38°
N (Nitrogen content - % by wt)	2.11	less than 0.05
S (Sulfur content - % by wt)	0.66	0.001
O (Oxygen content - % by wt)	1.16	less than 0.01

Raw shale oil presents unusual refining problems. It is notable for high nitrogen content, which can lead to poor product quality. Raw shale oil also contains large amounts of unsaturated hydrocarbons and metallic contaminants. Its unusual properties prevent its being mixed with crude oils for processing in most existing refineries. The upgrading of raw shale oil into synthetic crude involves several processing steps including: heavy metals (arsenic and iron) removal, nitrogen and sulfur removal, hydrogen manufacturing, sour water treating, and sulfur recovery. A flow diagram showing the general nature of the upgrading process is shown in Figure 2.3-10.

Air pollutants from the upgrading facility would be likely to include sulfur and nitrogen oxides, particulate matter, carbon monoxide, and hydrocarbons. The sources of these pollutants and the emission rates for each are presented in Table 2.3-4. Air emission controls are based on Best Available Control Technology. The control technologies are listed in Table 2.3-5. All other safety controls would be designed to meet applicable OSHA standards.

Table 2.3-2 EMISSIONS FROM RETORTING FACILITY

		Pollutants (tons/year)				
Plant Section	Source	Particulate Matter	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides	Sulfur Oxides
Retorting and Combustion	Coal Grinding System	25-40	15-20	0.5-2	50-65	15-20
	Ground Coal Feed Bins	0.05-0.15	—	—	—	—
	Coal Feed Bins	0.05-0.15	—	—	—	—
Retort Heat Recovery	Steam Super-heating Heaters	50-60	200-235	16-21	710-760	200-235
	Waste Gas Stacks	4,000-4,200	14,000-15,000	10,000-11,000	33,000-36,000	3,000-3,300
Treated Gas Drying	Reboilers	0.1-0.2	0.4-0.6	0.01-0.07	0.5-2	0.4-0.6
Flare System	Flares	0.05-0.2	0.1-0.5	0.005-0.03	0.5-2	0.3-0.5
Maximum Total		4,300	15,256	11,023	36,829	3,556

Source: Chevron (1982d).

Table 2.3-3 SUMMARY OF BEST AVAILABLE CONTROL TECHNOLOGY (BACT) FOR RETORTS

Source type	Pollutants[a]	BACT	Emissions Limit[b]
Retort Combustor Offgas	PM	3 stage cyclones and baghouse	0.03 SCF
	CO, VOC	Long residence time for combustion, excess oxygen	1000 ppm
	NO_x	Low combustion temperature, staged combustion	300 ppm
	SO_x	None	20 ppm
Heaters, Superheaters, and Oil Fired Boilers	SO_x	Process gas: Stretford absorbers Shale oil stock: Hydrotreating	0.04 lb/MMBTU
	NO_x	Minimize fuel consumption, low excess air, low NO_x burners where appropriate	gas fired: 0.13 lb/MMBTU oil fired: 0.3 lb/MMBTU
	PM, CO, VOC	Proper furnace design, oxygen control	
	PM	Flue gas from heater in coal grinding system: cyclones and baghouse	0.02 SCF
Coal and Shale Storage Bins	PM	Baghouses	0.02 SCF

Source: Chevron (1982d)

[a] PM = Particulate matter
CO = Carbon monoxide
VOC = Volatile hydrocarbons
NO_x = Oxides of nitrogen
SO_x = Oxides of sulfur

[b] MMBTU = Million BTU
SCF = Standard cubic feet
ppm = Parts per million

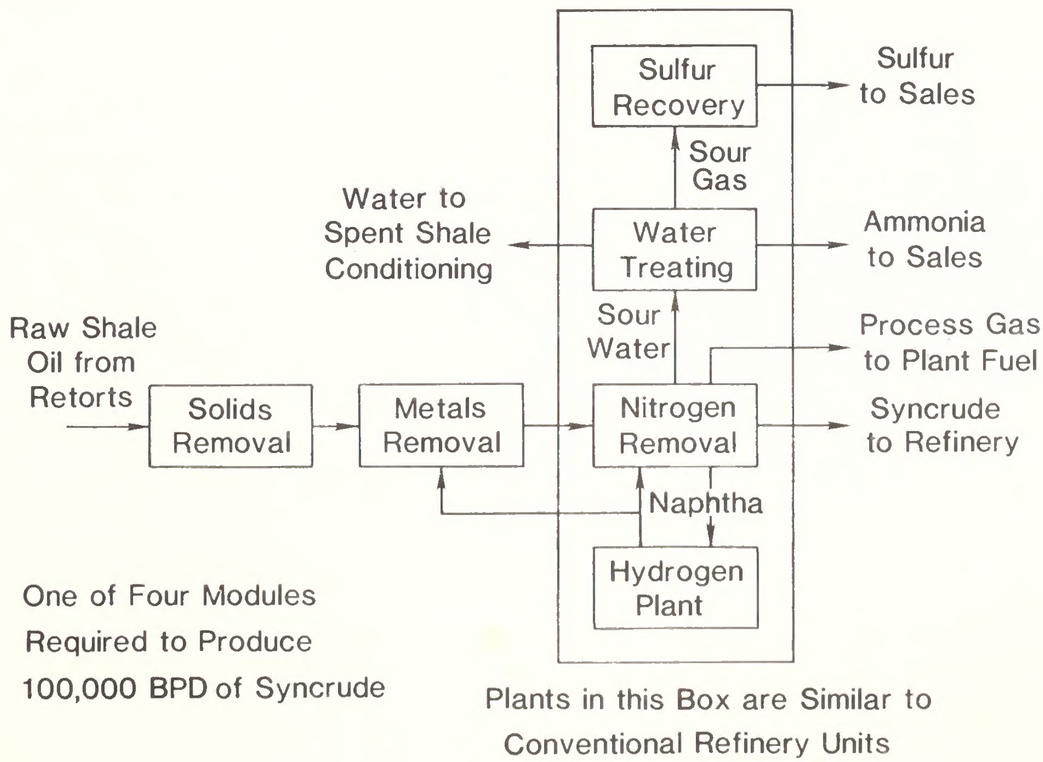


Figure 2.3-10 Flow Diagram of Upgrading Process

Table 2.3-4 EMISSIONS FROM UPGRADING FACILITY

		Pollutants (tons/year)				
Plant Section	Source	Particulate Matter	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides	Sulfur Oxides
Metals Removal & Hydrotreating	Reactor Heaters	15-20	55-75	4-7	200	55-75
Hydrotreated Oil Fractionization	Reboilers	18-22	80-90	6-10	250-300	80-90
Hydrogen Plant	Reformer Furnaces	350-380	375-400	60-70	2200-2500	375-400
	Vaporizers	3-5	15-18	0.5-2	50-60	15-18
	Preheaters	2-4	10-15	0.5-2	40-50	10-15
Sulfur Recovery	Tail Gas	—	40-50	—	—	30-40
Steam Generation	Steam Generators	130-150	150-200	55-65	3000-3500	850-950
	Coal Storage Bins	0.1-0.2	—	—	—	—
Flare System	Flares	0.01-0.05	0.05-2	0.001-0.01	0.1-0.5	0.05-0.2
Maximum Total		581	850	156	6,611	1,588

Source: Chevron (1982f).

Table 2.3-5 SUMMARY OF BEST AVAILABLE CONTROL TECHNOLOGY (BACT) FOR UPGRADING FACILITY

Source Type	Pollutants[a]	BACT	Emissions Limit[b]
Heaters & Oil Fired Boilers	SO_x	Process Gas: Ammonia Scrubbers Shale Oil Stock: Hydrotreating	0.04 lb/MMBTU
	NO_x	Minimize fuel consumption, low excess air, low NO_x burners where appropriate	gas fired: 0.13 lb/MMBTU oil fired: 0.3 lb/MMBTU
	PM, CO, VOC	Proper furnace design, oxygen control	
Sulfur recovery tail gas	H_2S	Beavon Sulfur Removal Unit or equivalent	0.1 g/dscf fuel gas 250 ppm SO_2 off gas
Hydrogen Plant	CO	Catalyst	100 ppm
Coal Storage Bin	PM	Baghouses	0.02 g/SCF

Source: Chevron (1982f)
SO_x = Oxides of sulfur

[a] NO_x = Oxides of nitrogen
PM = Particulate matter
CO = carbon monoxide
VOC = Volatile hydrocarbons
H_2S = Hydrogen sulfide

[b] MMBTU = Million BTU
SCF = Standard cubic feet
ppm = Parts per million
dscf = Dry standard cubic feet

Spent Shale Disposal

After the retorting of the oil shale, the residual material (spent shale) would be partially cooled through heat exchange with air. The shale would then be fed to moisturizers where the rock would be cooled to about 170 °F by direct contact with water. The cooled rock would contain from 5 to 12 percent water by weight when it leaves the conditioning section and would then be transported for disposal. The approximate chemical composition of STB processed shale is summarized in Table 2.3-6. Spent shale generated from the first phase of oil shale mining would be placed in Clear Creek canyon upstream of Clear Creek falls until an adequate area within the open pit mine is developed. Based on estimates of volume to be mined, a minimum requirement of approximately 604 million cubic yards would be needed to dispose of spent shale during underground mining and in the early stages of the open pit mine. Two years after recovery of oil shale commences from the open pit, spent shale would be transported to the mined-out pit as backfill.

The Clear Creek mesa disposal site ("Mesa Valley Fill", see Figure 2.3-1) would be developed in two phases. In Phase I, retorted shale would be placed in the draws and on the side slopes along the north side of Clear Creek. About 94 million cubic yards of material would be deposited at this site. Fill would be developed to an elevation ranging from 8,000 to 8,350 feet, which is below the existing ridge tops, with the toe of the pile remaining above the 100-year flood level of the stream. The entire fill would be constructed utilizing four zones of material: (1) Zone I, an impermeable barrier (highly compacted shale); (2) Zone II, moderately compacted shale; (3) Zone III, appropriate slope protection material such as overburden; and (4) Zone IV, the main portion of spent shale fill (Figure 2.3-11). Benches would be incorporated in the overall layout of the disposal area and would contain embankments to provide a means of controlling runoff water. The benches would be placed at approximately 200- to 300-foot elevation intervals along the face of the containing embankment.

Table 2.3-6 APPROXIMATE COMPOSITION OF STB PROCESSED SHALE[a]

Mineral Components	Formula	Weight %
Alpha Quartz	SiO_2	16
Analcime	$NaAlSi_2O_6H_2O$	7
Feldspar(s)	$(K,Na)\ AlSi_3O_8$	25
Calcite	$CaCO_3$	30
Dolomite/Ankerite	$Ca(Mg,Fe)(CO_3)_2$	10
Periclase	MgO	6
Hematite	Fe_2O_3	2
Other Trace[b]	—	4
		100%

Source: Moore (1982a).

[a] Average for three mining zones. Mineral content will vary with feed source.
[b] Includes 0.4 - 0.7% residual carbon.

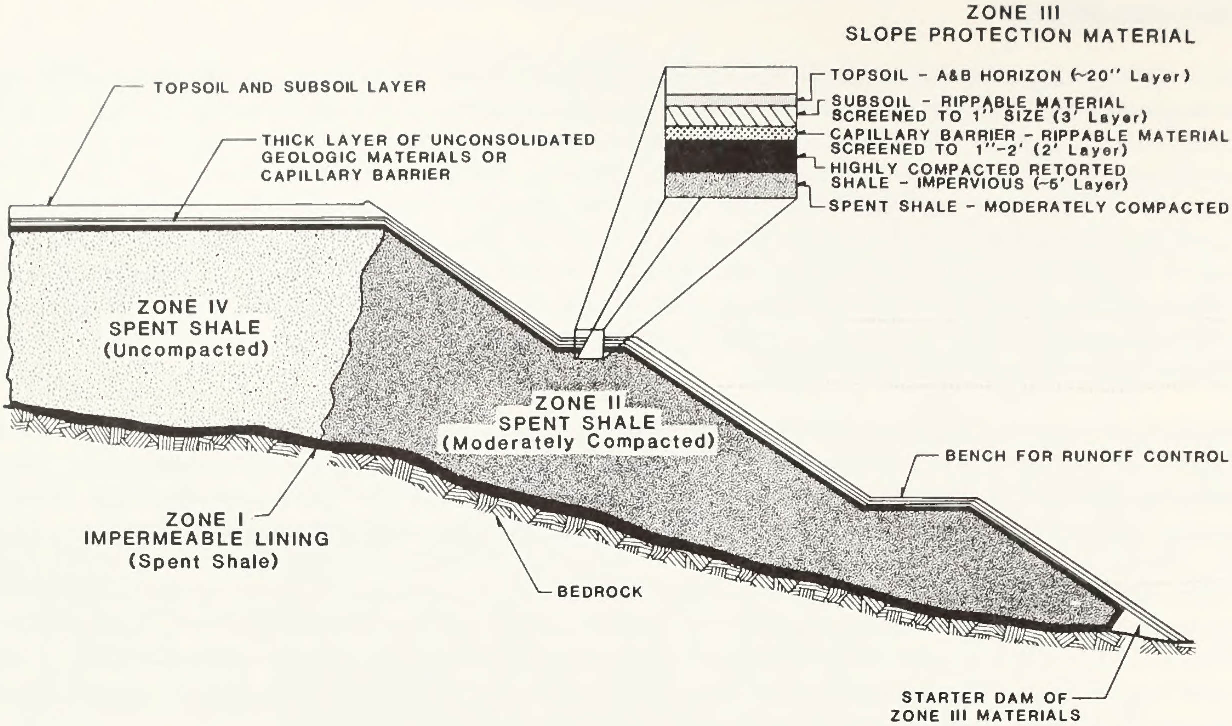


Figure 2.3-11 Conceptual Design for Retorted Shale Coverage

Preparation of the surface of the spent shale disposal piles for reclamation and revegetation would begin with compaction of the top 5 feet of the retorted shale to form an impervious layer (permeability less than 1 foot/year). Three layers of material would be placed on top of the compacted surface to provide a rooting and water storage zone for vegetation. The capillary layer would be approximately 2 feet thick and would be composed of broken rock material greater than 1 inch in diameter. This capillary barrier would prevent upward migration of salts into the plant root zone. A 3-foot-thick subsoil layer would then be placed over the capillary barrier. Capillary barrier and subsoil materials would come directly from the open pit as it is excavated. Over the subsoil, approximately 1.5 to 2 feet of topsoil would be placed to allow for a seedbed. Figure 2.3-11 illustrates a typical cross section for the coverage of retorted oil shale. The covering of spent shale would be concurrent with mining.

Phase II of the surface disposal of spent shale would begin with the disposal of retorted shale on the mesa valley floor. During this phase, the entire mesa valley, including the south side of Clear Creek, would be filled with about 510 million cubic yards of material for a total disposal capacity of 604 million cubic yards. The water control plan for this phase of disposal requires the diversion of Clear Creek through the exhausted sections of the underground mine. A series of three drop inlets are proposed to divert the flow from the existing stream channel into the underground mine. Clear Creek would be diverted into the underground mine workings upstream of the retorted shale and discharged from the mine portal back into its natural channel downstream of the retorted shale. Drainage control for the surface of the spent shale disposal area would include benching of disposal slopes during Phase I and diversion of Clear Creek through the exhausted workings of the underground mine. Details regarding this drainage system would be a part of the Colorado Mined Land Reclamation Board permit.

Although surface disposal of spent shale in the Mesa Valley Fill site would be utilized for the inital phases of the project, the major volume of spent shale would be backfilled into the open pit mine. Once an adequate area within the open pit has been evacuated, the spent shale backfilling into the mined-out pit would be accomplished using belt conveyors. The spent shale fill would be constructed by forming an impermeable embankment around the main pile and an impermeable layer under the pile. The Zone I-IV techniques of reclamation described for the Mesa Valley Fill would also be used in the open pit.

2.3.2.4 Project Support Facilities

Access Roads

An access road would be constructed from the De Beque area to the plant site on top of the Clear Creek mesa along the present Roan Creek road. This access road would be a two- to four-lane paved highway, to ensure that a reliable and safe traveling surface would be available and along the same general route as the existing county and private road. The total length of the route from De Beque to the plant site is approximately 28 miles.

Water Supply and Control Systems

The development of commercial shale oil operations by the CCSOP would occur incrementally. Accordingly, water requirements would increase in a stepwise manner. Multiple water supplies and water systems would be developed to meet each level of demand. The paragraphs that follow describe the CCSOP's anticipated water requirements, its sources of supply and the water systems which would be used to control and deliver water to plant sites.

Water Requirements. Estimated water requirements for CCSOP's 100,000-bpd oil shale operation per project component are listed in Table 2.3-7.

Table 2.3-7 ESTIMATED WATER REQUIREMENTS FOR 100,000-BPD PRODUCTION

	Estimated Water Requirement	
Project Component	Barrels/day	Acre-ft/day
Mining	60,000	8
Retorting	200,000	26
Upgrading	70,000	9
Domestic	180,000	23
Total	510,000	66

Water Sources. The primary source of water for the CCSOP would likely be the Colorado River near De Beque and Loma. During early stages of commercial production, large volumes of water from the Colorado River would not be required. Ground water from the Clear Creek basin, surface water from Clear Creek mesa, and/or small scale diversions from the Colorado River near Loma or De Beque would be used to satisfy initial demands. Diversion of water from the Colorado River near Parachute is also being considered.

Other potential sources of water for the CCSOP include:

- Parachute Creek near Parachute
- Ground water and surface water in other valleys adjacent to Clear Creek and Roan Creek
- Ground water and surface water from Chevron's Parachute Creek property
- Ground water and surface water from the northern portions of the Piceance Basin

- Irrigation water presently used in the Clear Creek/Roan Creek Basin, the Parachute Creek Basin, and the Colorado River Basin

- Ruedi Reservoir

- Other existing or planned reservoirs

Water Rights. Water supplies described previously would be made available by diversion under various water rights owned by Chevron. Chevron's decreed conditional direct flow water rights on the Colorado River are shown in Table 2.3-8.

Table 2.3-8 COLORADO RIVER WATER RIGHTS OWNED BY CHEVRON

Name	Decreed Amount (cfs)	Location (near)	Appropriation Date	Adjudication Date
Pacific Oil Pipeline & Pumping Plant No. 1	57.25	De Beque	06-09-1953	11-10-1970
Dragert Pumping Plant & Pipeline	94.0	Parachute	01-07-1950 11-16-1951 (Priority Date)	11-10-1966
Eaton Pumping Plant & Pipeline	100.0	Parachute	04-12-1951 11-21-1951 (Priority Date)	11-10-1966
Finley Ranch Pumping Plant	14.0[a]	De Beque	02-28-1967	06-14-1971

[a] 6.5 cfs of this amount is perfected.

Chevron has also recently submitted the following for adjudication:

- A 125-cfs conditional direct flow water right on the Colorado River near Loma

- A 12,000-acre-ft storage right on Big Salt Wash

- Ground water rights for 33 wells in the Clear Creek alluvium, the Roan Creek alluvium, and the Clear Creek bedrock aquifers

- Seven direct flow and seven storage rights on the Clear Creek property

Conoco (a 30 percent owner in the CCSOP) and Getty have acquired a combined total of 35 cfs of the Kobe Canal water right with an appropriation date of 06-30-1936 and an adjudication date of 11-10-1970. Each party will use 17.5 cfs of that right.

Chevron and Cities have options to acquire one-third interest each in the Roan Creek reservoir and the reservoir's enlarged storage rights for Roan Creek water. The Roan Creek rights are presently owned by Getty.

All rights are subject to Colorado water law, which allocates water under a system of prior appropriation. Water rights in Colorado are not subject to federal jurisdiction.

Preliminary studies suggest that storage may not be required to regulate the Loma supply. Diversions of ground water and mesa surface water may involve the implementation of court-approved augmentation plans to maximize yields and prevent injury to senior downstream appropriators.

Chevron, Cities Service (Cities), and Getty Oil Company (Getty) have formed a joint venture called the GCC Joint Venture, the purpose of which is to develop a common water supply system that would allow each participant to divert and regulate water available under their respective individual water rights for subsequent industrial use. Facilities associated with this system would extend from an intake in the Colorado River near De Beque through a main storage reservoir on Roan Creek referred to as the Roan Creek reservoir. The CCSOP's use of these facilities is described in the following paragraphs.

Water Development Plan - Phase I

In order to meet increasing water demands as the project develops, CCSOP would implement a phased water development plan. During Phase I, the first retort and 25,000-tpd underground mine would be developed and operated. One or more of the following water systems would be utilized:

- A small scale diversion and delivery system originating near Loma and/or De Beque
- A well field system in Clear Creek alluvium and bedrock
- A surface water system on Clear Creek mesa

Small Scale De Beque System. A small scale De Beque system would use GCC Joint Venture full scale intake (diversion) and pump station (with a minimal number of pumps) on the Colorado River near De Beque, a pipeline to the Clear Creek plant site, and booster pump stations along the pipeline route. A small-volume reservoir on Roan Creek or one of its tributaries might be required to ensure a continuous water supply when Chevron's water rights are out of priority or when the flow in the Colorado River near De Beque is inadequate to meet CCSOP needs directly.

Small Scale Loma System. A small scale Loma system would consist of an intake (diversion) and pump station on the Colorado River near Loma, a pipeline to the Clear Creek plant site, and booster pump stations along the pipeline route. A connection to the pipeline would service the upgrading plant north of Fruita (if that site were selected). A reservoir on Big Salt Wash might be required to ensure a continuous water supply when the Loma water right is out of priority or when the flow in the Colorado River at Loma is inadequate to meet CCSOP's needs directly.

Well System. Initially only a few wells would be drilled to satisfy site preparation and early production demands. As water needs increase, additional wells would be added to the system. Ultimately the well system would consist of approximately 21 wells in Clear Creek alluvium and approximately 8 wells in the mesa bedrock, with a total combined capacity of over 4,000 gallons per minute (gpm).

An augmentation water system could be required to prevent injury to senior downstream appropriators. This system could use Chevron's Finley Ranch Pumping Plant water rights on the Colorado River. The Finley Ranch Pumping Plant is part of an existing irrigation system which diverts Colorado River water from a point approximately 2 miles downstream of De Beque and delivers it by pipeline to land immediately north and west of the pump station. A new pipeline from the pumping plant would follow a northerly course and discharge into the Reservoir Ditch and/or other ditches requiring replacement water as a result of Chevron's upstream diversions. Additional augmentation water might be made available from a well system in Roan Creek alluvium downstream of the affected senior user(s). This water would be delivered by pipeline to required locations.

Clear Creek Mesa System. The surface water system on Clear Creek mesa would consist of seven diversions and reservoirs on the upper Clear Creek property (Figure 4.4-2, Section 4.4.2 Surface Water). These facilities, which would also be part of the mine water control system, might be used in Phase I to supplement other project water supply systems and minimize pumping water from the Colorado River and the valley alluvium to the plant site. It is anticipated that an augmentation plan might be required to maximize yields from this system and to protect senior downstream appropriators.

Water Development Plan - Phase II

The second phase of the water development program would involve using of large volumes of water from the Colorado River. During this phase, commercial development would reach the 100,000-bpd level. The De Beque and full scale Loma systems would be utilized to deliver this water.

De Beque System. The De Beque system would include all facilities which would divert, store, and deliver water from the Colorado River near De Beque for use inconnection with the CCSOP. The GCC system would be a major component. Other facilities would include a pipeline/pumping plant system which would deliver water from the Roan Creek reservoir to the CCSOP. Getty and Cities would install separate facilities to withdraw water from the reservoir.

Storage capacity would be required because Chevron's Colorado River rights are relatively junior and may not allow water to be diverted continuously. The proposed GCC Roan Creek reservoir would provide carryover storage for times when Chevron's water rights near De Beque are out of priority or when the flow in the Colorado River near De Beque is inadequate to fully meet the CCSOP's needs. Cities and Getty would use their respective capacities in the reservoir to regulate their supplies in a manner similar to Chevron.

In addition to Chevron's water rights described previously, Cities and Getty own the conditional direct flow water rights on the Colorado River near De Beque listed in Table 2.3-9.

Table 2.3-9 COLORADO RIVER WATER RIGHTS OWNED BY CITIES AND GETTY

Name	Amount (cfs)	Location (near)	Appropriation Date	Adjudication Date
Cities Service Pipeline	100.0	De Beque	08-02-1951	11-10-1970
Pacific Western Oil Co. Pipeline (Getty)	56.0	De Beque	11-19-1951	11-10-1966

The initial GCC system construction would consist of building an intake structure on the Colorado River near De Beque capable of diverting sufficient quantities of water to satisfy the needs of all the venturers. Figure 2.3-1 shows approximate locations of two intake sites being considered. A small weir with a low flow notch for fish migration and sediment sluicing would be installed across the river immediately below the diversion to improve hydraulic and economic efficiencies. The intake facility would have the capability of diverting up to 442.25 cfs from the river to a sedimentation/re-regulation pond. If this pond is not required, the pumping facilities would lift water from the intake directly to the reservoir. The pumping system would be constructed to allow the addition of pumping units as demand for water increases.

The GCC pipeline would be designed to deliver sufficient volumes of water from the Colorado River to the Roan Creek reservoir to satisfy the seasonal and reserve supply requirements of the three partners. Additional lines would be installed in the same corridor as the original pipeline to provide additional capacity, as required, to meet increased water needs. Above the 442.5?

Water storage in the Roan Creek reservoir would be accomplished by the construction of a zoned earth-fill dam with underseepage control, an emergency spillway, an inlet for Colorado River water, and a manifolded outlet works for making process water deliveries and discharges to Roan Creek. Process water deliveries could, alternatively, be made from an intake tower in the reservoir. This reservoir could be built by staged construction. The first stage would be in the range of 30,000 to 70,000 acre-feet. Depending on future needs, the ultimate active capacity could be as much as approximately 175,000 acre-feet. The proposed reservoir is the Upper Dry Fork site shown in Figure 2.3-1.

Full Scale Loma System. The full scale Loma system would be similar to the small scale system except that the intake facilities, pipeline, pump stations, and reservoir (if required) would be expanded in size and/or number.

The diversion would be located on the Colorado River near Loma (Figure 2.3-1). The intake facility would have a maximum withdrawal capacity of 125 cfs. Water would be withdrawn from existing gravel ponds adjacent to the river. An inlet channel, with control gates, would be constructed to ensure diversions when the ground water infiltration rate to the pondswas less than the pumping rate. The pipeline would followa northeasterly course to a point approximately 1 mile from the diversion. From this point it would follow the route shown on Figure 2.3-1.

As with the GCC system, a sedimentation/re-regulation pond may be required to remove excess sediment load and to improve pumping efficiency. Pipelines associated with the Loma system would connect the intake, a storage reservoir, and the plant site in a manner similar to the De Beque system. A reservoir for the Loma system would be located on Big Salt Wash near the Mesa/Garfield County line. This reservoir would have a capacity of up to 12,000 acre-feet. The dam would be a zoned earth-fill type similar in design to the one proposed for the reservoir on Roan Creek.

Well System and Clear Creek Mesa System. The well system and the Clear Creek mesa system would be used to supplement the Colorado River supply during Phase II. As such they would help to minimize costs associated with pumping water from the Colorado River.

Surface Ownership and Rights-of-Way - Water System

De Beque System. The surface ownership and rights-of-way for the De Beque system, including the diversion structure, pumping stations, pipeline systems, and Roan Creek reservoir are primarily controlled by the GCC Joint Venture and its participants individually. These lands are bounded on the east and west by federal lands under BLM administration.

Loma System. The surface ownership and rights-of-way for the Loma system are listed in Table 2.3-10.

Table 2.3-10 SURFACE OWNERSHIP AND RIGHTS-OF-WAY

Facility	Surface Ownership and R-O-W
Colorado River Intake Site near Loma	Controlled by Chevron
Pipeline to Big Salt Wash Reservoir	Mostly BLM administered land
Big Salt Wash Reservoir	Mostly BLM administered land
Pipeline and Pump Stations to Clear Creek Plant site	Mostly BLM administered land

Well System. The surface ownership for the well system, including wells and pipelines, is primarily held by Chevron although some private land is involved.

Clear Creek Mesa System. The surface ownership for the Clear Creek mesa system including dams, reservoirs, diversions, pipelines, and pump stations is held by Chevron.

Power Requirements and Supply

Estimates of power required for the CCSOP at 100,000 bpd are shown in Table 2.3-11. Steam produced on-site would be used to generate a maximum of 158 Mw, thereby supplying part of the project power requirements. The remaining power would be supplied by outside sources.

Table 2.3-11 ESTIMATED POWER REQUIREMENTS FOR THE CCSOP

Category	Approximate Power Demand (Mw)
Underground Mining and Spent Shale Disposal	29
Open Pit Mining	48
Upgrading, Syncrude Pumping, and Off-Plots	91
Retorting, Off-Plots, and Retort Feed Systems	119
Feed Preparation	67
Water Pumping (GCC)	20
	374

Initial power supply for the construction period would be provided by two on-site 5-Mw diesel generators which become backup power with the advent of additional power availability. The majority of the power supplied would be purchased from the Public Service Company of Colorado (PSCC) or Colorado-Ute through PSCC.

Railroad Facilities

Operation of the CCSOP would require a railroad spur and terminal for receipt of incoming materials by rail; storage and trans-shipment of these materials as required at the plant site; provision for laydown and equipment assembly areas; and loading for outbound products such as syncrude, ammonia, and diesel.

The proposed railyard and terminal would be located approximately 2.5 miles southwest of De Beque next to the Denver and Rio Grande Western Railroad (D&RGW) main line between mileposts 419 and 420. Access to the terminal would be via an upgraded existing county road from De Beque and a new 0.6-mile road. The existing county road would require upgrading, some realignment, and possible construction of a new bridge in De Beque. A future bypass around De Beque might be required. Approximately 80 acres are available for the yard area on the west side on the D&RGW mainline. An expansion area is available east of the D&RGW mainline for material overflow and fabrication, if required. Access to this area would utilize an existing grade crossing of the railroad tracks. A fleet of transport trucks would be utilized for movement of materials between the terminal and the plant site.

Product Transport Pipelines

A 12- to 18-inch pipeline would be needed to transport up to 100,000 bpd of syncrude (shale oil) to refineries and markets some distance from the project area. A pipeline would be constructed from the Clear Creek mesa plant site to existing or proposed pipeline terminals.

The syncrude pipeline included in the Proposed Action would connect into the La Sal pipeline, originally planned to transport syncrude from the Colony Oil Shale Project. Although the construction of the La Sal pipeline has been delayed, it still remains a viable link for transport of syncrude. The La Sal pipeline and its impacts have been evaluated by the BLM (1981c).

The link to the La Sal pipeline would begin on Clear Creek mesa, head north, and then head generally east to the La Sal-Parachute Creek pump station at Davis Point (Figure 2.3-1).

Natural Gas Pipelines

The syncrude pipeline corridors described above for the La Sal connection intersect an existing 8-inch natural gas transmission pipeline. This line is the most likely supply line for natural gas. The connection to the natural gas pipeline would be at an appropriate (to be defined) location, and the pipeline to the plant site would parallel the route of the syncrude line.

Transmission Line

The proposed project would include a transmission line loop from De Beque to Clear Creek mesa and from the Davis Point substation (Parachute Creek) to Clear Creek mesa. The corridor would include a 345-kilovolt (kv) transmission line extending from the existing shared Rifle-Cameo line near De Beque, north along Roan Creek to the Clear Creek property. The 345-kv De Beque to Clear Creek circuit would operate at 115 kV during the first phase. To provide reliable transmission capability for full phase project operation, a corridor for another 345-kv line would extend from the PSCC's substation at Davis Gulch west to the project site.

Solid and Hazardous Waste Disposal

Non-hazardous solid waste from construction and operation activities would be deposited by landfill methods in the processed shale disposal area. Solid waste would betransportedwith the spent shale by truck or conveyor. Construction-related waste would be disposed of at a landfill site which would be covered with processed shale. When processed shale is being produced, non-hazardous solid waste such as coal ash would be combined in the processed shale. Slurry waste would be mixed uniformly with processed shale. Overall, several small sites, all within the processed shale disposal area, would be involved. Non-process solid waste, such as trash and garbarge, would be collected by trucks. Waste would be disposed of by truck at a landfill in or adjacent to the proposed shale disposal area.

Certain hazardous waste, as defined by regulations, would be generated by the retorting and upgrading processes. Disposal of this waste would be either off-site in a licensed site or on-site within an appropriate area. At this time, on-site disposal seems most viable.

Other hydrocarbon liquid waste would be recycled back to the combustor or incinerated.

Worker Transport

Construction and operations personnel would be encouraged to use a proposed bus system. The number of buses available to project workers would fluctuate with the number of employees working. A professional mass transit management firm would handle detailed planning and operation. Undoubtedly, there would be passenger car traffic, but it is anticipated that the economic and fuel conservation advantages of multi-passenger vehicles would minimize the use of passenger cars for the majority of project personnel. For those that drive the Operator would encourage carpooling due to limited parking on Clear Creek mesa.

Materials Transportation

Coal would be needed to supplement site-generated energy sources for the retorts. A total of 450 conventional 20-to 25-ton capacity highway haul trucks would be required every day to transport 6,500 tons per day of coal from De Beque to the Clear Creek plant site via the Roan Creek road. Other materials would also be transported along this road but the number of trucks would be minimal by comparison.

2.3.2.5 Decommissioning and Reclamation

Decommissioning and reclamation methods are described in this section. The methods presented apply to the underground mine, surface spent shale disposal, open pit mine, plant site areas, and other disturbed areas.

Topsoil Salvage and Stockpiling

Topsoil would be salvaged from surface disturbances due to the construction of the underground mine. For surface mining activities, topsoil would be salvaged well in advance of the progression of the mine to minimize loss. The depths and volumes of topsoil salvage would be judged by the existing soil baseline data and by on-site observations during the stripping operations. In the initial phases of mine construction and operation, topsoil would be stockpiled. After mine operation is well underway, topsoil would be redistributed, whenever possible, immediately after salvage.

In those instances where topsoil is stockpiled, the stockpiles would be located in areas ensuring integrity. Stockpile slopes would not be greater than 3:1 (horizontal to vertical). Temporary topsoil piles (e.g., less than 1 year) would be seeded with a short-term mix to allow quick vegetation establishment, therefore providing adequate stabilization and erosion control. In a similar manner, long-term topsoil stockpiles would be seeded with a long-term seed mixture that would provide erosion control and stabilization.

Adequate erosion control would be ensured by proper reclamation techniques. In addition to vegetation stabilization, chemical and physical methods might be used. Such methods would include emulsifiers, coagulants, rock aggregate, riprap, mulches and netting. Any erosion that would occur, even with these control measures, would be mitigated by catchment in sediment ponds.

Final Reclamation Configurations

The overall final reclamation contours are shown on Figure 2.3-12. The spent shale disposal area would be constructed with a series of benches 40 feet wide, located at 50- to 60-foot vertical intervals. The benches would be constructed such that a berm would exist on the outer edge. The overall slope would be at 4:1, with intermediate slopes between the benches at approximately 3:1. The final mesa top configuration is the same as for the Mesa Valley Fill site.

Revegetation

Revegetation activities for surface spent shale disposal areas and the reclaimed open-pit areas would be undertaken in the fall of each year to allow seeding before snowfall. A disc would loosen and break up the soil surface in preparation for seeding. Seeding would be performed with a tractor-drawn seed drill; broadcast or hydroseeding might be used on steep slopes or in poorly accessible areas. Sites scheduled for permanent seeding would be planted with a cereal grain such as barley or oats, sown at 50 pounds of pure live seed (PLS)/acre, and allowed to grow until the following summer when it would be mowed before it goes to seed. This method provides a stubble mulch for the permanent seed mixture. Shrub seedlings would be planted using power augers and a slow-release fertilizer would be added. Either containerized or bare-root plants would be used, and they would be planted in clusters distributed over the site. Planting would occur in the fall of the year after permanent seeding. Seed mixtures were chosen for long- and short-term, temporary and permanent locations. The species selection and rates are provided in Tables 2.3-12 and 2.3-13. Shrub seedling mixes are provided in seedlings/acre.

Moisture conservation practices would be utilized in the reclaimed areas. Prior to seeding, but after topsoil replacement, soil fertility analyses would be conducted. Based on results from the analyses, soil amendments would be added to aid plant development.

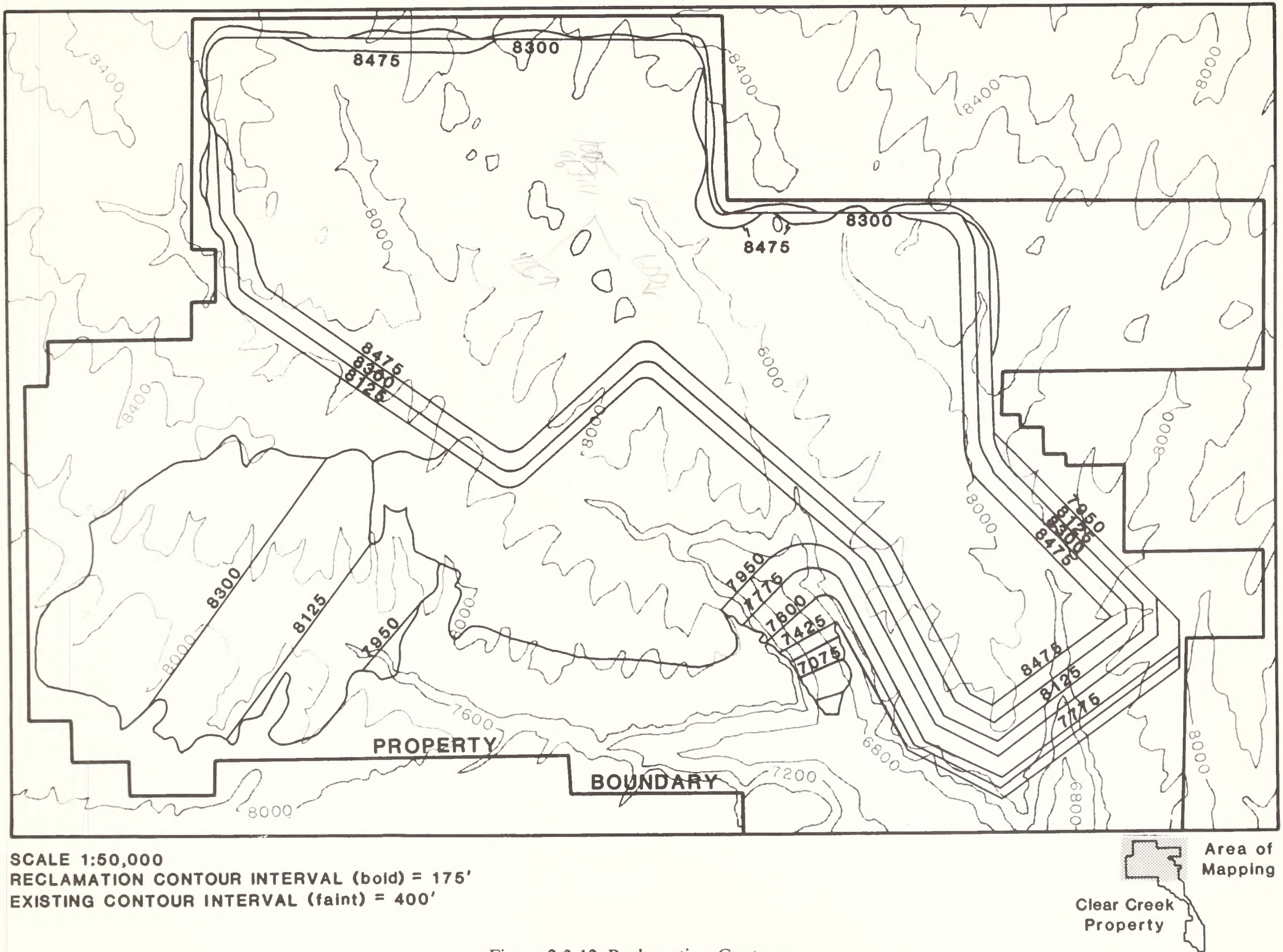


Figure 2.3-12 Reclamation Contours

Table 2.3-12 PROPOSED SEED MIXES

Scientific Name	Common Name		Pounds PLS/Acre[a]
Short-Term Temporary Seed Mix[b]			
Agropyron intermedium	"Tegmar" dwarf intermediate wheatgrass		3.0
Agropyron smithii	Western wheatgrass		4.0
Melilotus officinalis	Yellow sweet clover		2.0
Sanguisorba minor	Small burnet		1.0
		TOTAL	10.0
Long-Term Temporary Seed Mix[c]			
Agropyron desertorum	Crested wheatgrass		4.8
Agropyron intermedium	"Tegmar" dwarf intermediate wheatgrass		6.4
Agropyron smithii	Western wheatgrass		7.2
Artemisia tridentata wyomingensis	Big sagebrush		0.1
Chrysothamnus nauseosus	Rabbitbrush		0.3
Medicago sativa	"Ladak" alfalfa		1.0
Melilotus officinalis	Sweet clover		0.8
Sanguisorba minor	Small burnet		4.0
		TOTAL	24.6

Source: Moore (1982e).

[a] Drill seeding rate — double this rate for hydromulch or broadcast applications.
[b] Short-term seed mix is that used to control erosion on areas that will be maintained for a relatively short time (e.g., topsoil stockpiles).
[c] Long-term seed mix is that used to stabilize areas that are present for the life of the project (e.g., bench faces for facility sites).

2.3.3 Facility Siting Alternatives Producing 100,000 bpd

2.3.3.1 Proposed Action Configuration Alternatives

This section describes alternatives to the various components of the Proposed Action. These are discussed, as applicable, in the order presented in the preceding section.

Facility Sites and Processes

Surface and Underground Mine. Alternatives to the combination of surface and underground mining at the 100,000-bpd production rate are: (1) all open pit mining, or (2) all underground mining. Neither of these alternatives are viable at the 100,000-bpd rate. Therefore, they were eliminated from detailed study (see Appendix A).

Retorting. Alternatives considered to the proposed STB retorting process include the Lurgi, Paraho DH, Union B I-H, TOSCO II, Superior, and in-situ/modified in-situ processes. These were eliminated from detailed study as described previously. Discussion of these alternatives is presented in Appendix A.

Upgrading. Alternatives to the proposed upgrading process considered include coking followed by hydrotreating, and no upgrading. These were eliminated from detailed analysis. Discussion of these alternatives is presented in Appendix A.

Table 2.3-13 PERMANENT SEED MIXTURE[a]

Scientific Name	Common Name		Pounds PLS/acre[b]
Xeric Site			
Agropyron inerme	Beardless bluebunch wheatgrass		1.0
Agropyron tricophorum	Pubescent wheatgrass		2.0
Elymus junceus	Russian wildrye		1.0
Agropyron riparium	Streambank wheatgrass		1.0
Agropyron smithii	Western wheatgrass		2.0
Agropyron desertorum	Crested wheatgrass		1.0
Festuca ovina	Hard fescue		2.0
Sporobolus airoides	Alkali sacaton		0.1
Sporobolus cryptandrus	Sand dropseed		0.1
Melilotus officinalis	Yellow sweet clover		0.5
Artemesia tridentata vaseyana	Mountain big sagebrush		0.1
Purshia tridentata	Bitterbrush		0.5
Hedysarum boreale	Utah sweetvetch		0.1
Kochia prostrata	Summer cypress		0.5
		TOTAL	11.9
Shrub Seedling Mixture			Seedlings/Acre
Prunus virginiana	Chokecherry		100
Rosa woodsii	Woods Rose		50
Symphoricarpos oreophilus	Snowberry		150
Amelanchier alnifolia	Serviceberry		50
Quercus gambelii	Gambels Oak		100
		TOTAL	450

Source: Moore (1982e).

[a] Permanent seed mixtures are those to be used for permanent reclamation.
[b] Equivalent to 60 seeds/square foot.

Spent Shale Disposal. No other alternatives were considered in detail for the disposal of spent shale under the Proposed Action configuration.

Project Support Facilities

Access Roads. An alternative access route to the Clear Creek mesa plant site could be built along the proposed water pipeline route up the Big Salt Wash. This road would be a direct route from U.S. Highway 6 and 50 near Fruita, and would follow the 53-mile route shown on Figure 2.3-1. An existing general use road follows Mesa County 16 Road and may constitute the initial portion of this alternate route. However, any north-south sections or half-section road from County 16 Road to County 19 Road could possibly serve as the initial segment of the alternative access road.

Water Supply and Control. The proposed Roan Creek reservoir, Upper Dry Fork site, would be located above the confluence of Roan and Dry Fork creeks. Alternative reservoir sites to the Upper Dry Fork site are located within the Roan Creek valley. These reservoirs, referred to as Lower Dry Fork, Upper Conn Creek, and Lower Conn Creek, would have similar characteristics to the Upper Dry Fork reservoir. Locations of these alternate sites are shown on Figure 2.3-1.

Loma Intake and Pipeline Routes. Two alternative intake locations and routes at the Loma site were considered. These are:

- Diversion/Route B

  The diversion would be located on an existing north channel of the Colorado River approximately 1.8 miles upstream from Diversion A. The pipeline would follow a northeasterly course to a point approximately 2 miles from the diversion. From this point it would follow the route shown on Figure 2.3-1.

- Diversion/Route C

  The diversion would be located on the Colorado River near the I-70 exit for Mesa County Road 139 and about 3 miles downstream from diversion A. The pipeline would follow a northwesterly course to a point approximately 0.5 miles from the diversion. From this point, it would follow the route shown on Figure 2.3-1.

Drainage Control. Drainage control must be implemented for Phase I and Phase II of the spent shale disposal. The alternative method considered for drainage control is benching of disposal slopes during Phase I and eventual construction of an underdrain during Phase II.

Alternative Water Systems. One alternative to the De Beque water system would be the Parachute System. This system would pump water from the Colorado River near the town of Parachute to a sedimentation pond on Hayes Gulch, a tributary of Parachute Creek near Parachute. From the sedimentation pond, the water would be pumped to the proposed 33,773-acre-foot Parachute Creek reservoir on Parachute Creek, approximately 7 miles upstream of the confluence with the Colorado River. A Parachute Creek reservoir would provide the necessary seasonal and reserve storage to regulate CCSOP's water supply requirements. From the reservoir the water would be pumped up West Fork Parachute Creek and across the Roan Plateau to the CCSOP. This system will be addressed in detail in the upcoming Union Shale Oil EIS.

Another alternative to the De Beque System would involve storage of water within mined panels of the underground mine. In this system, water would be pumped from the Colorado River at or near the proposed GCC point and delivered by pipeline up the Roan Creek corridor to the underground mine.

Power Requirements. An alternative to the purchase of outside electrical power (as described above) would be cogeneration on site. During normal operation, most of the power for retorting would be produced within the plant retorting and upgrading processes. In addition, some diesel and syncrude would be used to fire boilers and reforming furnaces. Purchased natural gas would be used instead of diesel or syncrude fuel, when available. Coal would be used for heat balance within the retorts and to produce steam in the upgrading area. During production of 100,000 bpd of syncrude, part of the power for upgrading would be generated in the upgrading area for critical services. All process gas from upgrading would be used as fuel. In addition, some diesel would be used to fire boilers and reforming furnaces. Purchased natural gas would be used instead of diesel or syncrude fuel, when available. Coal would be used to produce steam in the upgrading area. As previously described, a maximum of 6,500 tpd of coal would be needed at the 100,000-bpd production rate when retorting and upgrading lean shale.

Railroad Facilities. An alternative to the short spur at De Beque would be a line constructed from the D&RGW mainline near De Beque to the confluence of Clear and West Willow creeks. This line would be approximately 25 miles long and would vary in grade from 1 to 2.5 percent.

Product Transport. Three alternative product transport pipelines are considered for the CCSOP: the SOPS pipeline and two routes to Rangely.

- The SOPS connection would be a relatively short pipeline heading southeast from the plant site on Clear Creek mesa, then north to tie into the SOPS line. The SOPS line is proposed to extend southward to Texas. At this time the location and connection requirements of the SOPS line are not known.

- The Rangely A route begins at the Clear Creek plant site and heads north on Cathedral Bluffs. It continues north on Cathedral Bluffs for approximately 7 miles and then turns northwest and descends from the top of Cathedral Bluffs via Soldier Creek along the valley of Cathedral Creek. The pipeline route then joins the Northern Gas route along the main highway from Douglas Pass to Rangely. The route continues along the highway to a point where the highway and Big Horse Draw converge, and then turns northwest crossing Johnson Draw, Wood Road Draw, and the White River near the Rangely terminal.

- The Rangely B route begins at the Clear Creek plant site heading northwest to Cathedral Bluffs. The route then turns northwest for approximately 5 miles and then remains along the Cathedral Bluffs ridge at an elevation of over 8,000 feet. From Big Ridge, the route turns west and descends along Gillam Draw, crossing the highway to Douglas Pass south of Rangely. The route continues west across Coal Mine Draw, Sulphur Draw, and the White river near the Rangely terminal.

Transmission Lines. As alternatives to the electrical transmission line system described previously, single transmission line radials could supply power to Clear Creek mesa. These two alternatives consist of either the De Beque radial or the Davis radial and are essentially the two halves of the looped system described previously. While either of these alternatives could adequately supply project power requirements, they would not allow the margin of safety and reliability of the full looped system. An additional alternative transmission line route would head due east from the Big Salt Wash — Echo Lake Route as shown on Figure 2.3-1.

Solid and Hazardous Waste Disposal. The three alternative methods of solid waste disposal considered in this EIS are (1) incineration of combustible wastes in an on-site incinerator with landfilling of noncombustible waste and incineration ash, (2) landfill of nonhazardous solid wastes within several small sites in the shale disposal area, or (3) transport of all solid wastes to a disposal site separate from the processed shale disposal area but still on the site.

Two alternatives exist for disposal of hazardous waste, (1) on-site disposal and (2) off-site disposal. Disposal of hazardous waste on-site would be by land farming or isolation. Disposal of hazardous waste in this manner would require the design and development of an appropriate site. Off-site disposal of hazardous waste would utilize a licensed contractor to haul wastes to an off-site licensed disposal area or to a resource recovery facility for recycling.

Hydrocarbon liquid waste disposal alternatives include: (1) recycling or (2) incineration. Recycling would entail feeding the liquid hydrocarbons back to the retort combustor for incineration. Incineration would involve feeding the liquid wastes to a thermal incinerator.

Worker Transport. The alternative to the proposed bus system for worker transport would be the use of private vehicles. It is anticipated that carpooling would, because of the economic advantages, be utilized under this alternative.

Materials Transportation. An alternative to coal transport by truck is rail transport using the Roan Creek Road corridor. A train of approximately 50-100 cars would be required per day to transport the needed 6,500 tpd of coal.

2.3.3.2 Clear Creek Project Configuration

The only difference between the Clear Creek configuration, as developed by BLM for impact comparisons, and the Proposed Action configuration is that the Clear Creek configuration does not include the Loma water system and Big Salt Wash corridor. The pipeline, intakes, Big Salt Wash reservoir, Big Salt Wash corridor, and related facilities would not be constructed under this alternative (see Figure 2.3-2).

2.3.3.3 Fruita I Project Configuration

Overview

This configuration, developed by BLM for EIS purposes, consists of mining, feed preparation, retorting, and spent shale disposal on the Clear Creek mesa the same as for the Proposed Action configuration. However, the upgrading facility would be located approximately 12 miles north of Fruita at the base of the Book Cliffs and near the mouth of Big Salt Wash on property owned by the Operator (Figure 2.3-13). This project configuration is shown on Figure 2.2-3.

Development of the upgrading plant in the Grand Valley area would require similar project support facilities, including water supply, transmission lines, pipelines, and access routes. In addition, an intertie pipeline would be required between the retorts on Clear Creek mesa and the upgrading facility in the Grand Valley. Descriptions of these alternative facilities are provided below.

Anticipated Labor Requirements

The total labor requirements would be similar to those of the Proposed Action. Employment projections for the Fruita I alternative are shown in Table 4.12-1 (Section 4.12, Socioeconomics).

Facility Sites and Processes

The upgrading facility would involve approximately 400 acres of a 1,600-acre tract of land owned by the Operator approximately 12 miles north of Fruita. The size of the plant, plant design, and processes used would not change significantly from the Proposed Action. Emissions from the facility and appropriate control technologies would be the same as described for the Proposed Action.

Project Support Facilities

Access Roads. In addition the alternative Big Salt Wash road, two additional alternative access roads could potentially be used to access the Fruita I project site.

- One alternative would be to improve the segment of the County 16 Road route from U.S. Highway 6 and 50 near Fruita to the plant site, for use as primary access.

- A second alternative access road could be established along the first portion of the existing Douglas Pass highway. The route would start at U.S. Highway 6 and 50, proceed directly north approximately 7.5 miles, then head northeast to the proposed upgrading site. This access road would be one component of a multiple-use corridor that also would potentially contain a railroad, transmission line, and water pipeline.

Water Supply and Control Systems. The water supply system would also be consistent with the proposed and alternative systems described for the Proposed Action configuration. Mining and retorting operations would utilize water primarily from the De Beque and Loma intakes; the Fruita upgrading facility would utilize water from the Loma intake, with potential storage in the Big Salt Wash reservoir. The water pipeline from Loma through the upgrade plant site to the Clear Creek mesa would be as described in Section 2.3.2.4. Similarly, the alternative water systems included in the Proposed Action configuration are applicable to this project configuration.

Power Requirements. The power supply requirements for location of the upgrading plant near Fruita would not differ from those of the Proposed Action. The potential sources of power are similar to those described for the Proposed Action configuration (Section 2.3.2.4).

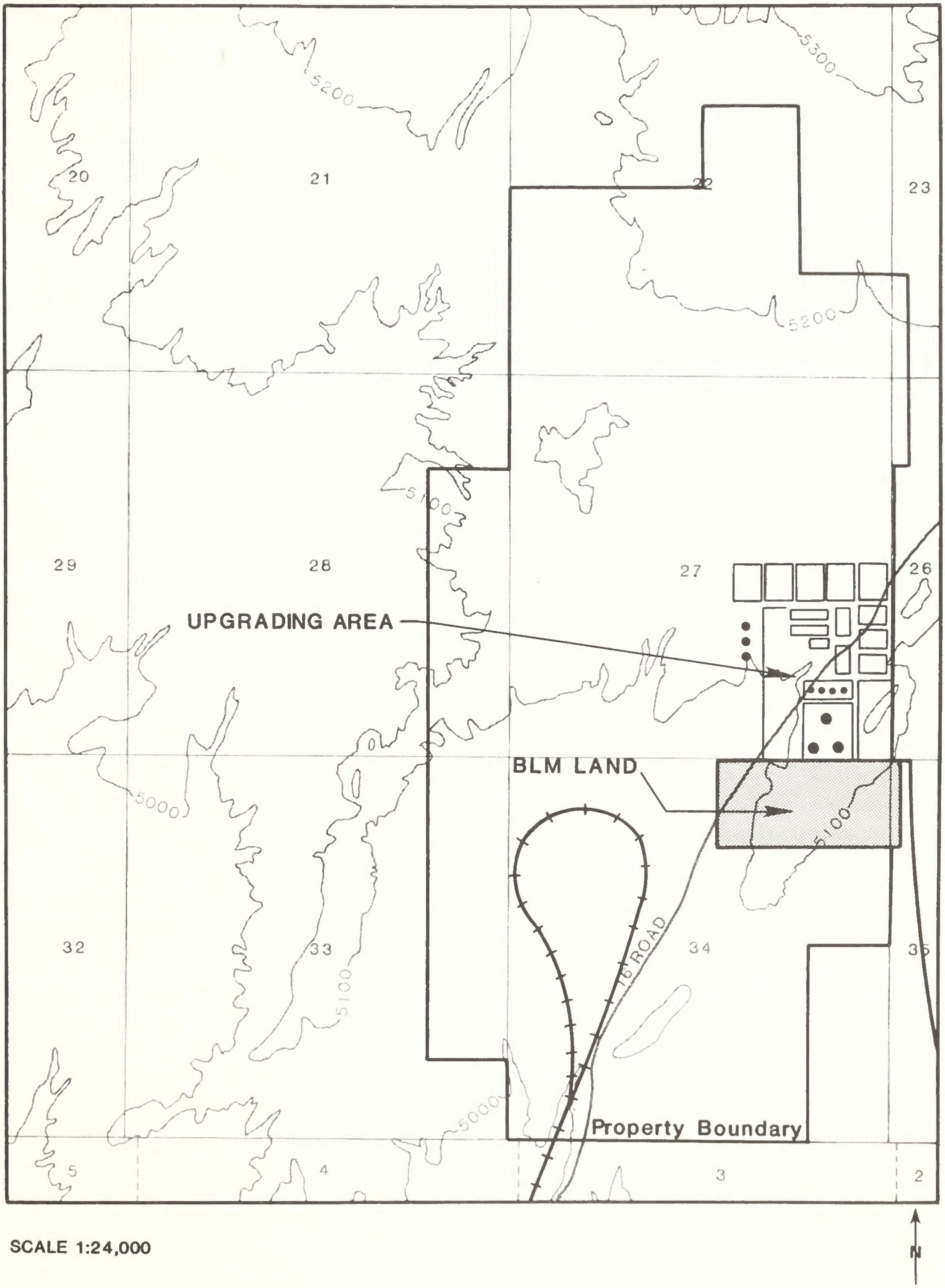


Figure 2.3-13 Plot Plan of Fruita I Upgrade Facility in the Grand Valley

Three alternative sources of power are considered for this alternative project configuration.

- The first alternative would be the proposed Colorado-Ute Southwest power plant, located approximately 4 miles to the west of the upgrade site. A 115 to 345 kv line would be constructed between the Colorado-Ute plant and the upgrading plant.

- The second alternative would be 115 to 345-kv transmission line constructed from the Fruita area to the plant site. This line would tap existing and/or planned power supplies. The line would follow the multiple use corridor along 16 Road (1.1 mile northwest of Fruita) and head directly north to the plant site.

- The third alternative would be cogeneration of power within the planned facility, as previously described.

Railroad Facilities. The proposed and alternative railroad corridors for the Proposed Action would also apply to the Fruita 1 configuration. However, an additional railroad facility would be needed to supply the upgrading plant with materials and to transport syncrude to appropriate refineries in the early years of the project.

Three alternative railroad lines for the Fruita I configuration are:

- The corridor along 16 Road heading directly north to the plant site.

- A route commencing at the D&RGW mainline west of Mack, which then follows the proposed Dorchester Coal route to the upgrading plant site.

- A railroad heading north following the Douglas Pass road corridor; this could be a joint railroad corridor with the proposed Colorado-Ute Southwest power plant.

Intertie Pipelines — Grand Valley Site to Clear Creek Mesa. Raw shale oil would have to be transported from Clear Creek mesa retorts to the Fruita upgrading plant via intertie pipelines. Under the Proposed Action configuration, the intertie pipeline system would be a part of the piping system contained within the plant site. However, if the upgrading facility is located in the Grand Valley, an intertie pipeline would have to be constructed to link the two plants. Three alternative routes are under consideration:

- Big Salt Wash to Clear Creek mesa (Echo Lake Route)

  This alternative route follows the same route as the Big Salt Wash to Clear Creek mesa water pipeline, described previously. It is approximately 42 miles long.

- Big Salt Wash to Clear Creek mesa (Deer Creek Route)

  This route would follow Big Salt Wash to Deer Creek, heading generally north and northeast between Big Salt Wash and Mud Spring Canyon. The route continues northwest then northeast to a point near the headwaters of Left Fork Lake Creek. From here the pipeline would head east then southeast to Clear Creek mesa.

- Roan Creek to Clear Creek Property (Overland Route)

  This pipeline would follow the routes described above to a point in Big Salt Wash near Mud Spring just west of Roan Creek. At this point it would ascend the ridge east then descend into Roan Creek canyon, continue east along Roan Creek to Clear Creek, then north up Clear Creek to the plant site.

Product Transport Pipelines. The product syncrude would be transported to a refinery from the upgrading plant north of Fruita. Four alternative routes are under consideration:

- Big Salt Wash to Clear Creek mesa (Echo Lake Route)

  This pipeline would involve construction of a 12- to 18-inch pipeline from the upgrading plant to Clear Creek mesa along the Big Salt Wash corridor as described previously. The syncrude would then be pumped from the Clear Creek property to the La Sal pipeline.

- Big Salt Wash West to SOPS Line

  This pipeline that would extend approximately 7 miles west of the Fruita upgrading site joining the proposed SOPS pipeline route.

- Big Salt Wash to Rangely

  This alternative would entail a syncrude line extending northward along the Big Salt Wash access route, intersecting the proposed Rangely pipeline (A or B routes), then traveling north to the Rangely terminal, as described earlier.

- Roan Creek to Clear Creek mesa (Overland Route)

  This line would follow the same route as described previously for the intertie pipeline. It would tie into either the La Sal or SOPS pipeline.

Natural Gas Pipeline. The system serving Clear Creek mesa would be as described in Section 2.3.2.4. There would also be a natural gas pipeline leading north from the Fruita area along the 16 Road multiple-use corridor. This system would link to existing natural gas supplies and would supply the upgrading plant.

Transmission Lines. The proposed and alternative transmission lines for the Clear Creek mesa facilities would be the same as those described for the Proposed Action. For the upgrading and associated facilities, a 115- to 345-kv transmission line would be required from the Fruita area to the plant site. This route would be constructed along the multiple-use corridor and would tap into existing and/or planned power supplies as described previously. The line would follow the access road to a point approximately 11 miles north of Fruita.

Solid and Hazardous Waste. The methods of disposal of solid and/or hazardous waste, as well as alternatives, would be as described for the Proposed Action. Since the upgrading facility is located in the Grand Valley area, waste generated by this facility would be transported and disposed of within the processed shale disposal area. Nonprocess solid waste, such as trash and garbage, would be collected with dumpster type trucks.

Worker Transportation. As with the Proposed Action, workers would be encouraged to use the proposed bus system, that will operate between adjacent communities and the project site. Undoubtedly, there will be passenger car traffic, but the economics and fuel conservation advantages of multi-passenger vehicles should minimize passenger car use. Also, since there would be greater numbers of employees in the Grand Valley area with this configuration, the distribution of the vehicles used for worker transportation would be shifted toward the Fruita upgrading site.

Materials Transportation. The total amount of truck and train traffic needed to supply the Fruita I alternative would not differ from the Proposed Action.

Decommissioning and Reclamation

With the Fruita I project configuration, the total acreage of disturbance would be very similar to that of the Proposed Action. Reclamation of the upgrading area would consist of decommissioning of the buildings, regrading, and revegetation. Reclamation efforts near Fruita, compared to reclamation on Clear Creek mesa, would be relatively small scale.

2.3.3.4 Fruita II Project Configuration

As described previously, this configuration is not considered viable under the 100,000-bpd production rate. It is, however, considered under the 50,000-bpd scenario and is described in detail in Section 2.3.4.3, below.

2.3.4 Facility Siting Alternatives Producing 50,000 bpd

Three project configurations (Proposed Action, Clear Creek, and Fruita I.) are being considered for a 50,000-bpd production rate scenario. In addition, the Fruita II configuration is only considered at the 50,000-bpd production rate. The three project configurations described above would remain generally the same; differences that would occur are described below.

2.3.4.1 Proposed Action and Clear Creek Project Alternative Configurations at 50,000 bpd.

Characteristics of these two project configurations at 50,000 bpd are as follows.

- All major facilities (e.g., retorts, upgrading modules) would be on Clear Creek mesa.
- The mine would be all underground, producing 75,000 tons per day of shale, and affecting the surface equivalent of 12,200 acres during the 25-year life of the mine.
- Three retorts capable of producing 17,000 bpd per retort would be required and affect a total of approximately 100 acres.
- Two upgrading modules capable of producing 25,000 bpd each would be required and affect a total of approximately 100 acres.
- Spent shale disposal would occur in the same locations and would utilize the same techniques as for these project configurations described above. Approximately 3,000 acres for disposal of 900 million cubic yards of spent shale would be required.
- Ancillary plant facilities would be as for the project descriptions previously described. Approximately 10 acres would be affected.
- The daily electrical power requirements would be approximately 149 megawatts.
- All other infrastructure facilities would be as described for the project configurations described previously.
- Anticipated labor requirements for these two project configurations are listed in Table 4.12-1 (Section 4.12, Socioeconomics).

The reader is referred to Figures 2.3-1 and 2.3-2 for the general layout of these configurations as modified above.

2.3.4.2 Fruita I Project Configuration

All features of this configuration would be as described previously for the Fruita I configuration with the following differences.

- The mine would be all underground, producing 75,000 tons per day of shale, and affecting the surface equivalent of 12,200 acres during the 25-year life of the mine.
- Three retorts capable of producing 17,000 bpd per retort would be required and affect a total of approximately 100 acres on Clear Creek mesa.
- Two upgrading modules capable of producing 25,000 bpd each would be located on the Chevron property north of Fruita and would affect approximately 100 acres.

- Ancillary plant facilities would be the same as required for the 100,000-bpd Fruita I alternative. Approximately 100 acres would be affected on Clear Creek mesa and 100 acres on the Fruita site.

- Spent shale disposal would occur in the same locations and utilizing the same techniques as for the project configurations described above. Approximately 3,000 acres for disposal of 900 million cubic yards of spent shale would be required.

- The daily electrical power requirements would be approximately 149 megawatts.

- Anticipated labor requirements for this project configuration are listed in Table 4.12-1 (Section 4.12, Socioeconomics).

The reader is referred to Figure 2.3-3 for the general layout of this configuration, as modified above.

2.3.4.3 Fruita II Project Configuration

Overview

Certain major facilities would be relocated under the 50,000-bpd production rate for the Fruita II project configuration. The feed preparation, retort, and upgrading facilities would be located on the property north of Fruita, as shown on Figure 2.3-4. The mine and associated facilities would remain on the Clear Creek mesa. The labor requirements for this project configuration are listed in Table 4.12-1 (Section 4.12, Socioeconomics).

Facility Sites and Processes

The Fruita II project configuration would encompass those project facilities similar to the other 50,000-bpd configurations. Mining would be all underground producing 75,000 tpd and would occur on Clear Creek mesa, as previously described. Feed preparation, retorting, and upgrading would occur at the plant site north of Fruita (Figure 2.3-14). Raw shale would be transported from Clear Creek mesa to the Fruita retorts. Details of this project configuration are described below.

Feed Preparation. The initial stages of feed preparation (i.e., crushing) of the oil shale would occur at the mine site. Shale would then be transported to the retorts and additional crushing would occur at the retort site prior to entering the retort modules.

Retorting and Upgrading. The retorts and upgrading modules would be located on the tract of land owned by the Operator, 12 miles north of Fruita. These facilities would include three modules for upgrading and two modules for retorting, and would require approximately 400 acres of the 1,600-acre tract. The plot plan of this facility is shown on Figure 2.3-14.

The structures and processes used for feed preparation, retorting, and upgrading would be the same as described for the other project configurations. Some minor design modifications may be necessary due to the lower altitude and change in production rate.

Spent Shale Disposal. Since the retorts are located at the Fruita site, the requirement for spent shale disposal would shift to that area. Spent shale from the Fruita II retorts would be transported to one (or more) of four alternate sites within 6-7 miles of the Fruita plant site. These sites are:

- The Stove/Buniger canyons site, located 2.7 miles northeast of the plant site, encompasses approximately 2,750 acres and has an estimated storage capacity of 1,300 million cubic yards.

- The Dry Gulch site, located 1.4 miles east of the plant site, is approximately 3,020 acres in areal extent and has a capacity of 915 million cubic yards.

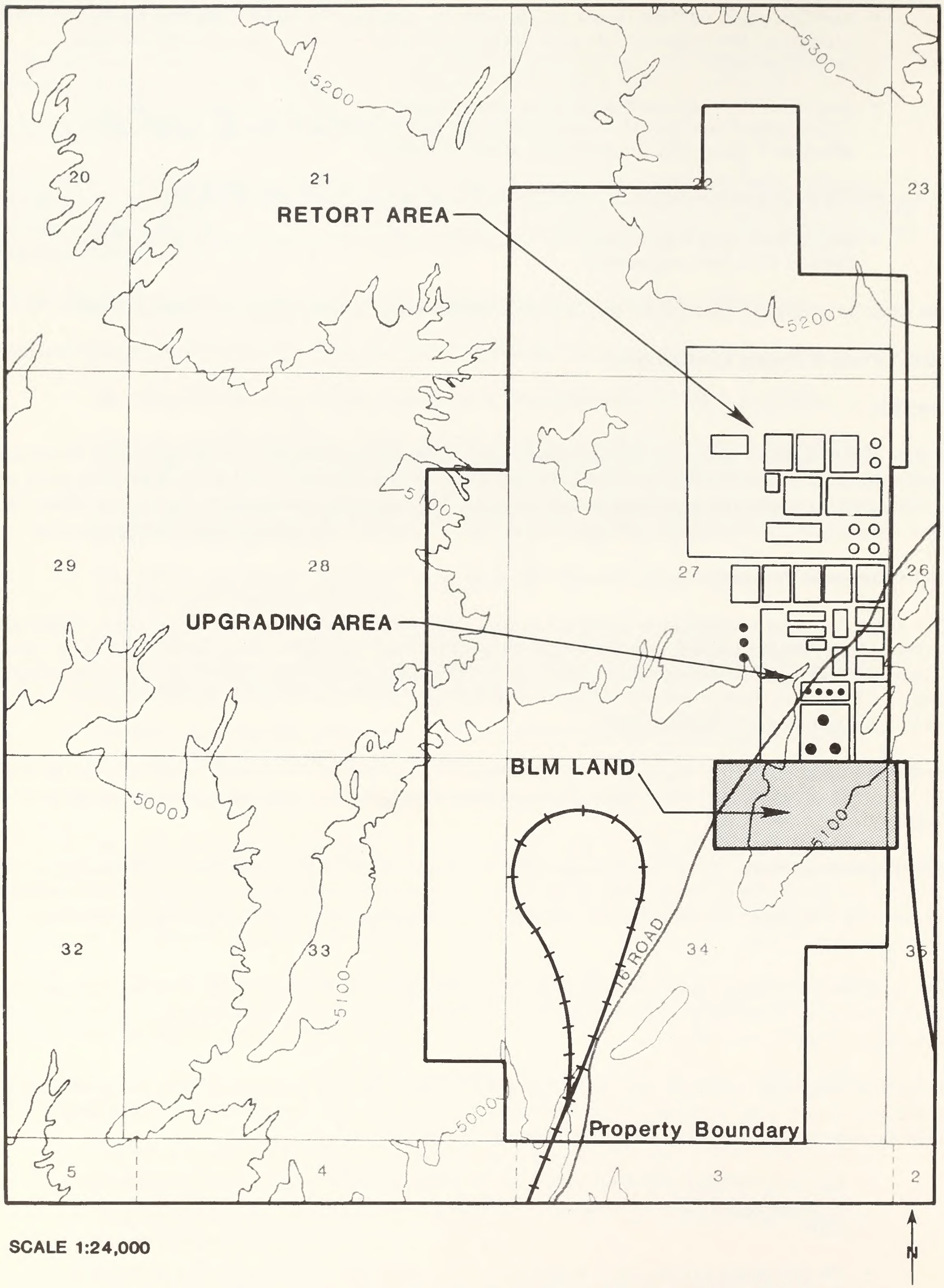


Figure 2.3-14 Plot Plan of Fruita II Upgrade and Retort Facilities in the Grand Valley

- Garvey Canyon, with a capacity of 900 million cubic yards, is 3.4 miles northeast of the plant site and would be 1,900 acres in extent.

- The Munger Creek disposal site, located 6.3 miles north of the plant site, is planned to have a capacity of 1,125 million cubic yards covering a 2,085 acre area.

Project Support Facilities

Project support facilities needed to serve the upgrading and retorts in the Grand Valley area such as access roads, water supply and control systems, power requirements, natural gas pipelines, transmission lines, and transportation systems would be the same as described for the Fruita I alternative. The major additional system is the raw shale transport system as described below. Intertie pipelines would be eliminated.

The product pipelines under the Fruita II configuration would include all those considered under the Fruita I configuration. In addition, syncrude pipelines could be constructed parallel to the shale transport railroad routes described below. One alternative pipeline route would use the Straight Line Tunnel Route. The other would follow the tunnel route to Roan Creek. In both instances, the pipelines would be located within the tunnels.

In order to locate the retorts in the Grand Valley, a raw shale ore transfer system would be needed between the Clear Creek mesa mine and the retorts. The proposed system would be a private railroad that would, at the peak, transfer approximately 75,000 tons of raw shale per day. Utilizing unit trains, this would require approximately eight train trips (round trips) per day between the mesa and the Grand Valley retorts.

Two alternative shale transport routes are considered for the Fruita II project configuration.

- Straight Line/Tunnel Route

  This route begins at the retort site near Grand Valley and proceeds up Big Salt Wash for approximately 12.5 miles, generally following the bottom of the canyon on the east side of the creek. At this point the route enters a tunnel which daylights at Carr Creek and again at Brush Creek. Total length of the route is approximately 28 miles, of which 15.2 miles is tunnel. Bridge structures would be required at Carr Creek and Brush Creek.

- Roan Creek Tunnel Route

  This route would follow the same initial alignment up Big Salt Wash for approximately 12.5 miles. At this point, the railroad would enter a tunnel which heads east until daylighting in Roan Creek. It would then follow the canyon bottom of Roan Creek until the confluence with Clear Creek. From that point, the route would head north up Clear Creek canyon to the mesa area.

Decommissioning and Reclamation

Decommissioning of the buildings at the retorting and upgrading sites near Fruita would be similar to the processes used with the Fruita I alternative. Reclamation efforts at both the Clear Creek mesa and Grand Valley sites would also be similar to those described previously.

2.3.5 No Action Alternative

Consideration of the No Action alternative is required in any EIS in accordance with regulations issued by the Council on Environmental Quality (1978) and under provisions of the National Environmental Policy Act of 1969. Under the No Action alternative, the construction of the shale oil facility would not take place. No action could occur due to (1) the denial of the right-of-way by the BLM, or (2) a decision by Chevron, Conoco, or both not to proceed with the project.

2.4 Comparison of Alternatives

2.4.1 Introduction

The impacts of the various project alternatives on the specific environmental disciplines were all compared to determine the relative impacts of each alternative. Section 2.4.2 presents a brief discussion of the methodology used for impact analysis. An overall comparison of impacts of the seven major project configurations (considering the 50,000-bpd and 100,000-bpd production rates) and the No Action alternative is presented in Section 2.4.3. The impacts of each alternative component are then summarized and compared in Sections 2.4.4 through 2.4.10. These summaries and comparisons were derived from the detailed impact assessments in Chapter 4.0. Finally, Section 2.4.11 presents the BLM's preferred alternative, along with the rationale for the choice based on the impact analysis.

2.4.2 Methodology

Project alternatives were analyzed at two levels: (1) the discipline-specific level (e.g., air quality, aquatic ecology), and (2) the interdisciplinary level. Impact methodologies used are described in the *Impact Analysis Guide* prepared for use with this EIS (BLM 1982a).

Results of the impact assessments for each alternative on a discipline-specific basis were summarized and documented in project files on impact analysis matrix forms, and rated on a numerical scale of +3 to −3. Further discussion of the impact ratings is presented in Appendix B-1.

It is important to note that these numerical impact ratings are subjective and based on best professional judgement. They are presented here to display the relative impacts between various alternative project components and major project configurations. The numbers presented in each table should not be construed as having any statistical significance.

Because of the complexity of the socioeconomic impacts, the numerical impact rating approach could not be used. Rather, socioeconomic impacts are summarized in a table of absolute numbers (e.g., total population, fiscal balances) in Section 2.4.3.

2.4.3 Major Project Configurations

Due to the large number of project components and possible alternatives, the BLM has developed alternative major project configurations for purposes of comparison with the Proposed Action. This process enables the BLM and the reader to (1) understand, in a comparative sense, the overall impacts that would result from implementation of each major project configuration, (2) sharply define the issues, and (3) provide a clear choice among the options. The environmental impacts of construction, operation, and residual activities* for each of the seven major project configurations and the No Action alternative were evaluated for 50,000-bpd and 100,000-bpd production rates. The following project features were assumed in each configuration (see Sections 2.2 and 2.3 for details).

- Proposed Action - 100,000 bpd (PA-100)
  - Mine (surface/underground)
  - Retorts (11) and upgrading (4 modules) on Clear Creek mesa
  - Spent shale disposal on Clear Creek mesa (Mesa Valley Fill and open pit mine).
  - Roan Creek, La Sal, and Big Salt Wash corridors
  - Water diversions at De Beque and Loma

*** - Residual activities are defined in the Glossary and Appendix B-1.**

- Upper Dry Fork and Big Salt Wash reservoirs
- De Beque railroad spur

• Proposed Action Alternative - 50,000 bpd (PA-50)
  - All underground mine on Clear Creek mesa (richer shale than surface/underground mine)
  - Retorts (3) and upgrading (2 modules) Clear Creek mesa
  - Spent shale disposal on Clear Creek mesa (Mesa Valley Fill)
  - Remaining features as shown for PA-100 above

• Clear Creek Alternative - 100,000 bpd (CC-100)
  - Mine (surface/underground)
  - Retorts (11) and upgrading (4 modules) on Clear Creek mesa
  - Spent shale disposal on Clear Creek mesa (Mesa Valley Fill and open pit mine)
  - Roan Creek and La Sal corridors
  - Water diversion at De Beque only
  - Upper Dry Fork reservoir only
  - De Beque railroad spur

• Clear Creek Alternative - 50,000 bpd (CC-50)
  - All underground mine on Clear Creek mesa
  - Retorts (3) and upgrading (2 modules) on Clear Creek mesa
  - Remaining features as shown for CC-100 above

• Fruita 1 Alternative - 100,000 bpd (FI-100)
  - Mine (surface/underground)
  - Retorts (11) on Clear Creek mesa
  - Upgrading (4 modules) in Grand Valley
  - Spent shale disposal on Clear Creek mesa (Mesa Valley Fill and open pit)
  - Roan Creek, La Sal and Big Salt Wash corridors
  - 16 Road corridor to upgrade site (multi-use)
  - Water diversions at De Beque and Loma
  - Upper Dry Fork and Big Salt Wash reservoirs
  - De Beque railroad spur

- Fruita I Alternative - 50,000 bpd (FI-50)
  - All underground mine on Clear Creek mesa
  - Retorts (3) on Clear Creek mesa
  - Upgrading (2 modules) in Grand Valley
  - Remaining features as shown for FI-100, above
- Fruita II Alternative - 50,000 bpd (FII-50)
  - All underground mine on Clear Creek mesa
  - Retorts (3) and upgrading (2 modules) in Grand Valley
  - Rail haulage of raw and spent shale via Straight Line tunnel corridor
  - Spent shale disposal in Stove/Buniger canyons site
  - Roan Creek, La Sal, and Big Salt Wash corridors
  - 16 Road corridor to retort/upgrade site (multi-use)
  - Water diversions at De Beque and Loma
  - Upper Dry Fork and Big Salt Wash reservoirs
  - De Beque railroad spur
- No Action Alternative
  - No development activities pertaining to the CCSOP

The comparisons of impacts of alternative project components (e.g., alternative rail corridors) are presented in sections 2.4-4 through 2.4-10. Based on those comparisons, the decision-maker and the public could substitute in one configuration or another (as feasible) a particular project component for purposes of evaluating the agency-preferred alternative (Section 2.4.11).

The following comparisons of impacts are presented by discipline for each of the major project configurations described above. Numerical impact ratings are presented by discipline in Table 2.4-1.

Air Quality

Potential air quality impacts for the alternative project configurations are strongly influenced by the location of the facilities with respect to critical receptors and phase of the project. Generally, construction activities for all configurations would produce a temporary, site-specific, low adverse impact due to fugitive dust and mobile sources. Assuming adequate reclamation of disturbed areas, only slight adverse air quality impacts from windblown fugitive dust would result during the residual phases.

During operations, all 50,000-bpd configurations would be expected to fall within established PSD increments and would not exceed National Ambient Air Quality Standards (NAAQS). FI-50 generally rates the least adverse impacts overall. PA-100 and CC-100 rate the highest adverse impacts for operations due to a predicted exceedance of the nitrogen dioxide annual standard based on all nitrogen oxides converted to nitrogen dioxide. However, the FI-100 configuration would not be expected to exceed Class II PSD increments or NAAQS. See Section 4.2 for further details.

Table 2.4-1 IMPACT COMPARISONS OF MAJOR ALTERNATIVE PROJECT CONFIGURATIONS FOR THE CLEAR CREEK SHALE OIL PROJECT[a]

	No Action			PA-100[b]			CC-100			FI-100		
Discipline	Cons[c]	Oper[c]	Res[c]	Cons	Oper	Res	Cons	Oper	Res	Cons	Oper	Res
Air Quality	0	0	0	−0.9	−3.0	−0.4	−0.9	−3.0	−0.4	−1.1	−2.0	−0.6
Noise	0	0	0	−0.6	−0.8	−0.1	−0.6	−0.8	−0.1	−0.4	−0.9	−0.1
Surface Water	0	0	0	−2.0	−1.5	−1.0	−1.5	−1.0	−0.5	−2.1	−1.7	−1.0
Ground Water	0	0	0	−0.4	−1.7	−1.2	−0.5	−1.6	−1.0	−0.4	−1.7	−1.2
Topography	0	0	0	−1.3	−1.5	−1.1	−1.2	−1.2	−1.0	−1.1	−1.6	−1.1
Geology	0	0	0	−0.5	+1.0	−0.6	−0.4	+1.0	−0.5	−0.6	+1.0	−0.7
Paleontology	0	0	0	−0.8	−0.5	−0.2	−0.5	−0.4	−0.2	−1.0	−0.5	−0.2
Soils	0	0	0	−1.0	−0.6	−0.2	−0.9	−0.5	−0.1	−1.1	−0.5	−0.2
Aquatic Ecology	0	0	0	−1.3	−2.3	−0.2	−1.0	−2.0	−0.1	−1.5	−2.4	−0.2
Vegetation[d]	0	0	0	−2.0	−2.0	−1.5	−1.8	−1.8	−1.1	−2.1	−2.1	−1.8
Wildlife	0	0	0	−1.8	−2.2	−1.5	−1.6	−2.0	−1.2	−1.8	−2.2	−1.3
Visual Resources	0	0	0	−1.3	−1.2	−0.5	−1.2	−1.1	−0.4	−1.8	−1.6	−0.6
Cultural Resources	0	0	0	−0.7	−0.2	−0.2	−0.5	−0.1	−0.1	−0.8	−0.3	−0.3
Land Use	0	0	0	−0.8	−0.5	−0.2	−0.6	−0.4	−0.1	−1.0	−0.6	−0.3
Recreation	0	0	0	−2.0	+0.5	+1.0	−2.0	+0.5	+1.0	−1.5	+0.3	+0.7
Wilderness	0	0	0	−1.0	−0.5	−0.5	−1.0	−0.5	−0.5	−0.8	−0.4	−0.4
Energy	0	0	0	−0.7	+2.0	−0.7	−0.6	+2.1	−0.1	−0.8	+1.9	−0.1
Transportation	0	0	0	−1.7	−0.7	−0.1	−1.6	−0.7	−0.1	−1.4	−0.5	−0.1

	PA-50			CC-50			FI-50			FII-50		
Discipline	Cons	Oper	Res	Cons	Oper	Res	Cons	Oper	Res	Cons	Oper	Res
Air Quality	−0.5	−2.0	−0.2	−0.5	−2.0	−0.2	−0.8	−1.0	−0.2	−0.5	−1.8	−0.2
Noise	−0.3	−0.4	−0.1	−0.3	−0.4	−0.1	−0.2	−0.5	−0.1	−0.6	−1.2	−0.1
Surface Water	−0.8	−0.5	−0.2	−0.5	−0.4	−0.2	−1.2	−0.7	−0.3	−1.3	−2.0	−1.2
Ground Water	−0.1	−0.7	−0.1	−0.1	−0.7	−0.1	−0.2	−0.7	−0.2	−1.0	−1.9	−1.2
Topography	−0.6	−1.1	−0.7	−0.6	−0.8	−0.5	−0.7	−1.2	−0.6	−1.0	−1.2	−1.2
Geology	−0.4	+0.7	−0.5	−0.3	+0.7	−0.4	−0.5	+0.7	−0.6	−1.0	+0.7	−0.8
Paleontology	−0.8	−0.4	−0.2	−0.5	−0.3	−0.2	−1.0	−0.4	−0.2	−1.2	−0.4	−0.2
Soils	−0.5	+0.8	−0.2	−0.4	+0.8	−0.1	−0.6	+0.8	−0.2	−0.7	+1.0	−0.2
Aquatic Ecology	−1.3	−2.2	−0.2	−1.0	−1.9	−0.1	−1.5	−2.3	−0.2	−1.5	−2.4	−0.3
Vegetation[d]	−1.3	−1.3	−1.5	−1.0	−1.0	−1.1	−1.6	−1.6	−1.8	−1.7	−1.7	−2.0
Wildlife	−1.6	−2.0	−1.0	−1.2	−1.5	−0.8	−1.6	−2.0	−1.0	−2.0	−2.5	−2.2
Visual Resources	−1.1	−1.1	−0.5	−1.0	−1.1	−0.4	−1.1	−1.2	−0.5	−1.6	−1.3	−0.5
Cultural Resources	−0.4	−0.1	−0.1	−0.2	−0.1	−0.1	−0.3	−0.1	−0.2	−0.8	−0.4	−0.4
Land Use	−0.5	−0.2	−0.1	−0.4	−0.3	−0.2	−0.6	−0.5	−0.3	−1.2	−0.9	−0.4
Recreation	−1.0	+0.2	+0.5	−1.0	+0.2	+0.5	−0.8	+0.3	+0.6	−0.8	+0.3	+0.7
Wilderness	−0.8	−0.6	−0.3	−0.8	−0.6	−0.3	−0.7	−0.3	−0.2	−0.8	−0.4	−0.4
Energy	−0.6	+2.3	−0.1	−0.5	+2.4	−0.1	−0.7	+2.1	−0.1	−0.6	+2.1	−0.1
Transportation	−1.2	−0.5	−0.1	−1.1	−0.5	−0.1	−1.0	−0.4	−0.1	−1.0	−0.4	−0.1

[a] See Section 2.3 for maps and explanation of features of the major alternative project configurations. Impact Rating System: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = No Impact; +1.0 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.

[b] Proposed Action configuration, production rate at 100,000 bpd.

[c] Cons = Construction.
Oper = Operation.
Res = Residual.

[d] Not including potential impacts to threatened or endangered plant species. See Section 4.8.

Noise

According to the noise impact analysis, the FII-50 alternative would result in the highest relative adverse noise impacts of all project configurations. The impacts of PA-100 and CC-100 are identical, and are considered to have low adverse impacts. The FI-100 alternative would have slightly higher operating noise impacts than PA-100 and CC-100, and slightly lower operation noise impacts than the FII-50 alternative. The FII-50 alternative would have higher noise impacts due to (1) placement of the facilities in a more densely populated area and (2) additional noise created by raw shale and spent shale transport systems. Lowest adverse noise impacts would result from FI-50, PA-50, and CC-50. Slight differences in total noise impacts exist between these alternatives. Thus, it appears that at either production rate, the PA, CC, and FI alternative configurations would result in low adverse impacts, with the FI configuration showing only slightly higher relative ratings than PA or CC. See Section 4.3 for further details.

Surface Water

The construction phase would result in higher adverse impacts to surface water resources than operation or residual phases. Comparisons indicate that, of the 50,000-bpd alternatives, PA-50 and CC-50 would result in low adverse impacts while FI-50 and FII-50 would result in low to medium adverse impacts. Because of additional disturbance due to retorts on the Fruita plant site, spent shale disposal piles in the Grand Valley, and the Straight Line Tunnel shale transport railroad route to Clear Creek Mesa, FII-50 would result in the highest relative adverse impacts during operation.

CC-50 would result in the lowest adverse impacts because no disturbance to surface water would occur in the Big Salt Wash corridor or in the Fruita area. Impacts of PA-50 would be slightly higher than CC-50 because of the Big Salt Wash corridor and Loma water system. FI-50 impacts would be slightly higher than PA-50 because of the addition of upgrading units near Fruita. Impacts of all configurations would be low to medium adverse.

Potential construction impacts of PA-100, CC-100, and FI-100 are similar to those for the 50,000-bpd alternatives. However, the differences in levels of impact are not as pronounced. CC-100, as expected, would have the lowest adverse impacts, and impacts of PA-100 and FI-100 would be slightly higher. Impacts from all 100,000-bpd configurations are considered to be medium adverse.

Comparison of operation and residual impacts for the 50,000-bpd configurations suggest that FII-50 would result in significantly higher adverse effects than PA-50, CC-50, and FI-50. Impacts from PA-50, CC-50, and FI-50 would be low adverse.

Comparison of operation and residual impacts resulting from the PA-100, CC-100, and FI-100 alternatives suggest similar relationships. CC-100 rates the lowest adverse impact with PA-100 and FI-100 showing relatively higher impacts. All adverse impacts are considered low to medium.

In summary, PA-50, CC-50, and FI-50 would result in lower adverse impacts than the PA-100, CC-100, and FI-100. CC-100 would create less impact than either PA-100 or FI-100. However, overall impacts of PA-100, CC-100, and FI-100 would be medium adverse. Proper management, especially during construction, would reduce expected impacts even further. See Section 4.4.1 for further details.

Ground water

The principal ground water resources impact would result from operation of the proposed open pit mine for all 100,000-bpd alternatives, and would extend through residual phases. Comparisons suggest only minor differences in the relative degree of impact between each of the seven alternative configurations. The differences are based primarily on type, location, and distribution of ancillary facilities associated with each configuration.

The FII-50 alternative would have the highest relative overall adverse impact to ground water of all project configurations considered. PA-50, CC-50, and FI-50 would result in low adverse impacts due to the smaller scale of these projects and absence of the open pit mine. The differences in level of overall impact between these configurations is insignificant.

Impacts to ground water resulting from PA-100, CC-100, and FI-100 are expected to result in low to medium adverse impacts even with the inclusion of the open pit mine. Differences in level of overall impact between these configurations are also insignificant.

The open pit mine was proposed to optimize and enhance resource recovery and extend project life. Impacts on ground water that would result from the open pit mine, while significant, are not considered prohibitive. Implementation of planned designs and management practices would be expected to reduce impacts from PA-100, CC-100, and FI-100 to acceptable levels. See Section 4.4.2 for further details.

Topography

The PA-100 and FI-100 project configurations would affect existing topography more than other configurations due to surface mining of oil shale and the extent of overall transport networks. CC-100 would also affect topography because of surface mining activity but, due to shorter transport networks, would result in slightly less adverse impacts than PA-100 and FI-100. Impacts of PA-100, CC-100, and FI-100 are considered low to medium adverse. Differences in level of impact between the three configurations are insignificant. The PA-50, FI-50 and FII-50 project configurations would produce roughly equivalent impacts on topography due to similarities in mine and ancillary facilities. CC-50 would impact topography the least due to the absence of surface mining and the shorter length of transport corridors from Clear Creek mesa to De Beque. See Section 4.5 for further details.

Geology

Implementation of any project configuration (except No Action) represents the best use of the oil shale resource, estimated to be in excess of 3.9 billion barrels. However, more efficient and complete recovery of the resource would be achieved with the 100,000-bpd configurations than with the 50,000-bpd configurations. From a geologic standpoint, maximum recovery of the resource with a 100,000-bpd alternative is preferable to only partial recovery under a 50,000-bpd alternative.

Consumptive use of sand and gravel resources would occur locally during construction of the Proposed Action or any of the alternatives. Higher consumptive use of these resources would be associated with PA-50, PA-100, FI-50, FI-100 and FII-50 due to length and complexity of proposed transport networks from both Fruita and De Beque to the Clear Creek mesa mine site. Geologic hazards that would be encountered during construction and operation are worthy of note. These would vary slightly for each of the configurations based on location and type of ancillary features, such as secondary access roads. See Section 4.5 for further details.

Paleontology

Impacts to paleontological resources may occur during construction of the Proposed Action or any action alternatives. The Fruita alternatives (FI-100, FI-50, FII-50) have been assessed as having the highest risk of creating adverse impacts on potential fossil collecting sites. This assessment is attributable to the location of project facilities in the Big Salt Wash area (an area that may contain such resources) and the amount of expected disturbance. However, the potential adverse impacts of FI-100, FI-50, and FII-50 are considered low. The adverse impacts associated with PA-50 and PA-100 would be somewhat lower than FI-100, FI-50, and FII-50 due to the reduced activity expected in the Big Salt Wash area. The CC-50 and CC-100 configurations disrupt the least area during construction and would not affect Big Salt Wash; therefore adverse impacts on paleontological resources would be less than for other alternatives. Operation and residual impacts of all project configurations would be comparatively similar and insignificant in all cases. See Section 4.5 for further details.

Soils

Impacts to soils during construction would cause the highest adverse impacts for any project alternative, due to initial disturbance and potential loss of soils. Of the 50,000-bpd alternatives, CC-50 would result in the lowest adverse impact on soils during construction. FII-50 would have the highest (relative) adverse impacts, largely due to disturbance of small acreages of prime farmlands in the Big Salt Wash area.

Similar comparisons can be made for the 100,000-bpd alternatives. The larger areas of disturbance associated with the 100,000-bpd alternatives particularly, would cause larger incremental soil losses than the 50,000 bpd alternatives. FI-100 would have the highest relative adverse impacts due to the loss of prime farmland. CC-100 would have the lowest adverse impacts.

Effects on soils during operation and residual phases would have insignificant impacts for all project configurations. Because erosional losses would be less than undisturbed conditions in spent shale disposal areas during operations, the 50,000-bpd alternatives show low beneficial impacts. The beneficial impact was determined because disposal of spent shale over the soil would limit or eliminate natural erosion. It is assumed that all areas disturbed during construction would be subsequently reclaimed.

Aquatic Ecology

Potential impacts to aquatic biota were based on the number of Colorado River intakes, location and extent of surface disturbances, and siting and use of pipeline, railroad, and road corridors. Construction, operation, and residual impacts would be similar for all alternative configurations. Consequently, impact comparisons do not differentiate between production rates.

All of the alternative configurations would result in medium adverse impacts to aquatic biota because of (1) diversion-induced losses and flow reductions in the Colorado River (which may result from operation of the De Beque intake structure) and (2) impacts due to surface disturbance (sedimentation), habitat elimination, flow reduction, and disturbance to riparian areas from development of the plant site, reservoir, and corridors in the Clear Creek and Roan Creek valleys. The CC-100 and CC-50 alternatives would result in the lowest impacts because they would not include an intake at Loma and would avoid impacts associated with construction and operation of transport (water, railroad, road, and product) corridors between Loma/Fruita and Clear Creek mesa. PA-100 and PA-50 include the Loma intake, but transportation corridor impacts would be limited to those caused by the water pipeline. FI-100 and FI-50 have a somewhat higher potential for impacts because they would include additional surface disturbance near Fruita and shale oil pipelines between Clear Creek and Fruita. However, the difference in expected impacts between the PA configurations and the FI configurations would be insignificant. The added shale oil pipelines would increase the chances of a pipeline break and spillage. FII-50 would eliminate the need for a raw shale oil pipeline, but this advantage is partially offset by potentially heavy utilization of the shale transport railroad with potential associated losses of bulk materials (e.g., raw shale) along the route, and the need for spent shale disposal near the Fruita plant site and in proximity to the Colorado River.

Although the CC-100 and CC-50 alternatives would result in the lowest levels of impact, the difference between those impacts and impacts from the PA-100, PA-50, FI-100, and FI-50 are minor. Impacts of all configurations would be low to medium adverse. See Section 4.7 for further details.

Vegetation

Construction, operation, and residual impacts on vegetation would be similar for each alternative project configuration within each production rate. At the 50,000-bpd production rate, FII-50 would have the highest relative adverse impacts because of the additional surface disturbance. CC-50 would have the lowest adverse impacts, followed by PA-50 and FI-50. The FI-50 and FII-50 alternatives would have the highest adverse impacts of these alternatives because the revegetation potential in the Fruita area is not considered as high as for areas affected by PA-50 and CC-50. However, it is important to note that the Fruita area is at a lower altitude, yielding longer and more favorable growing seasons. These conditions, combined with planned reclamation and revegetation practices, could increase revegetation potentials to levels comparable with the revegetation potential of areas affected by CC-50 and PA-50.

As expected, the 100,000-bpd configurations would have higher adverse impacts on vegetation than the 50,000-bpd alternatives. This is due largely to the additional acreages that would be affected by the open pit mine. Comparisons of the 100,000 bpd alternatives are similar to comparisons of the 50,000-bpd alternatives. However, differences in levels of impact between the configurations at 100,000 bpd are not significant.

Impacts on threatened and endangered plants would be similar for all project configurations. These impacts may result from disturbance of various candidate or threatened and endangered plants in the proposed Upper Dry Fork reservoir area. Since these areas are primarily private lands, mitigation measures undertaken by the Operator could minimize these impacts.

In summary, impacts from the 50,000-bpd alternatives would be less than impacts from the 100,000-bpd alternatives because less land area would be affected at the 50,000 bpd production rate. Impacts for all alternative configurations would be low to medium adverse. See Section 4.8 for further details.

Wildlife

Wildlife impacts due to construction, operation, and residual activities were compared for all alternative project configurations. These comparisons indicate that the FII-50 alternative will result in the highest adverse impacts.

Direct impacts to deer and elk winter ranges (i.e., habitat alteration) in the Clear Creek and Roan Creek drainages would occur under any of the alternative configurations. However, the extent of impacts to wildlife would be greatest for the FII-50 alternative as a result of development in Big Salt Wash and the adjacent Book Cliffs. Construction and operation of the shale haulage railroad and the spent shale disposal site, in addition to retorting and upgrading facilities in the Grand Valley, would result in potentially high adverse impacts to nesting raptors, big game winter ranges, and animal movement. Adverse impacts to pronghorn winter and summer habitat would also be high for FII-50.

The Proposed Action and Fruita I alternatives would result in similar levels of adverse impact at each production level. Potential loss or disturbance of habitat for raptors, including the endangered southern bald eagle, would be greater for either of the Fruita alternatives than for the Clear Creek or Proposed Action alternatives.

In summary, FII-50 would create the highest adverse impacts of the alternatives examined. The differences in potential impacts between the remaining project alternatives for the various project phases is insignificant. See Section 4.8 for further details.

Visual Resources

Visual resource impacts of the major project configurations were evaluated regarding total disturbance, location of sites, and relative visual sensitivity levels. The impacts during construction and operation for all alternatives would be moderately adverse and significant. The PA-100, PA-50, CC-50, CC-100, and FI-50 alternatives would have similar levels of impact, since activities would be either restricted to the Clear Creek/Roan Creek area, away from view by the general public, or small enough in scale to result in a similar level of visual impact. The FI-100 and FII-50 alternatives were rated as having the highest relative adverse impacts. FI-100 shows the highest impacts due to the higher visual sensitivity of project facilities in the Grand Valley. Differences in levels of construction and operation impacts for all alternatives would be minor, and all impact ratings are considered low to medium adverse. See Section 4.9 for further details.

Cultural Resources

In general, potential cultural resources impacts of all alternative configurations (given the existing regulatory structure) would be insignificant. FI-100 and FII-50 have higher potential adverse impacts (as a result of disturbance of more acreage during corridor construction) than the other configurations, as well as potentially higher operations and residual impacts due to increased areas that would be subject to unauthorized collection of cultural artifacts. All the 50,000 bpd configurations (except FII-50) show slightly lower adverse impacts, due to the all underground mine and lower chance for disturbance to potentially significant cultural sites on Clear Creek mesa. FII-50, however, has slightly higher potential for such disturbance because of the Straight Line Tunnel railroad corridor. Mitigation measures would eliminate most, if not all, adverse construction impacts to sites potentially eligible for the National Register of Historic Places. In summary, potential impacts from all project configurations are insignificant. Moreover, the relative differences in potential levels of impact between all alternatives are negligible. See Section 4.10 for further details.

Land Use

Construction and operation of the mine, plant, and ancillary faclities would directly impact existing land uses on the site(s). Lands which are now open space would become predominantly industrial. Direct impacts of the Fruita configurations would result in slightly higher adverse effects than the Clear Creek and Proposed Action configurations, largely due to the higher acreage of agricultural land that would be converted to industrial and residential uses at Fruita. Further, because all 50,000-bpd alternatives eliminate the surface mine, total affected acreages and resulting land use impacts will be less than for the 100,000-bpd alternatives. Potential land use changes from all project configurations would have very low adverse impacts, with the exception of FII-50, which would have slightly higher relative impacts. See Section 4.11 for further details.

Recreation

Impacts on recreation facilities would be more significant during construction than during operation or residual phases, because of the greater number of construction workers living in the region and the resulting need for recreational opportunities and facilities. Municipal recreational facilities would be more adversely impacted by the PA-100 and CC-100 configurations than by the Fruita configurations during construction, since there are currently fewer facilities existing in the De Beque area than in Grand Valley.

Recreation impacts would be beneficial during operation and residual phases. New recreational facilities would be built during construction, providing more facilities during operation and post-operation. The FI-100, FI-50, and FII-50 configurations would disperse both indoor and outdoor recreational impacts to the Fruita, Grand Junction, and Palisade areas. The CC-100, CC-50, PA-100, and PA-50 configurations would concentrate recreational impacts in the De Beque, Parachute/Battlement Mesa, and Rifle areas, thus leading to higher relative adverse impacts during construction. See Section 4.11 for further details.

Wilderness

Impacts on wilderness areas would be similar for all alternatives. Low adverse impacts may occur due to increased demand for wilderness experiences. As with land use, dispersal of workers to the Grand Junction area under the Fruita alternatives would create lower potential adverse impacts on existing and proposed wilderness areas. See Section 4.11 for further details.

Socioeconomics

Mesa and Garfield counties have experienced considerable population growth and urban development over the last several years. Population in the two-county area rose from 85,648 to 104,044 between 1977 and 1980. It is anticipated that without development of the CCSOP, population in the two-county area would continue to increase, although at a slower pace than the 1970-1980 period, and could reach 132,293 by the year 2000. Growth associated with the CCSOP at 100,000 bpd could raise this figure to as high as 157,904 over the same time period. Under the lower production rates, project employment would be less, and thus total incremental population would be less.

The two-county area, for the most part, would be positively impacted by the CCSOP (Tables 2.4-2 and 2.4-3). Employment opportunities, enhanced personal income, and an improved property tax base would be positive impacts. These benefits would occur primarily in the construction and mining sectors under all major project configurations.

Under all configurations, the majority of the population growth would occur in Mesa County, where municipalities and service districts presently provide urban levels of services. Under all configurations, most of the Garfield County growth is anticipated in the Parachute/Battlement Mesa area. Most of the growth, under all alternatives, would be directed to existing communities where adequate physical capacities exist, developable land is available, and the housing industry can meet demands.

The two counties, including most school districts (rather than individual municipalities), would benefit directly (from a financial standpoint) from increases in their property tax bases due to the CCSOP. Garfield County would benefit the most with the PA-100 and CC-100 alternatives, while Mesa County would benefit most under FI-100 and FII-50. However, both counties would receive substantial fiscal benefits and substantial surpluses under any alternative. FI-100 appears to provide the best balance between population and tax base. FI-100 would also provide the best balance with existing infrastructure, and would place growth where it is needed to support committed expansion plans. FII-50 would provide much the same advantages as FI-100, but FII-50's rapid buildup and decline would make provisions for housing, public facilities, and services more difficult.

Under all 50,000 bpd alternatives, the property tax base would be diminished due to the reduction in the number and value of facilities and reduced production. The effects of the lower production rates on municipal tax bases would be relative to the increase in population, retail sales, and ancillary facilities, since no project facilities would be within municipal limits. See Section 4.12 for further details.

Energy

Energy use during construction would constitute a low adverse impact for all configurations. During operation, the analysis shows beneficial impacts, with the 100,000-bpd production rates showing slightly lower production/consumption ratios. Of these production scenarios, the CC-100 configuration shows the highest ratio and the FI-100 the lowest. All, however, indicate favorable ratios. At the 50,000-bpd production rate the overall production/consumption ratios are even higher. At this production scenario the CC-50 configuration has the most favorable ratio (and therefore beneficial impacts), followed by PA-50, FI-50, and FII-50. See Section 4.13 for further details.

Transportation

Transportation impacts throughout the construction, operation, and residual phases would be generally less for the 50,000-bpd production rate than the 100,000-bpd rate due to less need for worker and material transportation. In addition, impacts would be generally less for the Fruita configurations than for the Clear Creek and Proposed Action configurations, due to shorter travel distances from major population and supply centers (Fruita, Grand Junction). Materials and workers would have to be transported shorter distances at lower altitudes (less snow in winter) over gentler grades for the Fruita developments. All project configurations at the 50,00 bpd rate would have low to moderate adverse impacts to the existing transportation system during construction. There would be no significant differences between any of the project configurations at 50,000 bpd. FI-50 and FII-50 are slightly favored during construction and operation for the reasons mentioned above.

At the 100,000-bpd rate, the most significant adverse impacts to transportation would occur with PA-100. CC-100 would also have similar but slightly less adverse impacts. FI-100 would result in the lowest adverse impacts of the 100,000-bpd configurations. The relative differences in level of impact between all alternative project configurations are not significant. See Section 4.13 for further details.

Table 2.4-2 GARFIELD COUNTY SOCIOECONOMIC IMPACTS BY MAJOR PROJECT CONFIGURATION

	No Action		PA-100		PA-50[a]		CC-100		CC-50[a]	
	1994	2000	1994	2000	1993	2000	1994	2000	1993	2000
Total Employment	15,861	16,410	24,088	23,427			24,058	23,427		
Total Population	31,394	31,757	44,403	43,040	44,100	37,264	44,403	43,040	44,100	37,264
Housing Units	16,056	16,504	19,525	21,300			19,525	21,300		
Total School[b] Enrollment	3,545	3,267	5,959	5,460			5,959	5,460		
County Assessed[c] Valuation	$1.0B	$1.21B	$1.78B	$2.51B			$1.78B	$2.51B		
Capital[d] Improvements Planned	$6.6M (County) $5.45M (Rifle) $2.0M (Parachute)		$7.7M $5.45M $2.5M				$7.7M $5.45M $2.5M			
Year 2000 Fiscal Balance (General Fund)	$193M (County) $ – 6.3M (Rifle) $ – 2.3M (Parachute)		$348M $ – 8.3M $ – 3.2M				$348M $ – 8.3M $ – 3.2M			

	FI-100		FI-50[a]		FII-50	
	1994	2000	1994	2000	1994	2000
Total Employment	22,017	22,246			17,029	17,512
Total Population	40,843	40,647	40,886	35,601	33,722	33,752
Housing Units	18,504	20,142			16,890	17,641
Total School[b] Enrollment	5,171	4,891			3,987	2,749
County Assessed[c] Valuation	$1.5B	$2.2B			$1.26B	$1.5B
Capital[d] Improvements Planned	$7.3M (County) $5.45M (Rifle) $2.4M (Parachute)				$6.7M $5.45M $2.2M	
Year 2000 Fiscal Balance (General Fund)	$302M (County) $ – 7.1M (Rifle) $ – 3.1M (Parachute)				$228M $ – 5.6M $ – 2.8M	

[a] Data are not available for all of the socioeconomic impacts at 50,000 bpd. Impacts are generally similar to the FII-50 configurations.
[b] Includes Garfield County #RE-2 and Garfield County #16
[c] 1982 Dollars
[d] (1982 dollars) - Years of completion of capital improvements program varies by jurisdiction; does not include water and sewer

Table 2.4-3 MESA COUNTY SOCIOECONOMIC IMPACTS BY MAJOR PROJECT CONFIGURATION

	No Action		PA-100		PA-50[a]		CC-100		CC-50[a]	
	1994	2000	1994	2000	1993	2000	1994	2000	1993	2000
Total Employment	45,260	47,442	54,145	54,629			54,145	54,629		
Total Population	98,248	100,536	113,270	114,864	110,050	107,432	113,270	114,864	110,050	107,432
Housing Units	43,176	45,817	48,815	52,196			48,815	52,196		
Total School[b] Enrollment	19,202	18,786	22,596	22,042			22,596	22,042		
County Assessed[c] Valuation	$641M	$662M	$721M	$764M			$721M	$764M		
Capital[d] Improvements Planned	$58.5 million (County) $53.0 million (Grand J.) $3.8 million (Fruita) $2.5 million (Collbran) $15,000 (Palisade) $1.6 million (De Beque)		$59.0M $58.3M $3.9M $2.5M $519,000 $2.23M				$59.0M $58.3M $3.9M $2.5M $519,000 $2.23M			
Year 2000 Fiscal Balance (General Fund)	$1.1 million (Mesa) $ – 71.8 million (Grand J.) $ – 1.6 million (Fruita $ – 3.0 million (Collbran) $140,000 (Palisade) $ – 387,000 (De Beque)		$24.3M $ – 70.7M $441,000 $ – 2.4M $236,000 $ – 4.0M				$24.3M $ – 70.7M $441,000 $ – 2.4M $236,000 $ – 4.0M			

	F1-100		F1-50[a]		F11-50	
	1994	2000	1993	2000	1994	2000
Total Employment	56,162	55,721			52,292	52,073
Total Population	116,848	116,980	113,264	109,095	112,315	110,945
Housing Units	49,731	53,218			50,354	51,136
Total School[b] Enrollment	23,513	22,576			22,426	21,065
County Assessed[c] Valuation	$943M	$1.0B			$1.01B	$1.06B
Capital[d] Improvements Planned	$59.0M (County) $59.0M (Grand J.) $4.6M (Fruita) $2.5M (Collbran) $472,000 (Palisade) $1.85M (De Beque)				$61.0M $55.0M $4.4M $2.5M $282,000 $1.75M	

Table 2.4-3 MESA COUNTY SOCIOECONOMIC IMPACTS BY MAJOR PROJECT CONFIGURATION (Continued)

	FI-100		FI-50[a]		FII-50	
	1994	2000	1993	2000	1994	2000
Year 2000 Fiscal Balance (General Fund)	$66.8M (County) $ – 71.8M (Grand J.) $ – 1.7M (Fruita) $ – 2.6M (Collbran) $456,000 (Palisade) $ – 1.5M (De Beque)				$86.6M $ – 56.2M $ – 1.4M $ – 2.0M $773,000 $ – 336,000	

[a] Data are not available for all of the socioeconomic impacts at 50,000 bpd. Impacts are generally similar to the FII-50 configuration.
[b] Includes Mesa County Joint District #49, Plateau Valley #50, and Mesa County Valley #51
[c] 1982 Dollars
[d] (1982 dollars) - Years of completion of capital improvements program varies by jurisdiction; does not include water and sewer

2.4.4 Spent Shale Disposal Sites

Comparisons were made of spent shale disposal at the Mesa Valley Fill site on Clear Creek mesa versus disposal at the four alternate sites in the Grand Valley adjacent to Big Salt Wash and Munger Creek. Numerical impact ratings are given in Table 2.4-4. Various related project facilities in combination with the disposal areas were not considered; only the disposal sites themselves were compared for environmental impacts. The reader should note that the Mesa Valley Fill site is applicable to all major project configurations except FII-50, while the Grand Valley (Fruita) sites are applicable only to FII-50 (retorting and upgrading at the Fruita site at 50,000 bpd). Therefore, the comparisons address partial environmental impacts of major project configurations rather than presenting discrete choices (e.g., Mesa Valley Fill vs. Dry Gulch). Table 2.4-5 presents descriptions of the Grand Valley spent shale disposal sites. The following assumptions were used in impact analysis.

Mesa Valley Fill

- The amount of spent shale fill would be approximately 604 million cubic yards for 100,000 bpd; 900 million cubic yards for 50,000 bpd.
- Shale would be placed by conveyor and/or truck.
- Fill would be placed in benches.
- Topsoil and other suitable cover material would be removed before placement of shale.
- Spent shale would be encapsulated by impermeable layers of compacted shale.
- A capillary barrier and suitable cover material (e.g., topsoil) would be placed on the shale pile. Revegetation of the shale pile would occur.

Grand Valley Sites

- All sites would be feasible for the approximately 900 million cubic yards generated by the FII-50 configuration.
- Shale would be transported by conveyor.
- Remaining assumptions are the same as for Mesa Valley Fill.

Table 2.4-4 IMPACT COMPARISONS FOR SPENT SHALE DISPOSAL SITE ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

Discipline[b]	Mesa Valley Fill[c]	Stove Buniger[d] Canyon	Dry Gulch[d]	Garvey Canyon[d]	Munger Creek[d]
Air Quality	−0.5	−0.5	−0.5	−0.5	−0.5
Noise	−0.5	−0.5	−0.5	−0.5	−0.5
Surface Water	−1.0	−1.5	−1.3	−1.6	−1.4
Ground Water	−1.0	−0.5	−0.5	−0.5	−0.5
Topography	−0.4	−0.3	−0.5	−0.2	−0.2
Geology	−1.2	−0.5	−0.6	−0.4	−0.5
Paleontology	−0.5	−0.5	−0.6	−0.4	−0.5
Soils	+0.2	+1.8	+1.9	+1.7	+1.7
Aquatic Ecology	−1.0	−1.5	−1.3	−1.4	−1.3
Vegetation	−1.0	−1.5	−1.6	−1.2	−1.4
Wildlife	−1.6	−2.0	−1.8	−1.8	−1.7
Visual Resources	−1.1	−1.1	−1.3	−1.0	−0.9
Cultural Resources	−0.3	−0.2	−0.2	−0.2	−0.2
Land Use	−0.2	−0.2	−0.3	−0.1	−0.1
Energy	−0.4	−0.3	−0.2	−0.4	−0.5
Transportation	−0.2	−0.2	−0.2	−0.2	−0.2

[a] Impact rating system: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = No Impact; +1.0 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.
[b] Impact assessments for applicable disciplines only.
[c] Applicable alternatives: All except F11-50.
[d] Applicable alternative: F11-50.

Table 2.4-5 DESCRIPTIONS OF GRAND VALLEY SPENT SHALE DISPOSAL SITES

	Area (acres)	Capacity (10^6 cu yd)	Elevation To Plant (feet)	Distance To Fruita Plant Site (miles)	Topsoil Required (10^6 cu yd)
Dry Gulch	3,021	915	250	1.4	24.4
Garvey Canyon	1,900	903	900	3.4	15.3
Stove/Buniger Canyons	2,741	1,300	1,100	2.7	22.1
Munger Creek	2,085	1,125	1,100	6.3	16.8

Source: Chevron (1982cc).

Air Quality

The spent shale disposal sites would have approximately equal, low adverse impacts to the total suspended particulates at locations of overall maximum impact. The site location would not have differing impacts on air quality as long as sufficient property is acquired.

Noise

Noise levels and time intervals are not dependent on location. Therefore, all sites would cause the same low adverse impacts.

Surface Water

Surface water impacts of spent shale disposal on the Clear Creek mesa would include stream flow disruption and watershed disturbance of Clear Creek. However, water quality impacts would be minimized because the sedimentation reservoir would collect surface runoff from the spent shale pile and settle the suspended solids. The Grand Valley disposal sites could impact stream flows and water quality. The four Grand Valley sites would all have low to medium adverse impacts. In addition to these impacts, water requirements for spent shale moistening could be higher at the Grand Valley sites due to the higher evaporation rate (resulting from higher air temperature) than at the Clear Creek mesa disposal site.

Ground Water

Ground water impacts of spent shale disposal at the Mesa Valley Fill site would include potential disruption of the existing Clear Creek alluvial aquifer system, potential ground water quality degradation due to leachate, and spring discharge/recharge removal. Adverse impacts of the Grand Valley spent shale disposal sites would be lower than the Mesa Valley Fill site since there are no alluvial aquifers in the canyons. Potential leachate may enter into the Big Salt Wash alluvial system causing water quality degradation. However, it is assumed that leachate would be effectively controlled at both sites by disposal and design practices.

Topography

Some topographic impacts would be associated with spent shale disposal in Grand Valley and the Mesa Valley Fill sites. Construction of ancillary roads would probably be necessary for access to these valleys. Disposal would fill at least portions of the valleys and could favorably impact reclamation and possible future land uses. Impact differences are minor and all are low adverse.

Geology

Spent shale disposal at the Grand Valley sites would potentially impact future use of alluvial aggregate resources. Aggregate may be used during construction or removed to facilitate placement of spent shale on more impermeable strata. The aggregate in these valleys does not presently represent a major resource because of the distance to Fruita. Better resources may be located in larger valley bottom areas closer to the population centers. The Mesa Valley Fill area would be located over the proposed underground mine. Since some subsidence is possible, a higher adverse impact could result at this site.

Paleontology

Disposal in the Grand Valley and the Mesa Valley Fill sites may impact potential fossil collection sites. The disposal of waste represents an irretrievable use of the land and any fossil beds beneath these materials would be totally inaccessible under normal circumstances. Adverse impacts for all sites are minor and low adverse.

Soils

Impacts to the soil resource in the spent shale disposal areas would probably be beneficial at all potential sites, assuming runoff and erosion from the disposal piles is controlled as outlined in the reclamation plan. Soil loss due to erosion should be less than undisturbed erosion losses, especially in the Stove/Buniger Canyon area and the other Grand Valley sites, where current soil loss is excessive because of steep slopes, sparse vegetation, and relatively little organic matter. No farmland would be covered by spent shale at any of the locations.

Aquatic Ecology

Assuming appropriate construction practices and zero discharge, potential impacts to aquatic ecology would be low to medium adverse and would be limited to the possible failure of the integrity of the spent shale pile. The Grand Valley disposal sites have a greater potential for impacts if such a failure should occur because of their proximity to the Colorado River. In contrast, the Mesa Valley Fill area would be more distant from the Colorado River, hence decreasing potential impacts.

Vegetation

Disposal of spent shale in Dry Culch, Garvey Canyon, Munger Creek, and Stove/Buniger canyons would affect from 1,900 to 3,000 acres of vegetation. The greatest amount of land would be affected by the Dry Gulch alternative (3,000 acres); the least by the Garvey Canyon alternative (1,900 acres). The revegetation potential of the Dry Gulch, Garvey Canyon, Munger Creek and Stove/Buniger canyons is lower than the revegetation potential of the Mesa Valley Fill area. Further, the Mesa Valley Fill would only affect approximately 1,600 acres. Vegetation productivity impacted by the various alternatives would be similar. Site-specific data concerning threatened or endangered plant species in Stove/Buniger canyons, Dry Gulch, Garvey Canyon and Munger Creek are not available; however, impacts to these species could be avoided by pre-construction searches.

Wildlife

The Mesa Valley Fill alternative would result in loss of mule deer and elk spring transitional habitat and loss of riparian habitat along Clear Creek. Shale disposal in the Stove/Buniger canyons area would also impact riparian habitat in Big Salt Wash and would result in loss of raptor foraging and nesting habitats. In addition, some critical winter range for mule deer would be lost as a result of the Stove/Buniger canyons spent shale disposal alternative. Both the Garvey Canyon and Dry Gulch alternative shale disposal sites would affect critical winter range for mule deer and active golden eagle and prairie falcon nest sites. Baseline wildlife habitat information concerning critical winter range and nest sites for the Munger Creek and Stove/Buniger canyons sites was not available for comparison purposes; however, available data suggest that impacts would likely be similar to those for Garvey Canyon. All impacts are rated low to medium adverse.

Visual Resources

Disposal of spent shale within Stove/Buniger, Garvey Canyon, Munger Creek, Dry Gulch, or the Mesa Valley Fill site would introduce visual form and color impacts. The canyons are narrow, steep, and v-shaped in form. Disposal of spent shale would reduce the vertical relief of side walls of the canyons and make the canyons u-shaped. Prior to reclamation, the grayish color of the spent shale would contrast with the brown and greens of the existing landscape. For the Clear Creek mesa, Stove/Buniger canyons and Garvey Canyon sites, fill activities would not affect views from an established activity center. The Dry Gulch site would be visible from the Grand Valley area, while the Munger Creek site might be visible from the Douglas Pass road. All impacts are rated low adverse, and impact differences are minor.

Cultural Resources

All sites would potentially have very low adverse impacts. Spent shale disposal in the Mesa Valley Fill area could affect cultural resource sites which are potentially eligible for the National Register of Historic Places. In the

Grand Valley area, literature survey data suggest that potentially eligible cultural sites could be encountered as well, given some identified sites and the use of the area as a migration route. However, exposure to the elements and distance from water on both Clear Creek mesa and at the Grand Valley spent shale sites suggest that neither were important cultural resources areas. The required preconstruction field surveys and necessary mitigation of significant sites would eliminate most adverse impacts.

Land Use

There would be very low adverse impact on land uses within and adjacent to the plant site from spent shale disposal at the Mesa Valley Fill site. Similarly, disposal of spent shale at Dry Gulch, Garvey Canyon, Munger Creek, and Stove/Buniger canyons would be considered a low adverse impact. The proposed Mesa Valley Fill would affect the least amount of land. The Dry Gulch alternative spent shale disposal site would potentially impact the greatest amount of land. No existing cropland would be affected by any of the spent shale disposal alternatives.

Energy

Disposal of spent shale in the adjacent sites (Mesa Valley Fill when retorting on Clear Creek mesa, and Grand Valley sites when retorting under Fruita II), would result in minimal energy consumption because of the proximity of sites to the retorts. The furthest site in the Grand Valley (Munger Creek) would have higher adverse energy impacts than the closest site (Dry Gulch). The Mesa Valley Fill would likely be the most energy efficient (in terms of unit volume moved) of all sites considered.

Transportation

Spent shale disposal in the Grand Valley sites should have minimal impact to transportation networks, as would disposal in the Mesa Valley Fill. Private roads or conveyors would probably be used. The shale transfer system, as proposed under the Fruita II alternative, would be necessary to transport raw shale and would probably be a private railroad. Transportation impacts as a result of secondary use connected with spent shale disposal would therefore be very low adverse and fairly equal.

2.4.5 Access Road Corridors

The following road corridors were considered for impact analysis.

- Roan Creek Road (applicable to all alternatives PA-100, PA-50, CC-100, CC-50, FI-100, FI-50, FII-50)
- Big Salt Wash Road - Echo Lake Route (PA-100, PA-50, FI-100, FI-50, FII-50)
- Fruita to plant site - 16 Road (FI-100, FI-50, FII-50)
- Douglas Pass Road (FI-100, FI-50, FII-50)

Summary impact comparisons, by discipline, for each of these roads follow. Numerical impact ratings are given in Table 2.4-6.

Air Quality

Air quality impacts due to the road corridors were assessed as low adverse. Impact differences for road corridors would depend on the number of automobile miles, medium truck or bus miles, and heavy truck miles traveled per day. The Roan Creek Road would show the highest relative adverse impacts due to the heavy volume of project-related traffic, particularly under the 100,000-bpd production rate. The route from 16 Road to the Fruita upgrading facility would also handle a high traffic volume for plant activities depending on the configuration. The Douglas Pass Road and Big Salt Wash - Echo Lake Routes would show similar impacts as 16 Road.

Table 2.4-6 IMPACT COMPARISONS OF ACCESS ROAD CORRIDOR ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

Discipline[b]	Roan Creek Road[c]	Big Salt Wash-[d] Echo Lake Route	Fruita to Plant[e] Site-16 Road	Douglas Pass Road[e]
Air Quality	−1.0	−0.6	−0.6	−0.6
Noise	−2.5	−0.1	−0.4	−0.5
Surface Water	−1.0	−1.5	−0.8	−0.9
Ground Water	−0.3	−0.2	−0.2	−0.1
Topography	−0.5	−0.8	−0.1	−0.1
Geology	−0.8	−0.7	−0.3	−0.3
Paleontology	−0.3	−0.5	−0.2	−0.1
Soils	−1.0	−1.9	−1.8	−1.2
Aquatic Ecology	−1.8	−0.8	−0.5	−0.6
Vegetation	−2.0	−1.0	−1.0	−1.0
Wildlife	−1.9	−1.3	−1.5	−1.5
Visual Resources	−0.7	−0.7	−0.1	−0.1
Cultural Resources	−0.2	−0.3	−0.1	−0.1
Land Use	−0.2	−0.2	−0.1	−0.1
Recreation	+0.2	+0.3	+0.1	+0.2
Energy	−0.6	−0.8	−0.4	−0.3
Transportation	+2.1	+2.0	+1.0	+1.5

[a] Construction, operation, and residual impact ratings were summed and averaged using the following weights: construction 20%, operation 60%, and residual 20%. For residuals impacts, it was assumed that roads would remain and be used for other purposes. Impact Rating System: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = Low Impact; +1 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.

[b] Only applicable disciplines for impact analysis are shown.

[c] Applicable alternatives: All 50, 100.

[d] Applicable alternatives: All except CC-50, -100.

[e] Applicable alternatives: FI 50, 100; FII-50.

Noise

Noise-related impacts due to the use of the four road corridors should be minimal except along Roan Creek Road. Variations of impacts are based on the length of the corridor and existing populations (noise receptors) affected. The Roan Creek Road would, however, experience medium to high adverse impacts due to the volume of heavy trucks or buses (approximately 450 per day worst-case). This level of traffic would result under the PA-100 and CC-100 configurations only. FI-100 would divide these noise impacts between Roan Creek Road and the corridor to the Fruita plant site. The other roads would experience only typical project-related traffic and subsequent noise and, hence, low adverse impacts.

Surface Water

Surface water impacts of access road corridors are generally dependent on the drainage areas and the number and types of stream channels disturbed, especially during construction. The Roan Creek corridor would cause watershed and stream flow disruption on Roan Creek. The Big Salt Wash corridor would have the highest adverse impact due to the longer length of the corridor. The remaining routes (16 Road, Douglas Pass) would have lower adverse impacts due to their relatively shorter length and construction along existing corridors. Impacts to the surface waters of the area would not differ significantly between the two production rates; all are considered low adverse.

Ground Water

Of the four road corridor alternatives, the Roan Creek alignment is considered the most sensitive due to its proximity to Roan and Clear creeks. However, given the nature of the anticipated traffic and haulage, the impacts would be low adverse. The greatest potential impact would be uncontrolled spills or leaks from the transport of potentially hazardous or contaminating materials.

Topography

Potential topographic impacts associated with the various road corridors were assigned on the basis of length and location. Very low adverse impacts are associated with the possible improvements to Douglas Pass Road and 16 Road. Roan Creek Road would have somewhat higher (low adverse) impacts because it is aligned in a relatively accessible valley at the base of the mesa, where topographic changes during construction would be more pronounced. A similar level of topographic disturbance would be associated with the construction of the Big Salt Wash Road because of its length and proposed alignment. It would have the highest (low adverse) impacts.

Geology

Impacts to the geological resources of the area would be primarily due to limitations to resource extraction (e.g. because of road construction and paving). Of the four road corridor alternatives, Roan Creek Road would have a higher low adverse impact on the existing geologic environment, as would the Big Salt Wash Road. Low adverse impacts are associated with the Douglas Pass Road and 16 Road routes.

Paleontology

The highest (low adverse) impacts to paleontological resources would occur with the Big Salt Wash Road. The Roan Creek Road corridor alignment would have low adverse impacts compared to Big Salt Wash Road due to the shorter length and differing geologic strata encountered along its proposed route. The proposed improvements to the existing Douglas Pass Road and 16 Road should have the least potential (low adverse) for impacting paleontological resources.

Soils

Potential impacts to soils vary widely among the road corridors. The Roan Creek corridor would not affect any prime farmland and would result in relatively insignificant incremental soil losses. The impacts are considered to be low adverse. The Big Salt Wash and 16 Road corridors would potentially disrupt up to 200 acres of prime farmland. The Douglas Pass corridor would potentially affect prime farmlands but would also have only low adverse impacts, due to the presently established road. Although new roads would cover existing soils, resultant cut-and-fill slopes would have significantly greater erosion rates because of steep slopes.

Aquatic Ecology

Potential impacts to aquatic biota as a result of the construction and operation of roads were determined on the basis of number of stream crossings and proximity to surface water. Impact mechanisms considered sedimentation during construction, airborne loss of materials from haulage vehicles, removal of riparian habitats, runoff of chemical road treatments, and spills from accidents. The Roan Creek corridor would have low to medium adverse impacts due to its proximity to Roan Creek. The Big Salt Wash corridor would have low adverse impacts. The Douglas Pass and 16 Road corridors would also have relatively low adverse impacts to the aquatic resources of the region.

Vegetation

Construction of roads would have residual low adverse impacts on vegetation and productivity. Corridors in the Roan Creek and Grand Valley areas would affect irrigated agricultural land and would remove valuable acreage from production. Corridors in the Roan Creek drainage include populations of threatened plant species and other sensitive plants. Impacts to populations of such species may not be avoidable within the Roan Creek corridor. Based on this assessment the impacts to vegetation in the Roan Creek Road corridor would be medium adverse. The impacts of the other three corridors would not be significant and are rated low adverse.

Wildlife

Construction, upgrading, and use of any of the four road corridors would have low to medium adverse impacts on the wildlife of the region. The Roan Creek Road transects critical range for mule deer and elk. The traffic on this road would restrict big game movements during the winter. Therefore, this route would have the highest (medium adverse) impact of the four roads considered. The impacts from the remaining three roads would be proportional to the relative length of each corridor, the sensitivity of wildlife habitats transected, and schedules of project traffic. The 16 Road would have low adverse impacts. The Big Salt Wash Road and the Douglas Pass Road would have relatively greater adverse impacts. These two latter roads would, however, have less impact than the Roan Creek Road.

Visual Resources

None of the road corridors would create a significant impact on visual resources in the area. The Roan Creek and Big Salt Wash corridors would have a higher impact potential due to the need for new road construction. All impacts are considered to be low adverse.

Cultural Resources

All roads show low adverse impacts based upon length and the potential for encountering cultural resources sites which are eligible for the National Register of Historic Places. Impacts would be mitigated prior to construction for all eligible sites on public lands. The Big Salt Wash corridor traverses portions of a prehistoric migration route, and could encounter significant cultural resources sites.

Land Use

Low minor adverse impacts on land use would result from development of all road corridors. Lands which are now open space would become industrial corridors. Impacts would vary according to length of the corridor and current land uses. The Roan Creek corridor, which is proposed for all configurations, would potentially affect the greatest acreage, and hence have the relatively highest (low adverse) impact. The Big Salt Wash corridor would have impacts of similar magnitude. The remaining two routes would have lesser, very low adverse impacts on land use.

Recreation

The recreational impacts of roads were assessed as low beneficial for all corridor alternatives. The assessments were made according to length and potential vehicle access to previously inaccessible areas.

The Big Salt Wash corridor would have a higher (relative) beneficial impact. The other roads would have low beneficial impacts to the recreational resources of the region. All positive impacts would be negated if portions of the roads were restricted for travel by the Operator. If this were to occur, impacts on recreation would be neither positive nor negative.

Energy

Energy use impacts are considered low adverse, depending on relative length and difficulty of terrain of the roads considered. The Big Salt Wash corridor is the longest and, hence, would have the highest (relative) adverse impacts on energy use. The Roan Creek Road would have similar but somewhat lower adverse impacts. The 16 Road and the Douglas Pass Road corridors would have lower adverse impacts to energy use since they are relatively short and on flatter terrain.

Transportation

The development of any of these roads for the CCSOP would result in an improved road access system for the region. All four corridors do, therefore, have high beneficial impacts. The Roan Creek and Big Salt Wash roads would have medium beneficial impacts, since significant improvements to existing roads would be necessary. The remaining two roads would have low to medium beneficial impacts.

2.4.6 Water Supply and Diversion Point Alternatives

The impacts of the following water supply and diversion points were evaluated.

- Water Supply
  - Alluvial wells - Clear Creek mesa
  - Mesa collection system
- Diversion Points
  - Colorado River at De Beque
  - Colorado River at Loma
  - Colorado River at Parachute

The water supply system, including Clear Creek mesa alluvial wells and the mesa collection system, would be implemented under any major project configuration. Diversion points on the Colorado River at De Beque and at Parachute would be applicable (singly or in combination) under any configuration as well. The diversion on the Colorado River at Loma would not be implemented under CC-100 or CC-50. Table 2.4-7 presents impact comparisons for the water supply and diversion point alternatives. Only applicable disaplines are discussed below.

Surface Water

The impacts of water supply systems could reduce stream flow and affect downstream water uses. The mesa collection system would divert surface water and would therefore have greater immediate impacts on the stream flows than the alluvial well system, the depletions from which might not be evident for years.

Surface water impacts at various diversion points would depend on the quantity of water diverted. Diversion of the Colorado River at De Beque and Parachute would have higher adverse impacts than the diversion at Loma because of the relatively higher flow diversion rate at De Beque.

Ground Water

Of the proposed water supplies, the highest adverse impacts to ground water would be anticipated from the alluvial well system on Clear Creek mesa. Local water level decline, removal of ground water from storage, and other effects are possible during periods of significant pumpage. A lower degree of impact would be anticipated from the proposed mesa collection system, as this system would rely primarily on retention reservoirs to capture surface runoff. A potential impact associated with this system would include reduced downstream recharge to local ground water resources due to retention of surface runoff. The potential offsetting effects of localized recharge due to infiltration at the proposed reservoir sites in the Roan Creek valley are unknown, but may be beneficial for alluvial ground water resources.

Minor ground water impacts would be anticipated for any of the proposed Colorado River diversion schemes. Increases in downstream salinity resulting from diversions may similarly affect the alluvial ground water quality along the Colorado River as a result of recharge from river water of increased salinity. There may be slight beneficial or adverse impacts associated with localized recharge to alluvial aquifers at proposed storage reservoirs in the Roan Creek valley and the Big Salt Wash, depending on the relative quality of local alluvial ground water and the quality of diverted Colorado River water stored in the impoundment. The magnitude of potential impacts is primarily a function of the amount of water diverted from the Colorado River. The largest diversion amounts are proposed for the De Beque and Parachute sites; thus slightly higher adverse impacts would be anticipated.

Table 2.4-7 IMPACT COMPARISONS FOR WATER SUPPLY AND DIVERSION POINT ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

	Water Supply		Diversion Points		
Discipline[b]	Alluvial Wells-[c] Clear Creek Mesa	Mesa[c] Collection System	Colorado River[c] at De Beque	Colorado River[c] at Parachute	Colorado River[d] at Loma
Surface Water	−0.5	−1.0	−1.5	−1.5	−1.0
Ground Water	−1.5	−1.0	−0.3	−0.3	−0.2
Aquatic Ecology	−1.0	−0.2	−2.5	−1.5	−1.5

[a] Construction, operation, and residual impact ratings were summed and averaged using the following weights: construction 30%, operation 60%, and residual 10%.
Impact Rating System: −3.0 = High Negative; −2.0 = Medium Negative; −1.0 = Low Negative; 0 = No Impact; +1.0 = Low Positive; +2.0 = Medium Positive; +3.0 = High Positive.
[b] Only applicable disciplines for impact comparison are shown.
[c] Applicable alternatives: All 50, 100.
[d] Applicable alternatives: All except CC-50, -100.

Aquatic Ecology

A well field located on the mesa would have a very low adverse impact on aquatic biota, only to the extent that springs and seeps supplied by the affected aquifers are reduced in flow. The plan for pumping water from the alluvium would likely have more substantial effects on flows in Clear and Roan creeks.

Substantial impacts to aquatic biota would be anticipated from operation of the diversion at De Beque. A maximum monthly average of up to 32 percent of the Colorado River could be diverted at this point. A weir (dam) planned as part of the intake design may serve to attract fish to the diversion location. Maximum diversions could be made at any time, including the winter, when fish swimming ability is impaired. These factors, in combination with a water withdrawal velocity and diversion design which does not mitigate potential losses of aquatic biota, suggest that up to 32 percent of the aquatic organisms in the vicinity of the diversion could be lost.

The proposed intake at Loma is of an environmentally preferred design. Flow rates to be diverted would also be substantially less than at De Beque. However, the location would be particularly sensitive because of the presence of protected fish species. Potential impacts of the Parachute diversion would be similar to that of the De Beque site.

2.4.7 Reservoirs

The following reservoir alternatives were identified for detailed study.

- Roan Creek sites
  - Lower Dry Fork
  - Upper Dry Fork
  - Lower Conn Creek
  - Upper Conn Creek

- Big Salt Wash (Garvey Gulch)

- Parachute Creek

Impacts of the four Roan Creek reservoirs do not differ significantly because of their similar environmental setting. The alternative Roan Creek sites presented in Table 2.4-8 show relatively high negative impacts for most disciplines because of flood hazards, occurrence of threatened and endangered plant species, inundation of wildlife habitat, and surface water quality. Impacts were compared for applicable disciplines.

Surface Water

Surface water impacts would include flood hazards, areas of inundation, and potential water quality degradation. Four of the reservoir sites are located in the Roan Creek valley upstream of the town of De Beque; all pose potential flood hazards to this community. Surface water impacts, as discussed in Section 4.4.1, would be similar for the four reservoir sites. However, the Lower Dry Fork reservoir site would inundate part of the existing channel of Dry Fork and is closest to De Beque. The Upper Conn Creek sites would inundate Conn Creek but pose a lower flood hazard due to the proposed lower dam heights. Impacts to Roan Creek would be eliminated under the Parachute Creek reservoir alternative. However, impacts in the Parachute Creek valley, such as erosion, sedimentation, and increased runoff, could result from pipeline construction in Garden Gulch and on the Roan Plateau; therefore, similar but somewhat lesser impacts would be anticipated. All these impacts would be low to medium adverse. The Garvey Gulch reservoir location poses the lowest level of adverse flood-related impacts of the alternatives considered.

Ground Water

Beneficial and adverse impacts to ground water would be likely for the various reservoir alternatives. Construction and operation of the proposed impoundments would, in some cases, deplete or impinge on downstream flows and could reduce recharge to alluvial or other ground water units. This loss in downstream recharge may be offset by some localized recharge by infiltration into the underlying alluvial aquifer from the reservoir itself. All reservoirs considered would probably have little or no net impact to the ground water resources of the area.

Topography

Reservoir construction would alter local topographic conditions. Acquisition of borrow material may necessitate construction of haul roads ancillary to those required for dam construction. The construction of embankments at the various proposed reservoir locations would alter existing topography on a localized basis. The impacts would be determined by the relative size and location of the reservoirs. In the Roan Creek valley, the Lower Dry Fork reservoir has the most potential for impact; the Upper Conn Creek the least. Other Roan Creek alternatives would be similar, with low adverse impacts. The Big Salt Wash reservoir would have low adverse impacts due to the smaller size of the reservoir. The Parachute Creek reservoir would have impacts similar to the Big Salt Wash reservoir. In all cases impacts would be low to moderate adverse.

Geology

The impacts on geological resources were determined based on reservoir location, proposed construction, possible borrow material sources, land disturbances, potential for aggregate resources beneath the proposed impounded water bodies, and construction of the zoned earth-fill dams. In addition, inundation of the areas would permanently restrict extraction of resources from the reservoir area. All alternatives generally show similar, slightly adverse impacts.

Paleontology

The construction of any of the reservoir alternatives would cause inundation and loss of potential paleontological resources. The impacts of all reservoir sites are essentially equal and slightly adverse.

Table 2.4-8 IMPACT COMPARISONS FOR RESERVOIR SITE ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

Discipline[b]	Big Salt Wash[c] (Garvey Gulch)	Upper Dry Fork[d]	Lower Dry Fork[d]	Upper Conn Creek[d]	Lower Conn Creek[d]	Parachute Creek[d]
Surface Water	−0.5	−1.5	−2.0	−1.8	−1.9	−1.2
Ground Water	-0-	-0-	-0-	-0-	-0-	-0-
Topography	−0.7	−1.0	−1.2	−0.8	−1.0	−0.7
Geology	−0.5	−0.8	−0.9	−0.7	−0.6	−0.5
Paleontology	−0.5	−0.5	−0.5	−0.5	−0.5	−0.5
Soils	−0.8	−1.7	−2.0	−1.9	−1.8	−0.7
Aquatic Ecology	−0.5	−1.2	−1.3	−1.5	−1.4	−1.5
Vegetation	−0.5	−3.0	−2.0	−2.9	−2.9	−1.0
Wildlife	−2.2	−2.1	−1.4	−1.6	−1.5	−1.8
Visual Resources	−0.7	−0.9	−1.0	−0.8	−0.8	−0.7
Cultural Resources	−0.5	−0.4	−0.4	−0.4	−0.4	−0.3
Land Use	+0.4	+0.4	+0.5	+0.2	+0.3	+0.4

[a] Construction, operation, and residual impact ratings were summed and averaged using the following weights: construction 40%, operation 30%, and residual 30%, considering both negative and positive environmental impacts. For residual impacts, it was assumed the reservoir(s) would remain following project shutdown and be used for various purposes (e.g., recreation and water supply). Impact Rating System: −3.0 = High Negative; −2.0 = Medium Negative; −1.0 = Low Negative; −0 = No Impact; +1.0 = Low Positive; +2.0 = Medium Positive; +3.0 = High Positive.

[b] Only applicable disciplines for impact comparison are shown.

[c] Applicable alternatives: All except CC-50, -100.

[d] Applicable alternatives: All 50, 100.

Soils

The principal impact to soils from construction and operation of the proposed reservoirs would be short-term incremental soil loss. Some farmland would be inundated. The greatest soil losses from erosion would occur at the Lower Dry Fork reservoir. The lowest soil losses due to accelerated erosion would occur at the Parachute Creek reservoir. Residual soil loss is generally nonexistent at reservoirs except on steep embankment areas. Soil loss from strongly sloping areas roughly approximates undisturbed erosion losses of the entire reservoir area; hence, no additional impact is expected. The Lower Dry Fork reservoir impacts would be moderately adverse and the Upper Dry Fork impacts would be relatively less adverse (low to moderate). Upper Dry Fork would have the least adverse effects of the Roan Creek reservoirs. The Big Salt Wash and Parachute Creek reservoirs would both have a low adverse impact to soils.

Aquatic Ecology

Impacts to aquatic biota were determined based on the potential length of stream inundated and the presence or absence of trout in the affected streams. These factors generally favored reservoirs constructed further downstream, hence the Upper Conn Creek and Lower Conn Creek would have the highest relative impacts (low to moderate adverse). The Upper Dry Fork location is likely to have the least relative impacts to aquatic biota. Based on regional data and assuming no uncontrolled spills of contaminants, the Big Salt Wash reservoir would have very low adverse impacts. The Parachute Creek reservoir would have potential impacts similar to the Roan Creek reservoirs.

Vegetation

The Roan Creek reservoir alternatives would have similar impacts to vegetation acreage and productivity. The Lower Dry Fork alternative would pose the lowest relative level of potential adverse impacts to populations of candidate and listed threatened and endangered plant species. The Upper and Lower Conn Creek alternatives would have slightly lower adverse impacts to such populations compared to the Upper Dry Fork site. All of these impacts are rated moderate to high adverse because of the threatened and endangered species present. The acreage and productivity potentially affected by the Parachute Creek reservoir are essentially the same as for the Roan Creek reservoir alternatives. The Big Salt Wash reservoir would affect only 10 percent of the acreage and 2 percent of the productivity affected by all other reservoir alternatives. No known populations of candidate and listed threatened and endangered plant species would be affected by the Parachute Creek and Big Salt Wash reservoirs; hence, the only low adverse impacts to vegetation are shown for these reservoir sites.

Wildlife

All reservoir sites under consideration involve critical mule deer winter range and habitat for other game and nongame species. Of the sites considered, inundation of the Lower Dry Fork site would result in the loss of the least amount of habitat. This loss would be proportionately greater for other Roan Creek reservoir sites, the Upper Dry Fork having the most affected area and the Lower Conn Creek the least. Inundation in the Big Salt Wash reservoir area would affect nesting raptors (golden eagles and prairie falcons) through reduction in prey availablility close to existing nest sites. Impacts would also occur through construction-related activities, which would result in noise and increased human activity in the area during the nesting season. Impacts due to the Parachute Creek reservoir would be low to moderate adverse and similar to the impacts of the Roan Creek reservoirs.

Visual Resources

Potential visual resource impacts which could result from reservoir construction and operation were evaluated based on the location and relative sensitivity of each alternative site. Although reservoirs can have a beneficial impact on overall scenic quality, it was assumed that fluctuating water levels would inhibit riparian vegetation and that drawdown would expose the banks and bottom of the reservoir. Thus, impacts due to the reservoir operation were generally considered low adverse. The Lower Dry Fork site was ated slightly higher (relatively) in adverse impacts, due to its proximity to the De Beque/I-70 area. The remaining Roan Creek reservoir sites were rated based on their distance from the De Beque/I-70 area. The Big Salt Wash site received the lowest adverse impact rating due to its remote location. The Parachute Creek reservoir was rated low adverse due to its distance from the Parachute/I-70 area.

Cultural Resources

All reservoir sites in the Roan Creek valley would have similar slightly adverse impacts to cultural resources. Mitigation of impacts to potentially important archaeological and historic sites would probably pose only minor problems during construction. All Roan Creek sites are therefore rated the same, given the thirteen eligible or potentially eligible (as deemed by the researchers) sites in the vicinity. The Big Salt Wash site might pose slightly higher adverse impacts due to its proximity to the Ute Trail; however, the potential difference in magnitude of impact is judged to be negligible. Potential cultural resource impacts should not be a significant constraint in reservoir siting. Regional data for the Parachute Creek site, although somewhat dated (BLM 1975), suggests similar and perhaps lesser chances for cultural resources sites of significance to be encountered in the Parachute Creek corridor.

Land Use

There would be a slight beneficial impact on land use values from development of any of the alternative reservoir sites. Differences among alternatives and actions would be slight. No prime farmland would be affected by any of the reservoirs. Development of reservoirs may create opportunities for more diverse land uses within the regional setting.

2.4.8 Railroad Corridors

The railroad corridors selected for detailed evaluation and their applicable major project configurations are:

- The Denver and Rio Grande Western (D&RGW) Spur at De Beque (All: 50, 100)
- The Denver and Rio Grande Western at De Beque to Clear Creek Property route (All: 50, 100)
- Route B - 16 Road route (FI-50, FI-100, FII-50)
- Route C - Dorchester Coal Company route (FI-50, FI-100, FII-50)
- Douglas Pass Road (SH 139) route (FI-50, FI-100, FII-50)
- Straight Line Tunnel route (Shale transport for FII-50 only)
- Roan Creek Tunnel route (Shale transport for FII-50 only)

The relative magnitude of potential impacts from each of these seven alternative routes are presented in Table 2.4-9 and discussed by discipline below.

Air Quality

Potential air quality impacts of all the alternative railroad corridors were assessed as low adverse. Differences in the magnitude of potential railroad corridor impacts would be directly influenced by the number of railroad miles which would be traveled per day. For all configurations, the De Beque spur would have the least adverse impact. The other railroad corridors, with the exception of the Roan Creek and Straight Line Tunnel routes, would have approximately the same (low adverse) impact. The Straight Line and Roan Creek tunnel routes would have the most railroad miles traveled per day, and thus would have the relative highest (low adverse) impacts.

Table 2.4-9 IMPACT COMPARISONS OF RAILROAD CORRIDOR ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

Discipline[b]	D&RGW Spur[c] at De Beque	D&RGW at[c] De Beque to Clear Creek Property	16 Road[d]	Dorchester[d] Route	Douglas[d] Pass Road Corridor	Straight Line[e] Tunnel Route	Roan Creek[e] Tunnel Route
Air Quality	−0.1	−0.5	−0.5	−0.5	−0.5	−1.0	−1.0
Noise	−0.2	−0.5	−0.8	−0.5	−0.7	−1.8	−2.0
Surface Water	−0.2	−1.2	−0.7	−0.5	−1.0	−2.0	−1.7
Ground Water	−0.1	−0.8	−0.3	−0.3	−0.3	−0.8	−0.5
Topography	−0.2	−0.8	−0.1	−0.2	−0.1	−1.0	−0.8
Geology	−0.4	−0.8	−0.2	−0.3	−0.3	−0.5	−0.6
Paleontology	−0.2	−0.3	−0.1	−0.2	−0.2	−0.7	−0.4
Soils	−0.1	−0.7	−1.1	−1.0	−1.0	−0.9	−1.0
Aquatic Ecology	−0.1	−1.5	−0.8	−0.9	−0.5	−1.0	−1.3
Vegetation	−0.5	−2.0	−1.0	−1.0	−1.0	−0.8	−0.5
Wildlife	−1.1	−2.0	−1.2	−1.6	−1.5	−1.4	−1.9
Visual Resources	−0.5	−1.1	−0.2	−0.6	−0.2	−1.3	−1.0
Cultural Resources	−0.1	−0.2	−0.1	−0.1	−0.1	−0.4	−0.4
Land Use	−0.2	−0.4	−0.1	−0.2	−0.2	−0.3	−0.3
Energy	−0.1	−1.4	−0.5	−0.8	−0.7	−1.7	−1.6
Transportation	−0.3	−0.3	−0.3	−0.3	−0.3	−0.1	−0.1

[a] Construction, operation, and residual impact ratings were summed and averaged using the following weights: construction 20%, operation 60%, and residual 20%. For residuals impacts, it was assumed that railroads would be decommissioned following project shutdown. Impact Rating System: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = No Impact; +1.0 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.
[b] Only applicable disciplines for impact analysis are shown.
[c] Applicable alternatives: All 50, 100.
[d] Applicable alternatives: FI-50, -100; FII-50.
[e] Applicable alternative: FII-50.

Noise

The noise impact ratings indicate that very low adverse impacts would be anticipated for all of the railroad corridors except the Straight Line and Roan Creek tunnel routes. (These two alternative railroads are applicable only to the Fruita II configuration, and would be primarily for raw shale transport.) The relatively high volume of trains which would be required per day for shale transport activities would create low to medium adverse noise impacts along these corridors.

Surface Water

Surface water impacts of railroad corridors would depend on the drainage area and the number and width of stream channels being disturbed, especially during the construction stage. The De Beque spur alternative poses the lowest potential for adverse surface water impacts. The railroad corridors for shale transport from Fruita to Clear Creek mesa (Straight Line and Roan Creek tunnel routes) pose the greatest relative (low to medium adverse) impacts. The Roan Creek corridor from De Beque to the Clear Creek property would cause watershed alterations and potential stream flow disruption in Roan Creek, which is a perennial stream. Other corridors from the Fruita plant site to various connections would have similar but lower adverse surface water impacts.

Ground Water

Ground water impacts from the various alternative railroad corridors would be low adverse. The alternative railroad alignment from De Beque to the Clear Creek property would, because of its proximity to the alluvial aquifers of Roan and Clear creeks, have a potential for ground water impacts from accidental chemical spills or leaks. The other three railroad corridors (excluding the shale transport railroads) would have similar (and low) levels of adverse impact. The spur at De Beque would have insignificant impacts on ground water.

The Straight Line Tunnel would be the most sensitive segment of the two rail alignments for transporting raw shale material and would have impacts of approximately the same magnitude as the D&RGW railroad to the Clear Creek property. There is potential for chemical spills or leaks along the Roan Creek portion of the Roan Creek Tunnel route; therefore, this route has similar, but lower adverse impacts.

Topography

Impacts to topography would be a function of corridor length and terrain conditions within the corridors. Construction of railroads in the Roan Creek valley (De Beque to Clear Creek property) and Straight Line and Roan Creek tunnel alignments would impact topography more than the remaining alternative corridors. Impacts to topography of all of the proposed railroad corridors are very low adverse.

Geology

Each of the proposed railroad corridor alternatives would have slight adverse impacts. The alignment from De Beque to Clear Creek property would be confined primarily to the valley bottoms of Roan Creek and Clear Creek, and could impact potential aggregate resource extraction. The Straight Line and Roan Creek tunnel routes show relatively higher (low adverse) impacts than the remaining alternatives, given the length and geologic conditions anticipated along each alignment. The potential for impacts along the remaining routes are considered to be very low adverse and approximately equal.

Paleontology

Impacts to paleontological resources would be slightly adverse in all corridors and vary depending on alignment, length, and location. The two tunnel routes (Straight Line and Roan Creek) would have (relatively) more potential for adverse impact than the remaining railroad corridors.

Soils

Potential impacts include disturbance of prime farmland and increases in soil erosion. These low adverse impacts to soils vary slightly among the alternative railroad corridors. Cut and fill slopes within these corridors may add to existing erosion rates due to the characteristic steepness of slopes in the region. The De Beque spur would have negligible impacts to soils. The De Beque to Clear Creek property route would not disturb prime farmland and would result in only slight increases in soil loss due to accelerated erosion. The 16 Road route would potentially disturb 200 acres of prime farmland. This route would have low to moderate impacts to the soil resources and would pose the highest relative adverse impacts of all alternative railroad routes. The other routes would pose low adverse impacts to soils based on the relative acreages of soils disturbed.

Aquatic Ecology

Impacts to aquatic biota may result during construction and operation of railroads; these were differentiated on the basis of number of stream crossings and proximity to surface water. Impacts considered were sedimentation during construction, airborne loss of materials from trucks and railroad cars, removal of riparian habitats, runoff of chemical road treatments, and spills from accidents. Longer routes crossing more streams therefore show relatively higher adverse impacts. Based on these conditions, the route from De Beque to the Clear Creek property would have low adverse impacts. The Straight Line and Roan Creek tunnel routes, the 16 Road, and Dorchester Coal routes would have relatively lower adverse impacts. The De Beque spur and Douglas Pass roads would have very low adverse impacts.

Vegetation

Construction of railroads would generally have low adverse impacts on vegetation and productivity. Corridors in the Roan Creek, Clear Creek, and Grand Valley areas would potentially affect irrigated agricultural land and would remove valuable acreage from production. Corridors in the Roan Creek drainage include populations of threatened plant species and other sensitive plant populations. The potential impacts to the vegetation resources in Roan Creek are moderately adverse. The 16 Road, Dorchester Coal route, Douglas Pass, and Straight Line Tunnel routes all show potential low adverse impacts. The Roan Creek Tunnel route and De Beque spur would have very low adverse impacts.

Wildlife

Wildlife impact assessments for railroad corridors were based generally on the relative lengths of each corridor, the sensitivity of wildlife habitats in each corridor, and the projected train schedules. All of the impacts to wildlife were rated low to moderate adverse. Of the railroad corridors under consideration, the 16 Road and Douglas Pass routes would pose the lowest adverse impacts to wildlife. These routes follow existing highways which presently receive vehicular use. The Dorchester Coal route transects areas which are not presently impacted by vehicular traffic; hence, this route has potential for relatively higher adverse impacts. The De Beque to Clear Creek property route transects approximately 1,400 acres of critical range for mule deer and 800 acres of critical winter range for elk (1,000 foot width assumed). As a result of potential impacts of this railroad on big game movements during winter, this route would result in relatively higher impacts and is least desirable of the railroad routes analyzed. Similar impacts could occur in the two tunnel route corridors. The De Beque spur would result in lower adverse impacts than any of the other routes.

Visual Resources

Railroad corridor impacts on visual resources were based on route length, visual sensitivity, and construction techniques. The De Beque to Clear Creek property and Straight Line Tunnel Route corridors would have the highest (low adverse) impacts, given cut and fill activities within Clear Creek canyon and the tunnel waste rock, fills, and bridges for the Straight Line Tunnel route. Impacts of the Roan Creek Tunnel route are potentially low adverse based on the Clear Creek canyon portion of the route. The 16 Road, Dorchester Coal, Douglas Pass routes, and the De Beque spur have the least (very low adverse) impacts.

Cultural Resources

Railroad corridors show slight adverse impacts to cultural resources. Variations are based on the length of the corridor and unsurveyed areas crossed. The Roan Creek and Straight Line tunnel routes show higher low adverse impacts due to the potential for disturbance of cultural artifacts or sites.

Land Use

Slight adverse impacts on land uses could result from development of any of the alternative railroad routes; differences among the alternatives are insignificant. Impacts would differ slightly due to length of corridor and nature of current land uses. The De Beque to Clear Creek property route, which is proposed for all major project configurations, would potentially affect the greatest acreage and, therefore, would have the most significant relative effect on land use.

Energy

Energy use impacts are low to moderate depending on length of travel and difficulty of terrain for the railroad routes under consideration. The De Beque spur would have the lowest adverse impact while the De Beque to Clear Creek property route would have the highest because of relative length and terrain. The 16 Road route would have a very low adverse impact to energy use. The Dorchester Coal and Douglas Pass routes would have relatively greater impacts than the De Beque spur and 16 Road, but less than those of the De Beque to Clear

Creek property route. The shale transport routes would, because of the large volumes of material to be transported, have low to moderate adverse impacts. Comparison of these two railroad routes shows that the Straight Line Tunnel route would have the highest relative impacts to energy use.

Transportation

Railroads were generally rated as having slight adverse potential impacts to transportation due to the potential for increased train traffic, slowdowns at spur locations, and future incremental effects if more rail systems are developed for other purposes. The De Beque spur, De Beque to Clear Creek property, 16 Road, Dorchester Coal, and Douglas Pass routes would all have relatively similar impacts to the existing rail transportation system. Shale transport railroad alternatives (Fruita II) would be used only for that purpose and have lower potential adverse impacts on the existing transportation system. The two shale transport railroads would have very minor adverse impacts.

2.4.9 Product Transport Corridors

Product transport from Clear Creek mesa involves the following alternatives:

- La Sal Pipeline Connection Corridor I (feasible for all major project configurations)
- Lisbon (SOPS) Connection (all configurations)
- Rangely Connection A (all configurations)
- Rangely Connection B (all configurations)

Product transport from the Fruita plant site involves the following alternatives:

- Big Salt Wash to Clear Creek Property
    - Echo Lake Route (feasible for the FI-100, FI-50 and FII-50 major project configurations)
    - Deer Creek Route (FI-100, FI-50, FII-50)
- Roan Creek to Clear Creek Property — Overland Route (FI-100, FI-50, FII-50)
- Roan Creek to Clear Creek Property — Tunnel Route (FII-50), in combination with railroad shale transport route
- Big Salt Wash Straight Line Tunnel to Clear Creek Property (FII-50), in combination with railroad shale transport route
- Plant Site West to SOPS (FI-100, FI-50, FII-50)

The tunnel routes above are applicable only in conjunction with shale transport railroad alternatives under FII-50.

Impact differences for product transport corridors are strongly influenced by the length of the corridor, topography, and relative location. A short corridor constructed on level terrain would generally cause lower adverse impacts than a longer corridor, or a corridor crossing previously undisturbed terrain or sensitive areas. Impact discussions by applicable discipline are given below. There are no significant differences in impacts between the two production rates. Table 2.4-10 shows numerical impact ratings.

Table 2.4-10 IMPACT COMPARISONS OF PRODUCT TRANSPORT CORRIDOR ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

Discipline[b]	La Sal[c] Pipeline Corridor 1	Lisbon[c] (SOPS) Corridor	Rangely[c] A	Rangely[c] B	Big Salt[d] Wash (Echo Lk)	Big Salt[d] Wash (Deer Cr)	Roan Creek[d] To Clear Creek (Overland)	Site to[d] SOPS	Roan Creek[e] To Clear Creek (Tunnel)	Big Salt[e] Wash-Straight Line (Tunnel)
Surface Water	−0.8	−0.5	−1.2	−1.1	−1.5	−1.5	−1.5	−0.2	−1.7	−2.0
Ground Water	−0.5	−0.1	−0.5	−0.5	−0.6	−0.6	−0.7	−0.1	−0.5	−0.8
Topography	−0.5	−0.2	−0.5	−0.5	−0.5	−0.5	−0.6	−0.2	−0.8	−1.0
Geology	−0.2	−0.2	−0.4	−0.2	−0.8	−0.8	−0.5	−0.1	−0.6	−0.5
Paleontology	−0.5	−0.1	−1.2	−1.1	−1.0	−1.0	−0.8	−0.1	−0.4	−0.7
Soils	−0.4	−0.6	−1.1	−0.7	−1.4	−1.4	−0.6	−0.3	−0.6	−1.0
Aquatic Ecology	−0.8	−0.5	−1.3	−1.1	−1.2	−1.2	−1.4	−0.9	−1.3	−1.0
Vegetation	−0.8	−0.5	−1.2	−1.1	−1.0	−1.0	−1.1	−0.1	−0.8	−0.8
Wildlife	−0.8	−0.5	−1.2	−1.0	−1.5	−1.5	−1.2	−0.5	−1.3	−1.3
Visual Resources	−0.5	−0.1	−0.7	−0.7	−0.7	−0.7	−1.1	−0.1	−1.0	−0.5
Cultural Res.	−0.2	−0.1	−2.5	−0.5	−0.3	−0.3	−0.4	−0.1	−0.4	−0.2
Recreation	+1.0	+0.5	+1.0	+1.0	+1.2	+1.2	+0.3	+0.3	+0.3	+0.3
Energy	−0.5	−0.3	−0.8	−0.6	−0.6	−0.6	−0.6	−0.2	−0.5	−0.5
Transportation	+0.8	+0.1	+0.9	+0.9	+0.6	+0.6	+0.6	+0.7	+0.6	+0.6

[a] Construction, operation, and residual impact ratings have been summed and averaged for compilation purposes using the following weights: construction 60%, operation 20%, and residual 20%, considering both adverse and beneficial environmental impacts. Concerning residual impacts, it was assumed that pipelines and corridors would remain in use following project shutdown to service other projects.
Impact Rating system: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = No Impact; +1.0 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.

[b] Only applicable disciplines for impact comparison are shown.

[c] Applicable alternatives: All: 50, 100.

[d] Applicable alternatives: FI-50, -100; FII-50.

[e] Applicable alternatives: FII-50.

Surface Water

Potential surface water impacts of product transport corridors are directly related to drainage area and the number of stream channels crossed. Overall, the impacts are potentially low to medium adverse. The product pipelines from the Fruita site generally would have low to medium adverse impacts because of their lengths. The only exception is the Fruita plant site west to SOPS connection, which has very low adverse impacts because it has the shortest pipeline length and only intermittent streams are disturbed. From Clear Creek mesa, the Lisbon (SOPS) connection would have a slight adverse impact and Rangely A would have a low adverse impact. For the routes from the Fruita plant site, the Big Salt Wash-Straight Line Tunnel corridor would have the highest adverse impacts. The route from the site west to SOPS would have the lowest adverse impact.

Ground Water

Overall, the potential impacts to the ground water resources by product transport corridors were rated very low adverse. Routes near potentially sensitive alluvial aquifer areas (e.g., Roan Creek, Big Salt Wash, Clear Creek) were considered to have slightly higher (relatively) adverse impacts than upland alignments. Impact assessment for the routes from Clear Creek mesa showed the Lisbon (SOPS) connection to be the lowest adverse, and the remaining three generally equal in impact. Routes from the Fruita site rate as follows: the Fruita plant site west to SOPS would have the least impact while all others would have similar adverse impacts.

Topography

All routes would have slight adverse impacts to topography. The magnitude of impact is related to the length and existing topography of each product transport corridor. For routes from the Clear Creek mesa, the Lisbon (SOPS) connection would have the least impact; the other three would have approximately the same low adverse impact. For the corridors associated with the Fruita plant site, the SOPS pipeline would have a very low adverse impact and the two tunnel routes the highest (low adverse) impact.

Geology

Impacts of all these corridors on the geologic resources of the area would be generally low adverse. Impacts to the geologic resources of the area would depend on the alignment and length of the product transport corridors and their proximity to resources such as sand and gravel deposits. The longer alignments have been assigned generally higher magnitudes of impact because of the increased construction activities that would be required. All the corridors for the Clear Creek mesa would have similar low adverse impacts. Rangely A would have the highest relative impact. Of the corridors from the Fruita plant site, the Big Salt Wash routes (Echo Lake and Deer Creek) would have the highest impacts and the SOPS corridor would have the lowest.

Paleontology

Paleontological resources are associated with certain geologic formations. Impacts would therefore occur in areas where corridor alignments coincide with potential fossil-bearing strata. The potential low adverse impacts on paleontological resources appear relatively highest for the Rangely corridors (A and B) than all other corridors considered, either from the Clear Creek mesa or the Fruita plant site. The La Sal Pipeline Corridor I and Lisbon (SOPS) connection both show generally slight adverse impacts. Similarly, the corridors from the Fruita plant site would have low adverse impacts, with the SOPS corridor having the lowest relative adverse impact and the Big Salt Wash to Clear Creek (Echo Lake and Deer Creek) having the highest.

Soils

The soils impacts of product transport corridors would be due primarily to the loss of prime farmland and the potential for accelerated soil erosion. For the pipelines from Clear Creek mesa, the highest (low adverse) impacts to the soils would be from the Rangely connections, due primarily to length of corridor disturbed. All four of these corridors would, however, only have low adverse impact. For pipelines from the Fruita plant site, the Big

Salt Wash Routes (Echo Lake and Deer Creek) would have the highest (low adverse) impacts, followed by the Big Salt Wash-Straight Line Tunnel route. All others would be relatively equal. For other corridors from the Fruita site, all potential impacts would be low adverse.

Aquatic Ecology

Potential impacts to aquatic ecology are related to sedimentation during construction and water quality changes resulting from pipeline breaks or leaks. Impacts for all routes were considered moderate. Impacts would be directly related to pipeline length and proximity to surface waters. In the impact evaluation process, proximity to the Colorado and White rivers was weighted more heavily because they are inhabited by endangered species. Potential impacts to Soldier Creek, East Fork Creek, Willow Creek, Carr Creek, Brush Creek, Upper Roan Creek, West Fork Parachute Creek, and Lake Creek were also weighted more heavily because of Colorado cutthroat trout populations. The Rangely A corridor would have the highest low adverse impact of the corridors from the Clear Creek mesa; the Lisbon (SOPS) would have the lowest relative impact. Of the corridors from the Fruita plant site, the Roan Creek to Clear Creek (Overland) route would have the relative highest (low adverse) impacts and the Big Salt Wash the lowest. All others would be approximately the same.

Vegetation

Impacts to vegetation would depend on the length revegetation potential of the proposed corridors. No known unavoidable impacts to threatened or endangered plant species are associated with these corridors. For the Clear Creek mesa corridors, the Lisbon (SOPS) connection would have the lowest adverse impact and the Rangely A the highest. Impacts for these corridors would be low to moderate adverse. Impacts to vegetation from the pipelines coming from the Fruita plant site would be generally low adverse; the SOPS corridor would have a very low adverse impact. The Roan Creek (Overland) route would have the highest (low adverse) impact to the vegetation of the area.

Wildlife

Wildlife would be affected most by short-term impacts to habitats associated with construction of the corridors. The degree of impact would be directly related to the length of the corridor. For the corridors associated with Clear Creek mesa, the Lisbon (SOPS) connection would have the lowest relative impact, and the Rangely A the highest. In general, the four pipelines would have low adverse impacts. The relative impacts of the corridors from the Fruita site, with the exception of the SOPS corridor, would be generally low to moderate adverse. The SOPS corridor would have the lowest adverse impact on wildlife.

Visual Resources

Visual resources in the vicinity of the transport corridors would be affected by the length of route and construction impacts. The Clear Creek mesa corridors would have low adverse impacts, with the Rangely A/B corridors the highest (relatively) and the La Sal Corridor I the lowest. The corridor routes for the Fruita plant site would have generally low adverse impacts, with the Roan Creek to Clear Creek (Overland) route having the highest (relative) impact. The SOPS corridor would have a very low adverse impact.

Cultural Resources

Most of the corridors would have slight if any impacts on cultural resources. The longer routes, or those that would cross previously unsurveyed territory (from a cultural resources standpoint) would have slightly higher adverse impacts due to the possibility of (1) inadvertent damage to cultural sites or (2) intentional damage to previously undiscovered sites from unauthorized collecting (e.g., arrowheads). The Rangely A pipeline route, which would involve several miles of the Canyon Pintado Historic District as designated in the National Register of Historic Places, would have potentially moderate to high adverse impacts to cultural resources.

Recreation

Beneficial impacts on recreation would probably occur due to development of any of the alternative product transport corridors. Lands which are currently unavailable for recreational use would be opened for possible off-road vehicle use, hunting, and rock collecting. Residents would have greater access to undisturbed areas. The impact levels assessed are generally based on the length of the area opened to public access and its previous accessiblity. For the Clear Creek mesa pipelines, the Lisbon (SOPS) connection would have the least beneficial impact. The other three routes would have the most potential for low beneficial impacts to recreation. The recreational impacts of those corridors associated with the Fruita plant site also would have low beneficial impacts. The Big Salt Wash (Echo Lake and Deer Creek) corridors would have low to moderate beneficial impacts; all other corridors would have low beneficial impacts.

Energy

Energy impacts would be directly related to length, and therefore proportional to energy use. Maintenance costs of pumps and other pipeline facilites would also vary with length of the corridor. Longer corridors would result in slightly higher adverse energy impacts, although all of the corridors considered would have generally low adverse impacts. For the Clear Creek mesa corridors, the Rangely A and B alternatives would have the highest (low adverse) impacts to energy use because of their greater lengths. The Lisbon (SOPS) connection would have the lowest adverse impacts. The corridors from the Fruita plant site would not differ much in terms of energy use; all would have very low adverse impacts. The Big Salt Wash routes (Echo Lake and Deer Creek) would have the highest impact and the SOPS corridor would have the lowest.

Transportation

Transportation impacts would probably be very low, yet beneficial, because of improvements to the existing transportation network, either strengthening existing systems or introducing systems available for other project use. The relative beneficial impacts were assessed based upon the length and potential availability of the transport network to future uses. The Rangely A and B connections would have the greatest beneficial impacts of the corridors associated with the Clear Creek mesa. The Lisbon (SOPS) connection would have the lowest beneficial impact.

The Fruita plant site corridors would have generally low beneficial impacts. Considering relative accessibility, all corridors would have approximately the same level of beneficial impact. The SOPS corridor would have slightly higher beneficial impacts due to its proximity to other transportation networks.

2.4.10 Materials and Worker Transport

Shipment of coal and limestone from De Beque to Clear Creek mesa to supply project needs could be accomplished by either truck or rail. A conveyor or similar system would probably be used with either the truck or rail alternative to ship coal from the confluence of Clear and Willow creeks to the top of the mesa. Other materials and equipment would also be transported by truck or rail facilities, particularly during project construction. Assumptions used are noted below, as applicable to all activity on Clear Creek mesa. This materials shipment is applicable to all major project configurations at 100,000 bpd.

Transport of workers from De Beque to Clear Creek mesa and from Fruita to the Fruita plant site would be accomplished either by bus or private car, with consideration for carpooling. Mandatory carpooling is assumed due to limited parking space on the mesa and encouragement of such by the Operator. Worker transport of the magnitude discussed is applicable to all 100,000-bpd project configurations at peak construction and operation levels, however divided between the Clear Creek mesa or the Fruita plant site. Worker transport impacts would generally be less than the worst-case discussed here. Worker transport impacts for the 50,000-bpd alternatives would be about half of those for the 100,000-bpd alternatives.

Various assumptions were made concerning truck capacities, carpooling, bus sizes, numbers of workers at various locations, and related matters for purposes of impact comparison. The assumptions below are for a worst-case analysis. Table 2.4-11 displays the numerical impact ratings.

- Rail Transport (Materials)
  - Maximum of 6,500 tons per day of coal and limestone would be transported for the 100,000-bpd production rate
  - Transport of coal would require one unit train of 50 to 100 cars per day
  - Railroad route would be built in an existing corridor up Roan Creek valley

- Truck Transport (Materials)
  - Maximum of 6,500 tons per day of coal and limestone would be transported for the 100,000-bpd production rate
  - Transport of coal would require a maximum of approximately 450 trucks per day (20-25 ton capacity per truck).
  - Transport route would be proposed Roan Creek access road (two- to four-lane paved highway); no special improvements would be required other than those already planned to accommodate project needs

- Bus Transport (Workers)
  - Two- to four-lane paved highway
  - Private bus company to manage operations
  - Maximum about 9000 workers per day going from De Beque to Clear Creek mesa (worst case)
  - Maximum of 225 bus trips per day in 3 shifts or 75 buses/shift (40 person bus capacity)

- Car Transport (Workers)
  - Road and worker assumptions same as for buses
  - Total use of private cars (probably unlikely due to lack of parking on mesa)
  - Up to 3600 vehicle trips per day (2.5 persons per car in 3 shifts or 1200 vehicles per shift)

Table 2.4-11 IMPACT COMPARISONS FOR MATERIALS AND WORKER TRANSPORT ALTERNATIVES, CLEAR CREEK SHALE OIL PROJECT[a]

	Material Transport[c]		Worker Transport[d]	
Discipline[b]	Rail	Truck	Car	Bus
Air Quality	−0.5	−1.0	−1.5	−1.2
Noise	−0.8	−2.5	−2.0	−1.5
Aquatic Ecology	−0.4	−0.4	−0.2	−0.2
Wildlife	−2.1	−2.4	−2.0	−1.5
Visual Resources	−1.1	−0.5	−0.7	−0.5
Energy	−0.2	−0.3	−1.8	−0.5
Transportation	−0.5	−1.5	−1.8	−0.5

[a] Impact Rating System: −3.0 = High Adverse; −2.0 = Medium Adverse; −1.0 = Low Adverse; 0 = No Impact; +1.0 = Low Beneficial; +2.0 = Medium Beneficial; +3.0 = High Beneficial.
[b] Impact ratings for applicable disciplines only.
[c] Applicable alternatives: PA-100, CC-100, FI-100.
[d] Applicable alternatives: All: 50, 100.

Air Quality

Use of trains to transport materials (for all major project configurations) would require a maximum of one train per day running about 26 miles (52 miles round trip) from De Beque to Clear Creek mesa and would result in very low adverse air quality impacts. Use of trucks to transport materials would require about 450 loaded trucks per day over the same route. Trucks would have slightly higher (low adverse) impacts on air quality, depending on control measures (e.g., wetting the loads, covers).

Specific data concerning air quality impacts of buses versus carpooling are not available. However, buses would have lower adverse air quality impacts than cars due to their reduced number.

Noise

The use of trains to transport materials would require one train per day, running approximately 52 miles round trip. Noise impacts of this train would be minimal. Use of 450 trucks per day would increase ambient noise levels significantly, causing a moderate to high adverse impact.

Worker transport in buses would have lower adverse impacts than car transport because for fewer vehicles would be reqired, even considering a higher noise level (per individual vehicle) for buses. Impacts of 3,600 car trips per day would be moderate adverse. Buses would have low to moderate adverse impacts.

Aquatic Ecology

The only potential impacts from materials transport to the aquatic resources of the area would occur from accidental spills of coal and from airborne particulate losses. Very low adverse impacts would probably result from both materials transport modes. Similarly, airborne particulate losses from bus or car transport of workers would probably be insignificant to aquatic resources. It is assumed that both would have slight adverse impacts.

Wildlife

Potential impacts of truck transport of materials within the Roan Creek access corridor would be medium to high adverse and of regional significance. Approximately 450 truck round-trips per day would effectively exclude most wildlife from areas impacted because of noise. In addition, this schedule of operation would result in alteration in big game movement and range use patterns throughout the Roan Creek drainage. Impacts due to construction of a railroad within the Clear Creek access corridor (one unit train per day) for materials transport would result in lower (medium adverse) impacts than truck transport.

For worker transport, the potential for road kills as a result of some thousands of car trips per day versus some hundreds of bus trips per day is substantial. Buses would cause low to medium adverse impacts, while the car traffic would cause medium adverse impacts. General impacts regarding wildlife disturbance would be substantial near road corridors under either alternative.

Visual Resources

Roadways and railroad rights-of-way would introduce similar line and color impacts, resulting in low adverse impacts depending on siting, design, and need for cut-and-fill structures. Materials transport by truck would require a loadout facility at the De Beque railroad spur, an area of high visual sensitivity. Rail transport of materials to Clear Creek mesa would require a railroad corridor, in addition to a road, up Clear Creek canyon. A loadout facility within the canyon would affect an area of higher scenic quality (but lower visual sensitivity) than the De Beque area.

Energy

Energy used for materials transport would be less for trains than for large trucks. Energy impacts due to materials transport by either mode would be very slight.

Worker transport by cars would have low to medium adverse impacts because of inefficient use of fuel, even with carpooling. The much greater number of potential car trips versus bus trips makes the impact differences greater. Bus transport would have very low adverse impacts.

Transportation

The impacts of materials transport on the transportation network would vary depending on whether trucks or trains are used. If the materials are transported by train, a maximum of one unit train per day would have slight adverse impacts. If transported by truck, a higher adverse (low to moderate) impact would occur due to the anticipated 450 truck round-trips per day. Truck traffic would be confined to the Roan Creek road, and road maintenance costs and traffic problems on this road would be increased by the volume of truck traffic. Rail transport would have very low adverse impacts.

For worker transport, similar impacts would be expected from cars and buses. The high number of car trips per day would increase congestion, maintenance costs, accidents, and system loads. Buses would cause slight adverse impacts, yet noticeable ones, to the transportation network.

2.4.11 BLM's Preferred Alternative

The BLM is required to identify an agency preferred alternative in the DEIS. The BLM may also identify an environmentally preferred alternative in the DEIS. The agency preferred alternative includes consideration of the agency's mission, national policy, technical issues, physical environment, and the human environment.

For the reasons described herein, the BLM has designated the Fruita 1 configuration at the 100,000-bpd production rate (FI-100) as the agency preferred alternative.

In the selection of the environmentally preferred alternative, the Council on Environmental Quality (CEQ) has directed that agencies consider the human environment, which would include the social and economic effects of the action.

The BLM has identified the Clear Creek configuration at the 50,000-bpd production rate (CC-50) as the environmentally preferred alternative considering only the biological environment.

Several options exist to select specific alternative configurations of discrete actions as part of the overall proposal. The BLM has selected the following configurations for various project components:

- Product transport corridors — The La Sal/Parachute Creek route is preferred if a northern market is chosen for shipment of the shale oil. For a southern market the Fruita to SOPS line is preferred. In the event the La Sal and/or the SOPS lines are not constructed, the Rangely B route would be selected.

- Railroad corridor — Access to the Fruita site via the Dorchester Coal route and access to Clear Creek mesa via the De Beque to Clear Creek route.

- Road corridors — Access to the Fruita site via 16 Road. The Douglas Pass Road would be preferred if Colorado-Ute activated its plan to build the Southwest Generating Plant. The Douglas Pass route could serve the power plant and the Fruita site. Access to Clear Creek mesa site would be via the Roan Creek Road.

- Water diversion points — the Loma intake and a modified design for the De Beque intake.

- Roan Creek reservoir — the Lower Dry Fork reservoir.

- Spent shale disposal — the Mesa Valley Fill site.

- Coal transport system — railroad transport system.
- Worker transport system — bus transport system.
- Powerline corridors — the east-west route.

The rationale for the BLM's selection of the preferred alternative is given below and addressess each of the scoping issues.

Production at the 100,000-bpd rate would make a greater contribution than the 50,000-bpd rate to the Federal policy and national interest of United States energy independence and reduced dependence on foreign petroleum supplies. Further, the higher production rate would be in accordance with BLM statutory and regulatory responsibilities to manage the Federal lands to best meet the present and future needs of the American people.

The preferred alternative would have the most favorable population and fiscal impacts of all the configurations. The ability of Mesa County to absorb the majority of the increased population and supply public services, and the location of the taxable project facilities in Mesa County, are important considerations.

The 50,000-bpd configurations would result in a more rapid increase in population at project startup and a more rapid decline at project completion. The project life at 50,000 bpd would be considerably shorter than at 100,000 bpd.

The preferred alternative would have essentially the same impacts on surface and ground water as the other 100,000-bpd configurations.

The air quality impacts would be within acceptable limits.

The land use and recreation impacts would be at an acceptable level.

The preferred alternative would have the lowest adverse impacts of all the 100,000-bpd configurations on the transportation system. The impacts would be essentially the same for the 50,000-bpd configurations.

The visual impacts would be slightly higher than for other configurations but would be within acceptable limits.

The impacts on energy consumption and use would be acceptable.

The impacts on all other biological resources would be within acceptable limits.

3.0

Affected Environment

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

The existing environmental conditions for the Clear Creek mesa and Grand Valley sites and related project corridors are described in this chapter. Baseline data were provided by the Operator and by the Operator's various contractors. Baseline data were also obtained from the Grand Junction and other BLM offices, and supplemented by federal, state, and local agencies, and other sources.

Determinations of baseline data availability and adequacy for the EIS were performed by BLM with the assistance of the third-party EIS contractor, Camp Dresser & McKee Inc. (CDM). As part of the EIS process, BLM prepared a *Final Plan of Study, Chevron Clear Creek Shale Oil EIS* (BLM 1982c), which describes existing data availability by discipline for the proposed project and alternatives. It also describes additional data needs and suggested methodologies, costs, and schedules for obtaining such data. This document was reviewed by pertinent agencies and the interested public in order to ensure that important data sources for this EIS were not overlooked.

The environmental disciplines presented in this chapter are listed below. The level of detail for each discipline was partially based on the significance of comments and issues raised during scoping meetings (see Chapter 1.0 — Purpose and Need).

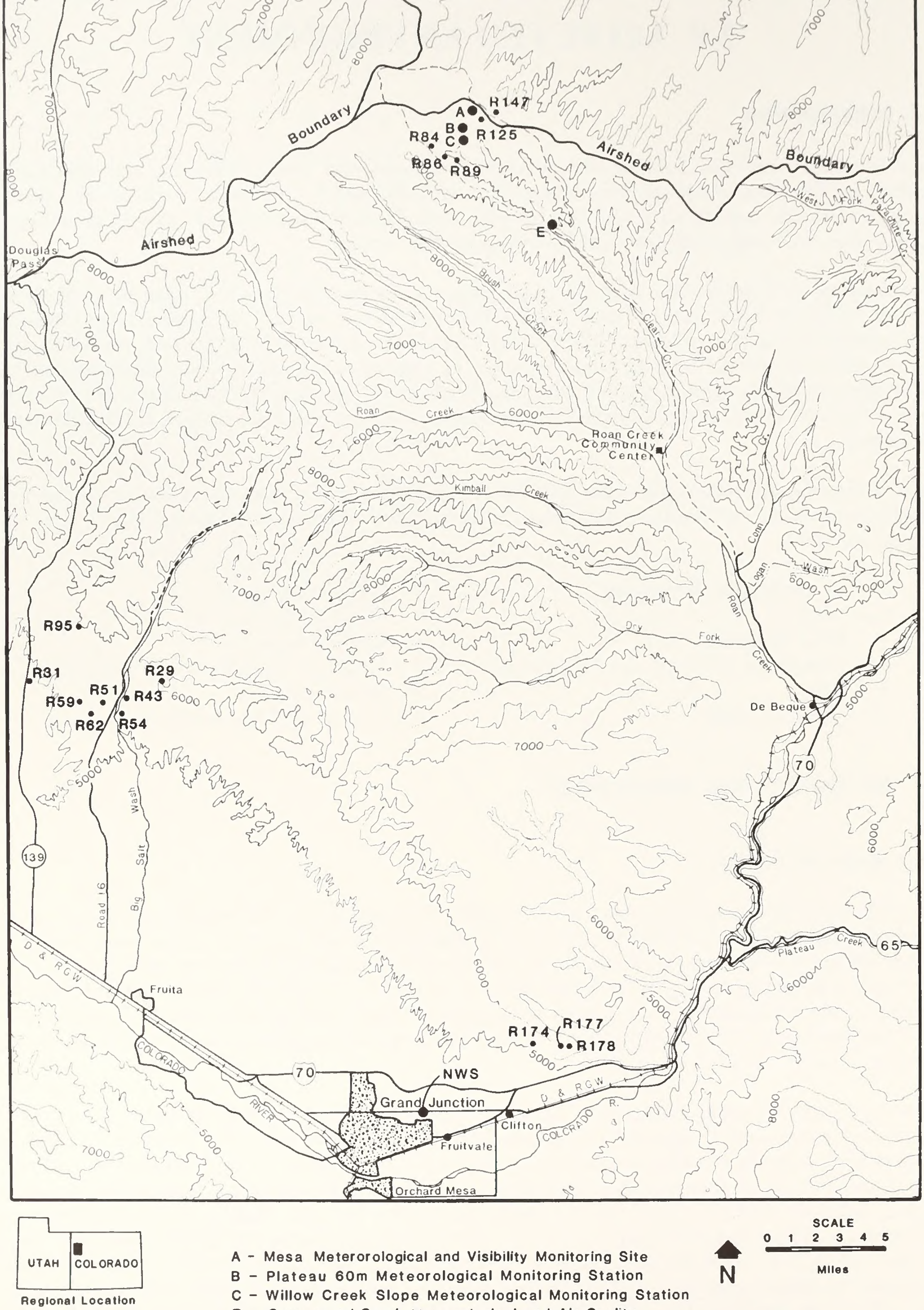
- Air Quality and Meteorology
- Noise
- Water Resources
- Topography, Geology, and Paleontology
- Soils
- Aquatic Ecology
- Terrestrial Ecology
- Visual Resources
- Cultural Resources
- Land Use, Recreation, and Wilderness
- Socioeconomics
- Energy and Transportation

3.2 Air Quality and Meteorology

3.2.1 Regional Setting

The CCSOP and alternatives are located in the Piceance Basin and the Big Salt Wash in the Grand Valley of western Colorado. Figure 3.2-1 displays the major air shed basin boundaries in the project area. The air shed concept implies that the local scale winds are driven by heating and cooling of the local valley floor and walls. The Piceance Basin area can be further subdivided into two smaller air sheds. The air shed boundary separating federal oil shale lease tracts C-a and C-b from the Parachute/Roan Creek area follows a ridge along an east-west axis. These smaller air sheds affect local meteorological conditions in the valleys and canyons. The Big Salt Wash area is also part of this southern air shed.

Sensitive receptors are points in the area of significant impact that are not within the project boundary but may be subjected to significant criteria pollutant concentration levels. These receptors are "sensitive" to increases in pollutant levels either from a desire to maintain the area as pristine or clean; or due to already elevated levels of air pollutants (non-attainment areas), or locations of potential high concentrations (e.g. project boundaries). Criteria pollutants include sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, total suspended particulates, and lead, and are those pollutants for which a National Ambient Air Quality Standard (NAAQS) has been set by U.S. EPA. Sensitive receptors important to this project are CCSOP property boundaries; designated wilderness areas (Flat Tops Wilderness Area and Arches National Park); areas under wilderness review (Colorado National Monument, Dinosaur National Monument, Little Book Cliffs, Wild Horse Area, Black Ridge Canyons, Black Ridge Canyons West, and Demaree Canyon); and the Grand Junction, Fruita, and Parachute urban areas (nonattainment areas for particulate matter).



A - Mesa Meterorological and Visibility Monitoring Site
B - Plateau 60m Meteorological Monitoring Station
C - Willow Creek Slope Meteorological Monitoring Station
E - Cottonwood Creek Meteorological and Air Quality Monitoring Station
R - Receptors
NWS - Walker Field Meteorological Monitoring Station

Figure 3.2-1 Locations of Air Sheds, Meteorological Monitoring Stations, and Receptors

The meteorological conditions and the dispersion potential of the project areas are affected by local topography and synoptic (large scale weather pattern) flow regimes. The climate of the Clear Creek and Grand Valley areas has been classified as mountainous semiarid/steppe and highland semiarid/steppe (Trewartha 1968). Characteristics of these climate types are abundant sunshine, low precipitation, low relative humidity, and large diurnal and seasonal temperature fluctuations.

The project area is located in the mid-latitude belt of prevailing westerly winds. Severe cold waves are rare within the region due to the blocking action of the high mountains. High pressure areas tend to form over the western slopes of the Colorado Rockies in winter, resulting in moderate temperatures. During the summer months, the Continental Divide is a very effective barrier to moisture transport from the Gulf of Mexico (Thorne Ecological Institute 1973).

The prevailing synoptic winds, if unaffected by terrain, are from the south to southwest (Meyer and Nelson 1975). These prevailing winds are the net result of the interactions of the mid-latitude westerlies and the passage of low and high pressure cells. These pressure systems generally move from east to west. However, low pressure cells and storm tracks are usually steered to the north or south by the Continental Divide.

3.2.2 Clear Creek Mesa and Associated Siting Activities

Meteorological and background air quality conditions for the CCSOP area have been extracted from the PSD application for the mine and process facilities on the mesa (Chevron 1982d) and the air quality and meteorology baseline report (Chevron 1982e).

Climatology

The local topography strongly affects the climatology of the CCSOP area. The following discussion summarizes temperature, precipitation, sunshine, humidity, and evaporation data collected on the Clear Creek mesa.

Average temperatures in the project area range from 25 °F in February to 63 °F in July with an annual average of 41 °F. Figure 3.2-2 illustrates the monthly temperature means on the mesa site. Meteorological data indicate that the winter of 1980-81 was abnormally mild. Temperatures on the mesa ranged from 82 °F to −5 °F.

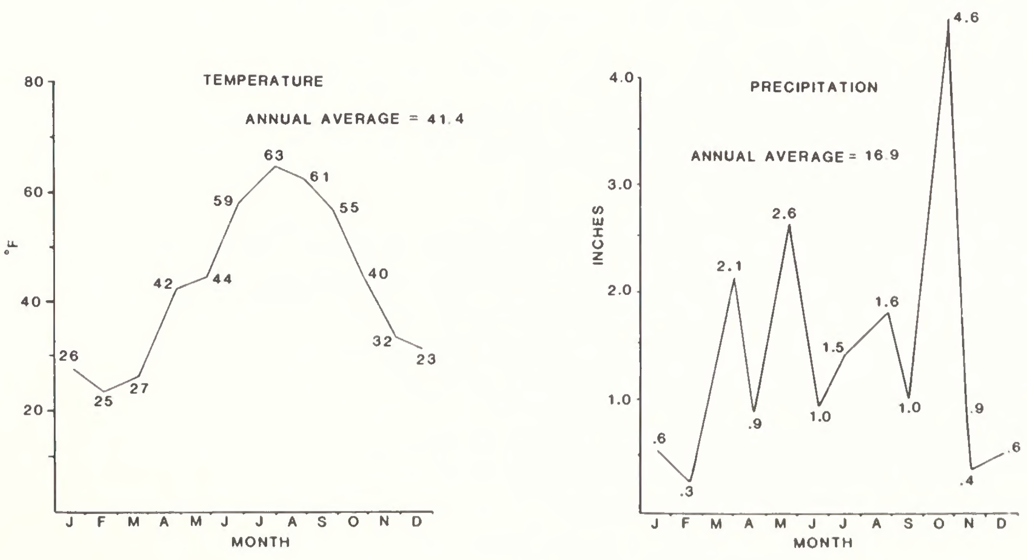


Figure 3.2-2 Temperature and Precipitation Summaries for the Clear Creek Mesa Site (1 October — 30 September 1981)

Precipitation in the study area is strongly influenced by elevation. The meteorological data reflect an abnormally dry winter on the mesa in 1980-81, with an annual average precipitation of 13.9 inches, as compared to the 20 inches per year indicated on the 1931-60 USGS annual precipitation map for Colorado. Summer storms are brief and highly localized with average intensity decreasing sharply with area. Snowpack data for 1980 and 1981 (Chevron 1982h) indicate that snowpack begins on about 1 December and continues to about 1 April.

Sunshine data are not available for the mesa site. Grand Junction data, which should correlate with the mesa site reasonably well, show annual average sunshine of 70 percent, ranging from 60 percent in the winter to 79 percent in summer and fall. The 30-year record from 1938 through 1977 indicates that clear days from sunrise to sunset occurred 140 days per year.

Relative humidity is assumed to be similar to Grand Junction data; very low during spring through fall, averaging approximately 30 percent during the day and 40 percent in the evening, up to 50 percent during winter days, and as high as 70 to 80 percent during winter evenings.

Evaporation was measured for 1 year (October 1980 through September 1981) at the mesa site. Available average evaporation data for the indicated periods is listed in Table 3.2-1.

Table 3.2-1 AVERAGE POTENTIAL EVAPORATION

Date	Evaporation (inches)
6 June - 19 July	3.4
19 July - 7 August	6.7
7 August - 8 September	1.3
8 September - 19 September	4.7
Annual Average[a]	16.1

[a] Based on above data.

Thunderstorms occur about 35 days each year, with the highest probability of occurrence in August. Summer storms appear to be brief and highly localized with average intensity decreasing sharply with area. Hail occurs rarely.

The prevailing winds for Clear Creek mesa are out of the south-southwest and average 10-14 mph. Strong wind speeds are a result of the relatively high elevations of the mesa areas and their subsequent exposure to prevailing winds. The westerly winds are usually guided north or south by the Colorado Rockies and interact with pressure cells, resulting in a southwest flow. These winds are channeled in deep canyons, causing prevailing winds at valley bottoms to be oriented along the valley axis.

In the absence of strong prevailing winds, wind movement within canyons and valleys is controlled by surface heating and cooling. During periods of strong solar insolation, air restricted by valley walls rises due to surface heating and tends to flow up the canyon or valley. This flow probably develops simultaneously with upslope winds which result from a greater heating of the sun-facing valley side with respect to the valley floor. At night, down drainage winds occur as the air near the ground being cooled by radiational heat loss. As this air is cooled, it becomes denser and flows downslope. Downward movements of cold air set in motion by this effect form downslope gravity winds, which drain through the valley or canyon bottom.

Atmospheric stabilities which were used for the modeling analysis were estimated by the Turner (1964) method, from the 1-year Clear Creek mesa data base. Stability wind roses and joint frequency distribution are located in Appendix 4 of the PSD application (Chevron 1982d). Table 3.2-2 shows the annual average distribution of stabilities from A, which is extremely unstable, through D, which is neutral, through F, which is moderately to extremely stable.

Table 3.2-2 ANNUAL AVERAGE DISTRIBUTION OF STABILITIES FROM CLEAR CREEK MESA

Stability	Class Percentage
A	17
B	5
C	8
D	34
E	16
F	20

Adverse meteorological conditions occur when dispersion potential is low and are conducive to maximum ground level concentrations of potential emissions. These conditions will vary depending on the location of the facilities. Nocturnal drainage flow from the mesa areas into the Clear Creek canyon is a strong and well developed phenomenon. Consequently, plumes originating on the mesa may be fully or partially entrained into canyon drainage air. Tracer studies performed in Parachute Creek canyon for Colony (Battelle 1975) indicate that substantial plume dilution takes place because of rapid air movement and drainage winds. Both effects will tend to decrease predicted ground level impacts, and thus result in increased dispersion potential.

Air Quality — Criteria Pollutants

Table 3.2-3 presents background air quality information for the Clear Creek mesa area compared to federal and state standards. Data were taken from the PSD application (Chevron 1982d).

Sulfur Dioxide (SO_2). Recorded concentrations of SO_2 at the Cottonwood Station have been very low, which is expected since there are very few industrial sources of SO_2 in the area. The mean concentration for the period is about 1 microgram/cubic meter (μg/cu m) with 3-hour and 24-hour peaks of 17 μg/cu m and 14 μg/cu m, respectively.

Total Suspended Particulates (TSP). Annual geometric means of TSP for the Mesa and Cottonwood stations are 15 μg/cu m and 15 μg/cu m, respectively. The 24-hour peak concentrations are 34 μg/cu m and 89 μg/cu m, respectively. Concentrations are low because of the lack of sources attributable to man.

Nitrogen Dioxide (NO_2). The mean for January 1981 through December 1981 for NO_2 at the Cottonwood Station is 4 μg/cu m and is assumed to be the background.

Carbon Monoxide (CO). The maximum 1-hour and 8-hour values for CO at the Cottonwood Station are 3,000 μg/cu m and 2,500 μg/cu m, respectively.

Ozone (O_3). The Operator has gathered O_3 data at the Cottonwood and Mesa stations. A maximum 1-hour concentration of 190 μg/cu m has been measured at the Cottonwood Station and 180 μg/cu m has been measured at the Mesa Station.

Lead (Pb). No known measurements of Pb exist in the vicinity of Clear Creek mesa. Ambient concentrations of Pb should be very low on the mesa because of its rural location and corresponding lack of automobiles and industrial sources.

Table 3.2-3 SUMMARY OF BACKGROUND CONCENTRATIONS AND AMBIENT AIR QUALITY STANDARDS AT COTTONWOOD CREEK SITE

			National Standards		Colorado Standards	
Pollutant	Averaging Time	Concentrations (μg/cu m)	Primary (μg/cu m)	Secondary (μg/cu m)	Primary (μg/cu m)	Secondary (μg/cu m)
SO_2	Annual	1	80	-	-	-
	24-hr	14	365	-	-	-
	3-hr	17	-	1,300		1,300
TSP	Annual geometric mean	15	75	60	75	60
	24-hr	89	260	150	260	150
NO_2	Annual	4	100	100	100	100
CO	8-hr	2,500	10,000	10,000	10,000	10,000
	1-hr	3,000	40,000	40,000	40,000	40,000

Source: Chevron (1982d).

Air Quality Related Values (AQRVs)

The EPA has determined that a PSD permit will be required for CCSOP mining, retorting, and upgrading facilities. The existing Class I area near the project area which may be affected is the Flat Tops Wilderness area in the White River National Forest (about 55 miles direct distance from the CCSOP property). The U.S. Forest Service has recommended that a long-term visibility monitoring program be conducted in the Flat Tops Wilderness Area to measure current conditions and predict future emissions of those pollutants that have a potential to degrade visibility (USFS 1981). The Operator has conducted a visibility monitoring program on the mesa for the period from October 1980 through February 1982.

The Forest Service has identified sensitive, poorly buffered, high mountain lakes in the Flat Tops Wilderness (Haddow 1982). These pristine lakes are Ned Wilson, Oyster, and Upper Island. Modeling of acid deposition from the CCSOP facilities have not been performed, but should be low based on previous studies (Fox et al. 1981).

3.2.3 Grand Valley and Associated Siting Activities

Meteorological and background air quality conditions for the Grand Valley area have been extracted from the PSD application for Grand Valley upgrading facility (Chevron 1982f) and local climatological data for Grand Junction from 1970 through 1977 (NOAA 1978, 1981). The PSD application uses a 5-year meteorological data record from 1 January 1977 to 31 December 1981 from Walker Field in Grand Junction, and the 10-month air quality data set measured near Mack, Colorado by the Colorado-Ute Electric Association.

Climatology

The climate of the Grand Valley area is marked by the wide seasonal range common to inland localities at mid-latitudes. Temperatures at Grand Junction have ranged from 105 to −23 °F, but readings of 100 °F or higher are infrequent, and about one-third of the winters have no readings below 0 °F. Summer days with highs in the middle and low 90's and lows in the low 60's are common. Average temperatures range from 80 °F in July to 24 °F in January, with an annual average of 52.6 °F, as shown in Figure 3.2-3. Due to the warming of the frequent downslope valley winds, first and last frosts normally occur in late October or early November and late April or early May.

The interior continental location, ringed by mountains on all sides, results in low precipitation in all seasons (Figure 3.2-3). Summer rains occur chiefly as scattered light showers from thunderstorms which develop over nearby mountains. Winter snows are frequent, but most are light and melt off quickly (Figure 3.2-3). Even the infrequent snows of 4-8 inches, which are heavy for this locality, seldom remain on the ground for prolonged periods. Annual average precipitation is 8.4 inches. Average annual snowfall is 26.3 inches. Grand Junction has 69 days per year during which precipitation is greater than 0.01 inch.

The climate of the Grand Junction area is characterized by abundant sunshine. Annual average sunshine is 70 percent and ranges from 60 percent in the winter months of December and January to 79 percent in September. The 30-year record from 1938 through 1977 shows an annual average of 140 days per year that were clear from sunrise to sunset.

Relative humidity is very low during the spring, summer, and fall, averaging 20-30 percent during daylight hours and 30-40 percent in the evenings. Wintertime relative humidity increases to 50-60 percent during the day and 70-80 percent in the evenings.

An 8-year record of evaporation from 1970-77 (1978-81 data are unavailable) was compiled from monthly climatological summaries (NOAA 1978, 1981) from the Grand Junction Colorado State University Orchard Station. Monthly average potential evaporation is presented in Table 3.2-4.

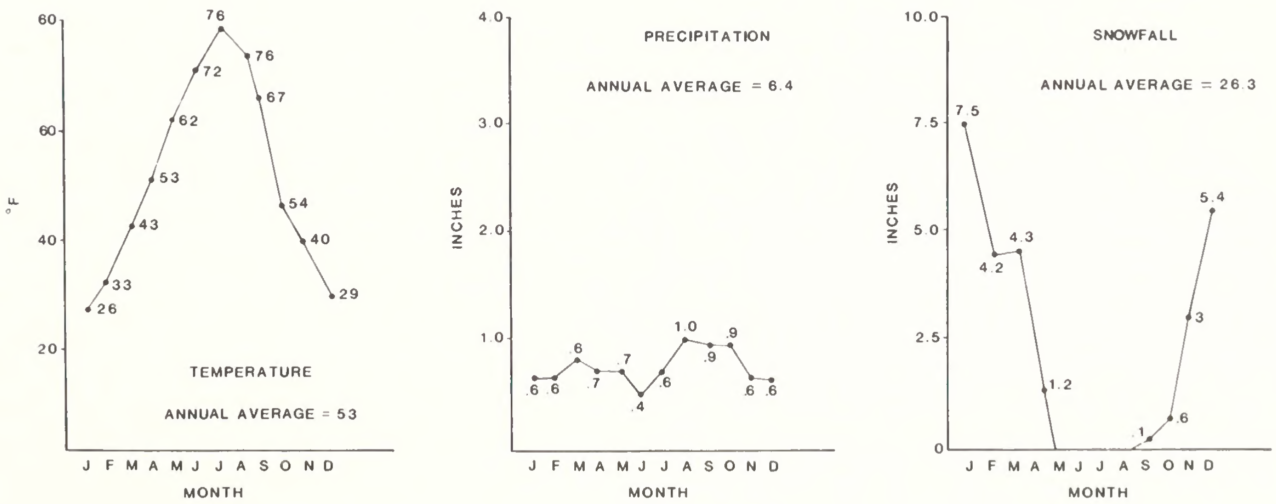


Figure 3.2-3 Temperature and Precipitation Average Summaries at Grand Junction

Table 3.2-4 MONTHLY AVERAGE POTENTIAL EVAPORATION AT GRAND JUNCTION, COLORADO

Month	Evaporation (inches)
April	6.5
May	9.3
June	11.7
July	11.9
August	10.0
September	7.6
October	4.4
November	1.7
Annual Average	63.1

Sudden and severe weather changes are rare because of the protective topography of the vicinity. Summer thunderstorms which develop over nearby mountains are brief and highly localized with average intensity decreasing sharply with area. Hail occurs rarely. Winter snowstorms are frequent but light (less than 4 inches). Blizzard conditions in the Grand Valley area are extremely rare.

The prevailing winds in the Grand Valley area are oriented along the northwest/southeast axis of Grand Valley and average 5-10 mph. Overall, the Grand Valley is subject to the same prevailing westerly winds as the Clear Creek mesa area. However, these winds are channeled by the broad Grand Valley, causing prevailing winds at lower elevations in the valley to be oriented along the valley axis.

When high pressure cells or weak pressure systems prevail over the area and the general wind flow is weak, wind flow regimes within the Grand Valley are controlled by surface heating and cooling of the valley floors and walls. During periods of strong solar insolation, the air is constricted by the valley walls and tends to flow up-valley. This up-valley flow is reinforced by upslope winds which result from the difference in heating of the sun-facing valley side and valley floor. At night, drainage winds dominate. As this air is cooled and becomes denser, it flows downslope, causing gravity winds to develop, which in turn drain along the valley bottom.

Atmospheric stabilities which were used for the modeling analysis were estimated by the Turner (1964) method from the 5-year Grand Junction data base. Stability wind roses and joint frequency distribution are located in Appendix 4 of the PSD application for upgrading in Grand Valley (Chevron 1982f). Table 3.2-5 shows the annual average distribution of stabilities from A, which is extremely unstable, through D, which is neutral, through F, which is moderately to extremely stable, for the Grand Junction data set. Over 70 percent of all stabilities fall in the neutral to extremely stable classes.

Table 3.2-5 ANNUAL AVERAGE DISTRIBUTION OF STABILITIES FROM GRAND JUNCTION, 1977-1981

Stability Class	Percentage
A	1
B	9
C	15
D	35
E	20
F	19

The dispersion potential at the upgrading site is affected by local and regional topography. The terrain characteristics in the vicinity of the Grand Junction airport are quite similar to those near the proposed upgrading site and as such, the meteorological characteristics and dispersion potential of the two sites are also expected to be similar. Grand Junction meteorological data show the most frequent direction of plume transport to the northwest or the valley axis. Due to drainage conditions, much of this transport occurs during stable flow along the Colorado River. The actual frequency of northwesterly stable plume transport at the upgrading site is probably less than indicated in the Grand Junction data because of the potential influences of northeasterly stable flows out of canyons.

Dispersion of pollutants within the Grand Valley could be suppressed during periods of inversions. Grand Junction experiences one of the highest frequencies of inversions anywhere in the United States (BLM 1975). In summer, inversions of short duration occur because of dispersion of the stable layers due to strong convection from increased surface heating. In winter, well defined inversions usually begin in the late afternoon and dissipate after sunrise. Inversion conditions may exist over 50 percent of the time in the fall and winter (BLM 1975). A severe episode which would inhibit dispersion may be expected to occur at least once a year, and may last from 3 to 6 days (BLM 1975). The mixing height during such an episode is typically less than 1,600 ft (Holzworth 1972). Periods of stable inversions are often associated with elevated pollutant levels.

Air Quality — Criteria Pollutants

Table 3.2-6 presents background air quality information for the Grand Valley area compared to state and federal standards. Data were taken from the upgrade facility PSD application (Chevron 1982f), which presents Colorado Department of Health data for Grand Junction and Fruita.

Sulfur Dioxide (SO_2). The Air Pollution Control Division (APCD) measured SO_2 in Grand Junction from May through November 1981 (Chevron 1982f). Recorded concentrations have been low, as expected since there are very few industrial sources of SO_2 in the area. The mean concentration for this 6-month period was about 15 μg/cu m, with 3-hour and 24-hour peaks of 59 μg/cu m and 26 μg/cu m, respectively.

Colorado-Ute's measurements of SO_2 at the Mack monitoring site were obtained for the period January-October 1981 (Chevron 1982f). The recorded mean for this period is about 3 μg/cu m, with 3-hour and 24-hour peaks of 39 μg/cu m and 24 μg/cu m. The SO_2 concentrations at the Mack site are lower than those at Grand Junction, probably because the Mack site is more rural. These readings, plus the proximity of the two sites, probably makes the Mack data more closely representative of conditions at the Grand Valley upgrading site. Therefore, the background SO_2 concentration at the upgrading site is assumed to be 3 μg/cu m for annual average time, 39 μg/cu m for the 3-hour peak, and 24 μg/cu m for the 24-hour peak.

Total Suspended Particulates (TSP). Since 1980, the APCD has obtained TSP measurements at one location in Fruita and two locations in Grand Junction using high volume air samplers. Measured concentrations are high; annual geometric means for the years 1980 and 1981 exceed the Colorado and national secondary ambient air quality standard of 60 μg/cu m. In addition, maximum 24-hour concentrations occasionally exceed the secondary standard of 150 μg/cu m. The Grand Junction/Fruita area is classified as nonattainment for TSP based on these measurements. These data are not considered representative of TSP concentrations at the more rural upgrading site.

TSP data have also been collected at the Mack monitoring site from January through October 1981. The geometric mean of these measurements is 33 μg/cu m; the peak 24-hour average is 121 μg/cu m. The relatively high 24-hour maximum was reportedly caused by windblown dust. Naturally occurring fugitive dust is characteristic of arid and sparsely-vegetated areas such as Grand Valley.

Nitrogen Dioxide (NO_2). No NO_2 measurements have been obtained in Grand Junction with EPA-approved techniques. NO_2 measurements were taken at the Mack monitoring site. The mean for the period January through October 1981 is about 2 μg/cu m. This value is assumed as background at the upgrading site.

Carbon Monoxide (CO). The APCD has taken CO measurements in Grand Junction for calendar 1980. The maximum 1-hour and 8-hour values are about 18,720 μg/cu m and 7,930 μg/cu m, both of which are below corresponding ambient standards. At the Mack monitoring site, a continuous CO analyzer measured maximum 1-hour and 8-hour CO concentrations of about 2,680 μg/cu m and 1,040 μg/cu m. Concentrations at the Mack site are much lower than in Grand Junction because the Mack site is in an area containing fewer automobiles or other CO sources, and therefore lower CO emissions. The Mack volumes are assumed to be representative of the 1-hour and 8-hour backgrounds at the upgrading site.

Ozone (O_3). No continuous O_3 measurements exist for Grand Junction. A maximum 1-hour concentration of 52 μg/cu m has been measured at the Mack site.

Lead (Pb). No known measurements of Pb exist in the vicinity of the upgrading site. Ambient concentrations of Pb should be very low at the upgrading site because of its rural locale and corresponding lack of automobiles and industrial sources.

Table 3.2-6 SUMMARY OF BACKGROUND CONCENTRATIONS AND AMBIENT AIR QUALITY STANDARDS AT GRAND VALLEY UPGRADING SITE

			National Standards		Colorado Standards	
Pollutant	Averaging Time	Concentrations (μg/cu m)	Primary (μg/cu m)	Secondary (μg/cu m)	Primary (μg/cu m)	Secondary (μg/cu m)
SO_2	Annual	3	80	-	-	-
	24-hr	24	365	-	-	-
	3-hr	39	-	1,300		1,300
TSP	Annual Geometric Mean	33	75	60	75	60
	24-hr	121	260	150	260	150
NO_2	Annual	2	100	100	100	100
CO	8-hr	2,680	10,000	10,000	10,000	10,000
	1-hr	1,040	40,000	40,000	40,000	40,000
O_3	1-hr	52	235	235	160	160

Source: Chevron (1982f).

Air Quality Related Values (AQRVs)

The EPA has determined that a PSD permit will be required for the CCSOP upgrading facility in the Grand Valley. The closest Class I area to the project is Arches National Park, which lies 56 miles southwest of the facility and has an entrance 1 mile north of Moab, Utah. Other areas of concern for AQRVs are Dinosaur National Monument, Colorado National Monument, and Black Canyon of the Gunnison Wilderness.

Baseline visibility data from the proposed Grand Valley upgrading facility to Arches National Park were not collected. However, some insight into general visibility conditions in Class I areas can be obtained by examining the regional airport visibility (visual range). Both Arches National Park and the project area are located in the best visibility area in the United States which occurs in the mountainous Southwest. The annual median visibility exceeds 70 miles for this area (EPA 1979c).

Information concerning acid deposition in Arches National Park is not currently available. No lakes exist in the park.

3.3 Noise

Ambient noise is defined as the level of sound associated with a given environment resulting from composite sounds from many sources, near and far. Typical sources of ambient noise in western Colorado include automobiles, trucks, airplanes, heavy equipment, wildlife activity, wind (rustling brush or leaves), and flowing water.

The ambient noise level on Clear Creek mesa is about 40 decibels (dBA). This estimate is based on representative levels according to population densities (U.S. Department of Commerce 1977) and noise level measurements in rural western Colorado (Gulf Oil Corporation-Standard Oil Company 1977). Existing traffic noise levels were determined based on road segments shown in Figure 3.3-1 and traffic volumes shown in Table 3.13-2 (see Section 3.13). The calculated noise levels 50 feet from the roadways presented in Table 3.3-1 are based on peak traffic hour volumes of autos and heavy trucks. Railroad and heavy equipment noises are generally nonexistent on CCSOP sites at this time.

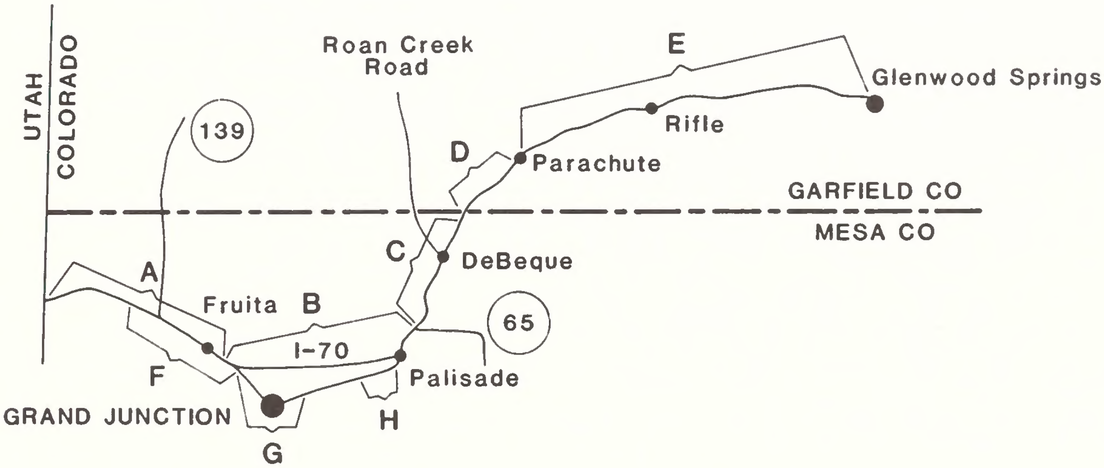


Figure 3.3-1 Regional Road Segments Evaluated for Noise Impacts

Table 3.3-1 BASELINE TRAFFIC NOISE LEVELS (Leq), EXISTING AND PROJECTED

Road[a] Segment	Decibel Level (dBA) at 50 feet								
	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	74	75	76	76	77	77	78	79	81
B	76	77	77	78	79	79	79	80	83
C	76	77	77	78	79	79	79	80	83
D	76	77	77	79	79	79	80	80	83
E	76	77	77	78	79	79	80	80	83
F	72	73	73	74	75	75	75	76	79
G	82	83	83	83	84	84	85	85	87
H	76	77	78	79	79	79	79	79	83
RCR[b]	46	46	47	47	47	47	48	48	49
Road 16[c]	46	47	47	47	47	47	48	48	49

[a] See Figure 3.3-1 for locations of road segments.
[b] RCR: Roan Creek Road from DeBeque to Clear Creek plant site.
[c] Road 16 from I-70 to Fruita alternative plant site.

3.4 WATER RESOURCES

3.4.1 Surface Water

3.4.1.1 Regional Setting

Water Supply

The proposed CCSOP is situated within the Upper Colorado River Basin (Colorado River Basin above Lees Ferry, Arizona). A major portion of the basin is drained by tributaries flowing southwest toward the Colorado River. Stream runoff in the Upper Basin is highly variable on a yearly and monthly basis. Stream flow data for the Colorado River at De Beque, shown on Table 3.4-1, illustrate this point.

Long-term records show that the average annual virgin flow for the Upper Colorado River Basin, computed at Lees Ferry, is 14.7 million acre-feet for the period from 1896 to 1979 (CRBSCF 1981). The Bureau of Reclamation has estimated that an annual average of up to 5.75 million acre-feet is available for Upper Basin depletion (consumption). This quantity is based on the estimated runoff of the Colorado River at Lees Ferry. The Upper Colorado River Compact of 1948 gave Arizona the right to the consumptive use of the first 50,000 acre-feet per year; the remaining water is apportioned to the other Upper Basin states in the following percentages (USDI 1973):

Colorado	51.75 percent
New Mexico	11.25 percent
Utah	23.00 percent
Wyoming	14.00 percent

The allocated share of the 5.75 million acre-feet of consumption for Colorado would be 2,976,000 acre-feet (BLM 1975).

Water Uses

In-basin consumption and out-of-basin exports account for average depletions of 3.362 million acre-feet per year (CRBSCF 1981) under 1979 "conditions of development", exclusive of evaporation from Colorado River Storage Project (CRSP) reservoirs (including Fontenelle, Flaming Gorge, Blue Mesa, Morrow Point, Crystal, and Lake Powell reservoirs). Nearly 66 percent (2,216,000 acre-feet) of the depletion is attributed to agriculture. Slightly less than 26 percent is attributed to exports out of the Upper Colorado River Basin, while the balance is distributed among the remaining uses. Given the depletions that occur during 1979 "conditions of development" and reservoir evaporation, the annual amount and monthly distribution of stream flows have been substantially altered. Colorado's portion of the 1979 depletions is 1,785,000 acre-feet; its distribution is presented in Table 3.4-2 (CRBSCF 1981). Stream flow depletions are expected to increase in the Upper Colorado Basin. By the year 1990, consumption for the Upper Colorado River Basin may range from 3,935,000 to 4,640,000 acre-feet per year (increasing 17-38 percent from 1979 "conditions of development").

Water Quality

Dissolved solids (salts) concentrations and loadings have long been recognized as the most prevalent water quality problems in the Colorado River Basin. Salts are contributed primarily during runoff in the Upper Basin and are concentrated downstream in the lower basin. In the Colorado River, approximately 60 percent of the salt load comes from natural sources (BLM 1975). The balance is from man's activities. Irrigation results in increases in salinity. Water is removed through evaporation and consumption by plants, but nearly all of the salt is returned to the river, concentrating the salts in a smaller volume of water. At the same time, agricultural return flows leach salts from soil and rocks, which adds to the river's salt load. Reservoir evaporation also contributes to increasing salinity. Out-of-basin export and in-basin uses that do not return water to the system ordinarily cause higher salt concentrations downstream. Salt loads contributed by municipal and industrial use are of minor significance.

Table 3.4-1 SUMMARY OF MEAN MONTHLY DISCHARGE AND TOTAL MONTHLY DISCHARGE FOR THE COLORADO RIVER NEAR DE BEQUE, 1966-1980

	Mean Monthly Discharge (cfs)												
Water Year	October	November	December	January	February	March	April	May	June	July	August	September	Total Flow (acre-ft)
1966-1967	1,712	1,468	1,306	1,298	1,280	1,632	2,295	5,408	9,099	4,520	2,173	2,027	2,067,000
1967-1968	1,764	1,666	1,539	1,384	1,428	1,473	2,088	5,149	12,770	4,046	3,579	1,959	2,346,000
1968-1969	1,963	1,821	1,625	1,646	1,537	1,526	3,821	8,893	8.126	5,598	2,348	2,059	2,478,000
1969-1970	2,727	2,185	1,859	1,659	1,689	1,903	2,667	13,820	14,760	5,983	2,696	3,042	3,326,000
1970-1971	2,618	2,354	1,989	2,143	1,980	2,418	4,705	8,430	14,940	7,356	2,725	2,603	3,276,000
1971-1972	2,191	2,144	1,901	1,712	1,818	2,294	2,789	6,447	11,010	3,297	2,019	2,231	2,407,000
1972-1973	2,425	2,282	1,875	1,789	1,819	1,940	1,999	9,531	14,030	9,102	3,361	2,167	3,166,000
1973-1974	2,230	2,141	1,819	1,791	1,758	2,251	3,031	11,620	10,950	4,468	2,423	2,035	2,814,000
1974-1975	2,047	2,027	1,740	1,700	1,646	1,793	2,280	5,934	12,400	9,429	3,242	2,170	2,806,000
1975-1976	2,083	2,077	1,811	1,630	1,734	2,102	2,544	6,428	7,656	3,400	2,314	2,073	2,169,000
1976-1977	2,026	1,731	1,586	1,496	1,290	1,178	1,643	2,273	2,890	1,862	1,732	1,685	1,292,000
1977-1978	1,474	1,289	1,257	1,251	1,321	1,565	2,816	6,803	14,000	5,955	2,076	1,759	2,508,000
1978-1979	1,686	1,855	1,417	1,255	1,413	1,710	2,604	9,700	15,410	8,510	2,903	1,945	3,048,000
1979-1980	1,958	1,891	1,711	1,700	1,772	1,762	2,879	9,693	14,470	5,287	2,268	2,011	2,865,000
Mean for Period of Record	2,065	1,924	1,674	1,604	1,606	1,825	2,726	7,866	11,608	5,630	2,561	2,126	2,612,000

Source: USGS (1968 to 1981).

Table 3.4-2 ESTIMATED WATER RESOURCES DEPLETION FOR 1979

Type of Use	On-Site Depletion (acre-ft) Colorado
Coal Development and Power Generation	12,000
Fish, Wildlife, Recreation, and other uses	58,000
Subtotal	70,000
Irrigation	1,175,000
Exports	540,000
Grand Total	1,785,000

Source: CRBSCF (1981).

The average annual salinity concentration of the Colorado River at Imperial Dam from 1941 to 1970 was 757 milligram per liter (mg/l) (BLM 1975). In 1972, the salinity concentration of the Colorado River at Imperial Dam was 879 mg/l. A projection of future salinity levels without a salinity control program suggests that a value of 1,070 mg/l could occur by 1995 (CRBSCF 1981). Although salinity is considered the most serious water quality problem, other potential problems include municipal wastes, industrial wastes, dissolved oxygen content, temperature, heavy metals, nitrate, sulfate, and bacteria (BLM 1975).

3.4.1.2 Clear Creek Mesa and Associated Siting Activities

Watershed Characteristics

Clear Creek Drainage. The topography of the upland plateau of the Clear Creek mesa is rugged, with high drainage density and moderate slopes. These upland drainages are truncated at their outlets by the near vertical cliffs formed from the resistant sediments of the Green River Formation. Clear Creek and its associated tributary streams (East Willow Creek, West Willow Creek, Willow Creek, No Name Creek, Mud Springs Creek, and Cottonwood Creek) flow through narrow V-shaped valleys near their headwaters on the plateau and through U-shaped canyons below the plateau. Clear Creek flows southeast into Roan Creek with a plateau gradient of approximately 145 feet/mile and a canyon gradient of approximately 120 feet/mile. There are no lakes or reservoirs in the area. Several irrigation ditches divert flow from Clear Creek for canyon floor irrigation.

Sediment yields vary with respect to the soil material of slopes, stream gradient, and vegetation cover. The top of the plateau is a relatively stable surface which contributes only a small amount of sediment (less than 340 tons/square mile/year). The canyons yield high amounts of sediment (about 1,700 tons/square mile/year) due to unstable canyon walls and steep stream gradients. The total estimated sediment yield for the Clear Creek drainage is about 101,500 tons/year (Moore 1982e).

Roan Creek Drainage. Roan Creek and its major tributaries (Clear Creek, Dry Fork, Conn Creek, Brush Creek, Kimball Creek) form the Roan Creek basin, which drains into the Colorado River. Roan Creek is a perennial stream, which receives flow from snowmelt, rainfall, runoff, and springs. Roan Creek flows east through a U-shaped valley with valley floor widths ranging from 25 to 100 feet on the plateau and from 500 to 1,500 feet in the canyon bottom. The stream channel is relatively unstable with significant meandering, braiding, and lateral gravel/sand bars. Stream banks are often undercut and highly erodible. Sparse riparian vegetation and some shrubs and grasses help to stabilize the channel. Roan Creek carries a very high sediment load during periods of moderate to high flow. Numerous diversions are found along Roan Creek. Water resources on Roan Creek are fully developed and are used to irrigate pastures and hay meadows and for stock watering.

The Roan Plateau has moderate relief, with elevations approaching 8,900 feet. The plateau has been deeply dissected as a result of regional uplift with relief up to 4,000 feet between the plateau and lower valley floors. The drainage basin is characterized by stream flow to the south across the structural dip toward the Colorado River. There are numerous short tributary segments with relatively steep gradients. Streams have dissected deeply through Tertiary sediments down into the Wasatch Formation underlying the Green River Formation. The southern edge of the Roan Plateau is marked by a fall line with vertical relief of about 600 feet. Streams cut through the resistant sandstone units of the Parachute Member into less resistant strata. The result is a system of deeply dissected canyons with vertical walls having relief up to 2,000 feet.

Stream Flows

Clear Creek Drainage. Discharge for streams in the CCSOP study area varies with respect to location and time. Monitoring stations on the plateau are located in the upper reaches of Clear Creek, West Willow Creek, East Willow Creek, No Name Creek, and Mud Springs Creek (Figure 3.4-1).

The mean annual discharge of the plateau streams ranged from 0.14 cubic feet per second (cfs) for No Name Creek to 0.98 cfs for Clear Creek (Table 3.4-3). The annual yield of these drainages ranges from 107 acre-feet for No Name Creek to 705 acre-feet for Clear Creek.

The canyonland streams include the lower reaches of Clear Creek, No Name Creek, Willow Creek, and Cottonwood Creek. The mean annual discharge of the canyonland streams ranged from 0.17 cfs for No Name Creek to 14.4 cfs for Clear Creek (Table 3.4-3). The annual yield of these drainages ranged from 122 acre-feet for No Name Creek to 10,473 acre-feet for Clear Creek. When the mean annual discharge and yield of the canyonland streams are compared to those of the plateau, the canyonland values are noticeably higher. The increase in stream discharge and yield is attributed to a higher number of contributing streams and the contribution of more springs and seeps.

The magnitude and continuity of stream discharge in the study area is also dependent upon seasonal and diurnal trends. Seasonal factors include total precipitation and snowmelt. During the summer, precipitation usually occurs in response to convective storms. These storms occur, on the average, 35 days each year, with the greatest probability of occurrence in August (30 percent). These storms produce intense localized rainfall which results in high stream flows of short duration. In the absence of this storm runoff, most of the stream channels are dry during the summer months (June-September).

During the winter, snow accumulation provides temporary storage of precipitation. Snowfall on the plateau occurs on an average of 20 days per year (Chevron 1982h). Annual snowfall on the plateau is approximately 100 inches, with drift accumulations greater than 72 inches in areas protected from insolation (sunlight). Regionally, the snowpack begins to build in December, reaches a maximum depth by April, and then dissipates within three to six weeks. The annual snowmelt produces peak discharges which may be 10-100 times the average discharge. Stream flow during melting represents approximately 21 to 57 percent of the total annual yield from the drainages studied.

Roan Creek Drainage. The stream flow in Roan Creek at USGS gaging station 09095000 has an average value of 43.2 cfs for 21 years (1922-1926, 1963-1972, 1975-1980) of record (USGS 1981). Flows range from 3.2 cfs (25 November 1963) to 2020 cfs (11 May 1980). Stream flow varies seasonally, with the high flow season from April to July. The 1980 flow records (Chevron 1982h) show that mean daily flow in May can be as high as 47 times the mean daily flow in October.

Irrigation diversions and return flows are the dominant factors in the Roan Creek hydrologic system. Streamside pasturelands and fields are flood-irrigated from March through November each year. Diversions located on the lower reach of Clear Creek totally dewater this tributary periodically. Diversions on Roan Creek downstream of Clear Creek have left the mainstream dry during portions of the year.

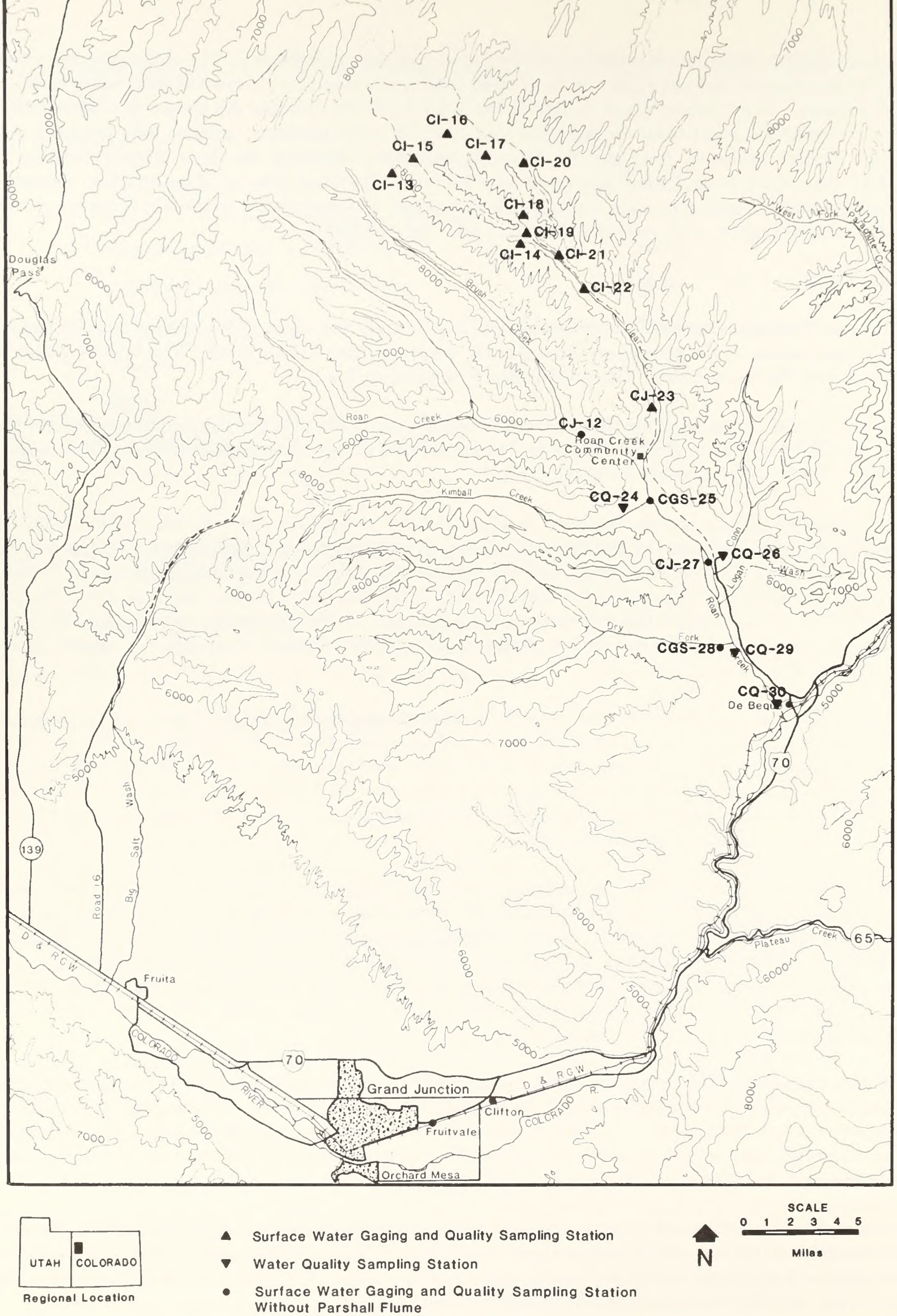


Figure 3.4-1 Location of Surface Water Monitoring Stations

Table 3.4-3 STREAM DISCHARGE AND ANNUAL YIELD FOR CLEAR CREEK WATERSHED, JULY 1980 THROUGH JUNE 1981

Station	Stream Discharge (cfs)		Area (acres)	Annual Yield (acre-ft)	Runoff (inches)
	Mean Annual	Range			
PLATEAU					
CI-13 (Clear Creek)	0.98	13.3-0.00	5,146	705	1.68
CI-15 (West Willow Creek)	0.30	22.4-0.00	2,618	218	0.96
CI-16 (East Willow Creek)	0.29	7.75-0.00	1,005	206	2.40
CI-17 (No Name Creek)	0.14	8.98-0.00	525	107	2.40
CI-20 (Mud Springs Creek)	0.25	8.98-0.00	890	178	2.40
CANYON					
CI-14 (Clear Creek)	0.74	5.57-0.00	11,283	488	0.48
CI-18 (No Name Creek)	0.17	1.20-0.00	2,675	122	0.60
CI-19 (Willow Creek)	0.87	7.65-0.00	11,072	631	0.72
CI-21 (Cottonwood Creek)	0.39	4.67-0.00	4,730	282	0.72
CI-22 (Clear Creek)	1.24	18.2-0.71	33,165	1,246	0.22
CI-23 (Clear Creek)	14.40	48.0-8.10	64,966	10,473	1.92

Source: Chevron (1982h).

Tributaries of Roan Creek, in addition to the Clear Creek drainage, include Brush Creek, Conn Creek, Kimball Creek, and Dry Fork. Kimball Creek flows east into Roan Creek through a U-shaped valley that widens downstream. Kimball Creek is much smaller than Roan Creek and carries a much lower range of flow. Water is used to irrigate pastures and hay meadows and for stock watering. Brush Creek is a perennial stream which flows southeast into Roan Creek. There are numerous small springs and seeps at the headwaters and a few large springs in the valley streambed. Recharge to the headwater springs is supplied by infiltration of snowmelt and precipitation (Chevron 1982h). Conn Creek flows southward into Roan Creek with a drainage area of 37.4 square miles. Water uses are primarily for stock watering and pasture irrigation. Dry Fork had an average annual flow of 4.73 cfs (Chevron 1982h) during water year 1980, with a maximum monthly average flow of 70.9 cfs in April and minimum of 3.33 cfs in December.

Water Quality

Clear Creek Drainage. The quality of surface water is dependent upon its physical and chemical properties. These properties reflect the influence of geology and climate on the hydrologic cycle. The physical properties of surface water quality include water temperature, concentration of suspended solids, and turbidity. Water temperature for the Clear Creek watershed ranged from −1 °C in February 1981 to 24 °C in August 1980 (Table 3.4-4). The greatest range of water temperature (7.5-24 °C) occurred during August 1980.

The concentration of total suspended solids ranged from below detection limits to extremely high values (Table 3.4-4). During periods of low precipitation, stream flow may be entirely comprised of ground water spring discharge in which the concentration of suspended solids is low. During the spring runoff and immediately following summer thunderstorms, the concentration of suspended solids is relatively high. As a result of the high concentration of suspended solids, the turbidity of the water reached a maximum of 3900 Nephelometric Turbidity Units (NTU).

Table 3.4-4 RANGES OF BASELINE WATER QUALITY DATA FOR CLEAR CREEK WATERSHED, 1980-1981

Parameter	Range[a,b]	Parameter	Range[a,b]
Inst. Discharge (cfs)	0-47.84	Nitrite, as N	ND-0.31
Temperature (°C)	-1.0-24.0	Fecal Coliform (colonies/100 ml)	0-36,800
Dissolved Oxygen	6.4-13.8	Boron	ND-0.90
pH (units)	7.10-8.68	Aluminum	ND-9.30
Total Suspended Solids	ND-13,000	Arsenic	ND-0.01
Total Dissolved Solids	188-3,300	Barium	ND-0.17
Settleable Solids	ND-150.0	Beryllium	ND
Turbidity (NTU)	ND-3,900	Cadmium	ND-0.006
Conductivity (umhos/cm)	195-3,700	Chromium, Hexavalent	ND
Total Hardness	140-1,200	Chromium, Total	ND-0.009
Biochemical Oxygen Demand	ND-11	Chromium, Trivalent	ND-0.007
Chemical Oxygen Demand	ND-149	Copper	ND-0.01
Silica	ND-120	Iron	0.02-7.20
Oil and Grease	ND-5	Lead	ND-1.60
Phenols	ND-0.05	Manganese	ND-0.21
Total Organic Carbon	ND-109	Mercury	ND-0.08
Calcium	26-510	Nickel	ND
Magnesium	14-260	Selenium	ND
Sodium	11-640	Silver	ND-0.002
Potassium	0.50-36.00	Thallium	ND
Chloride	ND-37	Uranium	ND- 25
Fluoride	ND-1.20	Zinc	0.02-0.05
Sulfate	15-2,150	Cyanide	ND-0.01
Carbonate Alkalinity, as $CaCO_3$	ND		
Total Alkalinity, as $CaCO_3$	100-1,100		
Sulfide	ND		
Phosphate, as P	ND-4.80		
Kjeldahl Nitrogen, as N	ND-2.87		
Ammonia, as N	ND-1.20		
Nitrate, as N	ND-10.10		

Source: Chevron (1982h)

[a] All units are in mg/l (ppm), unless noted otherwise
[b] ND = not detected

The chemical character of surface water is comprised of both organic and inorganic constituents. The parameters which represent the characteristics of surface water quality include: pH, dissolved oxygen, total dissolved solids (TDS), major cations, major anions, and fecal coliforms. The pH of the Clear Creek watershed ranged from 7.0 to 9.0 (Table 3.4-4). The water may be regarded as being neutral to mildly alkaline. The variation in pH appears to be independent of flow or season.

The concentration of dissolved oxygen (DO) is an indicator of oxygen availability for aquatic organisms. The concentration of dissolved oxygen in the Clear Creek watershed ranged consistently from 6.8 to 13.8 mg/l, approaching saturation (Table 3.4-4). The concentration of dissolved oxygen varies with respect to water temperature. As water temperature decreases, the solubility of oxygen increases, resulting in increased DO concentrations.

The concentration of total dissolved solids (TDS) represents the concentration of soluble inorganic anions and cations, organic material, and dissolved materials. The principal inorganic anions dissolved in water include carbonate, chloride, sulfate, and nitrate. The principal cations include sodium, potassium, calcium, and magnesium. For the Clear Creek watershed, TDS ranged from 188 to 3300 mg/l (Table 3.4-4).

Fecal coliforms (bacteria) are commonly used to indicate the contamination of water by warm-blooded animals. In the Clear Creek area, grazing animals are the most likely source of fecal coliforms. Values of fecal coliform ranged from 0 to 36,800 colonies per 100 milliliter (ml). Most values were in the range of 0-2,500 colonies/100 ml with few high values reported.

A number of potentially hazardous trace metals and bacteriological constituents were identified. The maximum concentrations of lead and mercury were sometimes in exceedance of established EPA drinking water standards (EPA 1976). Parameters such as arsenic, barium, cadmium, chromium, fluoride, and silver were either never detected or within EPA primary drinking water limits (Table 3.4-4).

The relative quality of water varies with respect to location and time. For the plateau and upper canyonland drainages, the concentration of dissolved solids was consistently lower than that recorded at the lower canyon sampling sites. Furthermore, the concentration of dissolved solids increased at each sampling site with decreasing stream discharge. Only the concentration of suspended solids and the turbidity of water were found to increase with increasing stream discharge.

Roan Creek Drainage. Roan Creek and other tributaries extending upstream from the above confluence with Clear Creek have been recommended for cold water biota classification to protect trout populations (CDOH 1976). Roan Creek (from Clear Creek to the confluence with the Colorado River) and Clear Creek meet the criteria necessary for classification for irrigation and warm water biota usage.

The water quality of Roan Creek is affected by sedimentation resulting from erosion of the Wasatch and Green River formations. Overgrazing combined with erosion of bedrock units results in high sediment yields for the area. Roan Creek has been identified as a high sediment yield area with an annual erosion rate of 0.5-1.0 acre-feet/square mile (Colorado Land Use Commission 1974). The mainstems of Roan and Conn creeks and Dry Fork have been listed as systems with "severely eroding banks and gullies", losing from 1 to 2 acre-feet/bank-mile/year (CDOH 1976). Elevated erosion rates in Roan Creek are positively correlated to stream flow. These two factors have accelerated erosion and increased suspended solids and dissolved solids in the stream. In 1975 the annual average concentrations of total dissolved solids in Roan Creek exceeded 1,000 mg/l for all stations downstream of Kimball Creek and exceeded 400 mg/l upstream of Kimball Creek (CDOH 1976). The relationship of the TDS concentrations between Roan Creek and the Colorado River is shown in Figure 3.4-2.

The effect of the Wasatch Formation on Roan Creek water quality is evidenced by high sulfate concentrations. The Wasatch Formation contains an abundant quantity of calcium sulfate, while the overlying Green River Formation contains sodium bicarbonate. Annual average sulfate concentrations in 1975 ranged from 280 mg/l upstream of Kimball Creek to 530 mg/l downstream of Kimball Creek, thereby exceeding the 250 mg/l concentration specified by the Colorado Domestic Water Use criteria (CDOH 1976).

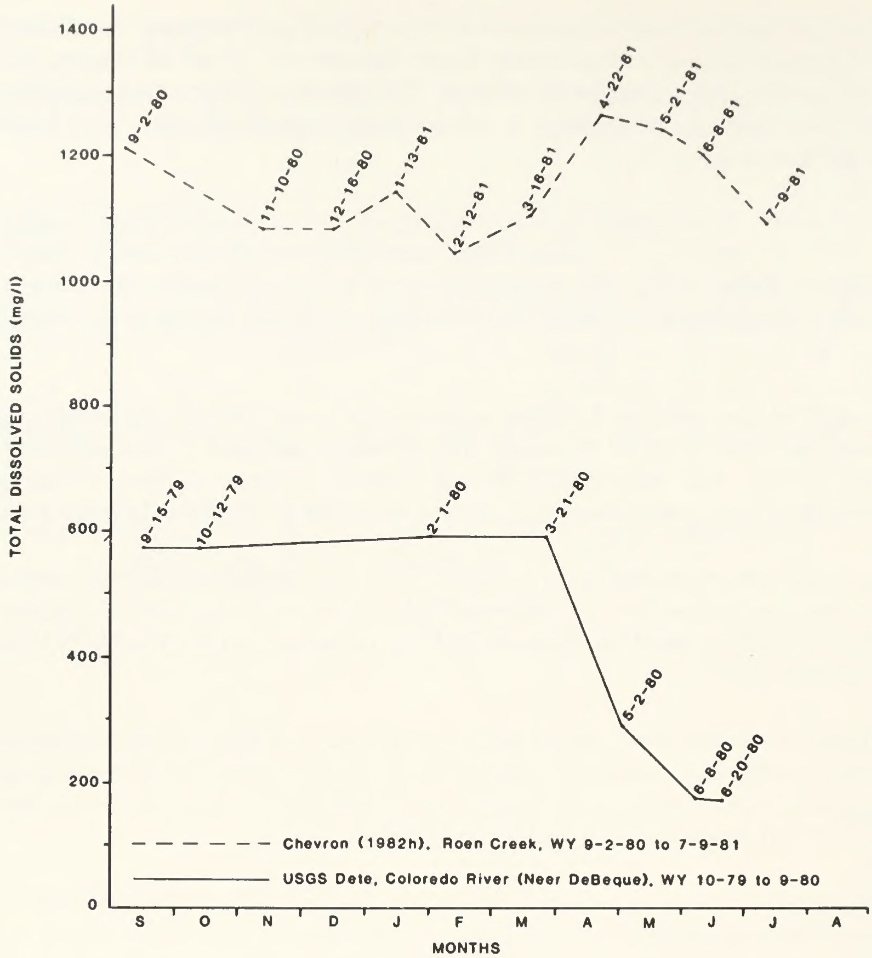


Figure 3.4-2 TDS Comparisons Between Roan Creek and the Colorado River, 1979 to 1981

3.4.1.3 Grand Valley and Associated Siting Activities

Five types of water bodies are found in the Big Salt Wash drainage area: lakes and reservoirs (Echo Lake, Ruby Lee Reservoir), perennial streams, intermittent streams, ephemeral streams (e.g., Mack Wash and Coyote Wash), and man-made canals (Highline Canal and Grand Valley Canal). Most of the streams exhibit considerable monthly and seasonal fluctuations in physical and chemical conditions.

The Big Salt Wash drainage basin is confined by a narrow southwest trending valley with flow to the southwest and south into the Colorado River just west of the town of Fruita. The stream is marginally perennial with intermittent flows during dry summers. Mean monthly discharge data from USGS gaging station 09153270 (1973-1977) range from 6.8 cfs to 142 cfs (BLM 1981b). However, discharge at the proposed upgrading site would be considerably less due to decreased watershed area and flow introduced to Big Salt Wash from the Highline and Grand Valley canals below the site. Big Salt Wash is a moderately stable meandering stream with a silt/sand substrate with some cobbles. Significant bed material movement probably occurs during high flows. The channel gradient averages 15 feet of drop per 1,000 feet of stream length. The channel width averages 10-20 feet and the depth averages 5 feet, with some reaches incised 10-15 feet. Some steep banks are undercut and highly erodible. In general, bank vegetation is dominated by a low to moderate density of shrubs with some grasses and deciduous trees. Heavy livestock grazing has resulted in moderate bank and vegetation disturbance. Water use is limited to stock watering in the lower stream reaches.

Tributary drainages to Big Salt Wash are ephemeral, average 1-2 square miles in area, and generally flow less than 1 month each year in response to spring snowmelt or intense summer thunderstorms.

Irrigation from Big Salt Wash and the Grand Valley Canal occurs primarily during the summer at lower elevations in the canyons and valleys. Ditch records for the 1979-80 water year indicate that irrigation began in mid-May and ended in December (Chevron 1982h). Irrigation causes high evapotranspiration losses and greater ground water recharge during periods of diversion. Although a highly variable portion of the water used for irrigation reappears in the stream as return flow, the net result is lower stream flows during irrigation periods.

3.4.1.4 Alternative Siting Activities

Streams that could potentially be impacted by the various corridors include perennial streams of Parachute Creek, Piceance Creek, Soldier Creek, Lake Creek, Cathedral Creek, East Douglas Creek, and Douglas Creek. Soldier and Lake creeks are tributaries of Cathedral Creek, which empties into East Douglas Creek. The physical and chemical characteristics of these creeks show a consistent pattern of high quality in the upper stream with decreasing quality downstream, partially caused by irrigation and subsequent drainage through salty soils. Some portions of the stream system are polluted with livestock wastes during the grazing season. Parachute Creek has higher concentrations of total dissolved solids (TDS), sulfate, sodium, and manganese, but lower concentrations of suspended solids and BOD (Chevron 1982b) compared to other drainages in the vicinity of the project area.

Douglas Creek receives water from East Douglas Creek and flows predominantly northward, emptying into the White River about 2 miles northeast of Rangely, Colorado. Douglas Creek is used almost exclusively for irrigation. Surface water in most streams in the region results primarily from surface runoff. However, base flow in perennial streams during low flow periods is fed by ground water. Snowmelt occurs during the months of May and June. Brief intense thunderstorms cause most stream flow peaks during the summer months of July and August.

Surface water records indicate that Piceance Creek, which drains northward into the White River, and a few of its major tributaries are perennial streams. Spring discharge during the dry season often accounts for the majority of the flow. Stream flow may disappear where the alluvium is thick and then reappear where the alluvium thins and the saturated zone reaches the channel bottom. Water in the uplands is supplied only by precipitation, but bottomland precipitation is supplemented by irrigation diversions, ground water discharge, and runoff from adjacent valley slopes. The surface water supplies of the Piceance Basin are moderately developed for irrigation.

Parachute Creek drains an area of approximately 200 square miles and discharges into the Colorado River. Tributaries include Davis Gulch, Middle Fork, East Fork, West Fork, and East Middle Fork of Parachute Creek. There are numerous springs, gulches, and arroyos along the stream's course which run intermittently. Stream flow during the low flow period depends mainly on springs which emerge near or in the creek bed. The tributaries to the main stem of Parachute Creek show wide fluctuations in stream flow. Based on flow data from above and below its mouth, Parachute Creek contributes approximately 1 percent to the total flow of the Colorado River at Parachute (Grand Valley).

3.4.2 Ground Water

3.4.2.1 Regional Setting

Ground Water Occurrence

The Green River Formation serves as the principal ground water source in the Piceance Basin (Figure 3.4-3). Water-bearing strata of lesser importance have also been identified in the overlying Uinta Formation and the underlying Wasatch Formation. The alluvial deposits of the area's larger drainages carry significant quantities of ground water.

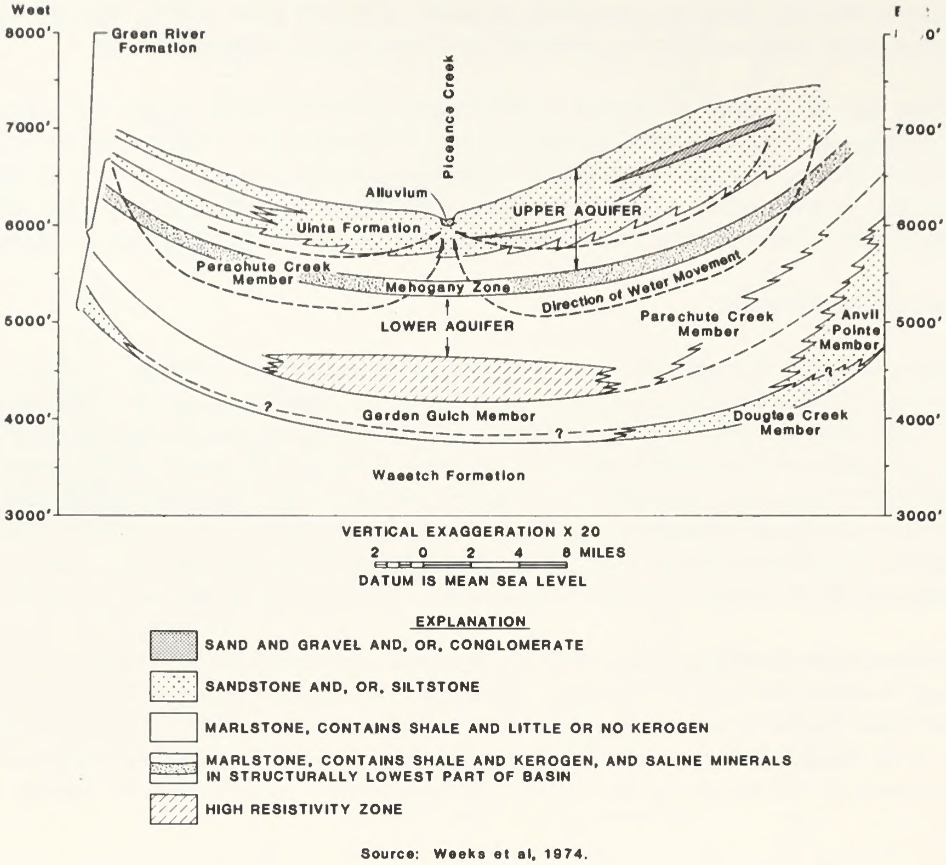


Figure 3.4-3 Diagrammatic Hydrostratigraphic Section Across the Piceance Creek Basin Showing Relation of Regional Ground Water Flow to the Green River and Uinta Formations

The Uinta Formation outcrops on mesa and ridge tops and is the youngest bedrock strata in the area. Wells commonly yield water around 100 gallons per minute (gpm), although yields as high as 500 gpm have been observed (Weeks et al. 1974). In many locales, the Uinta has been deeply incised by streams and erosion. In these areas the Uinta is well drained and essentially devoid of ground water. Permeability in the Uinta is generally the result of secondary permeability features (e.g., fractures and faults). This is typical of the ground water hydrology of the Piceance Basin, which is dominated by fracture-controlled permeabilities in sedimentary strata. Ground water movement generally occurs through interconnected, open fractures (secondary permeability) rather than the porous spaces of the rock matrix (primary permeability).

The Parachute Creek Member of the Green River Formation underlies the Uinta Formation and is often hydrologically connected with it (Weeks et al. 1974). The Uinta and Parachute Creek strata are typically referred to as the "upper aquifer". As the most significant aquifer in the region, the Upper Parachute Creek Member produces well yields as high as 1,000 gpm. Higher quantities of ground water may be obtained where fracture systems are better developed. Recharge to the Uinta and Upper Parachute Creek aquifers is largely through direct infiltration of precipitation and snowmelt. Ground water is discharged through springs and seeps to stream valleys of the region.

A "lower aquifer" has also been identified in the Parachute Creek Member below the Mahogany oil shale zone. Ground water occurs in fractured and leached marlstones and may extend into the underlying Garden Gulch Member. Recharge to this zone is apparently rather limited. It is restricted largely to infiltration of precipitation through fractures in the outcrop areas.

Water-bearing geologic units below the lower aquifer yield small quantities of ground water. No appreciable water-bearing intervals have been identified in the lower Garden Gulch Member or the Douglas Creek Member of the Green River Formation. The underlying Wasatch Formation is also generally devoid of ground water, although ground water may occur in sandstone units of the Shire and Molina members.

In summary, ground water flow in bedrock aquifers of the Piceance Basin is highly variable due to secondary permeability structures (fractures and faults). As depicted in Figure 3.4-3, ground water occurring in the upper and lower aquifers flows from the recharge areas on the basin margin toward the north central part of the basin.

Alluvial deposits are also a major source of ground water in many of the region's stream valleys, including Piceance, Roan, Clear, and Parachute creeks. The alluvial aquifers yield higher quantities of ground water and are typically more transmissive than bedrock aquifers, although their extent is more limited. Alluvium ranges in thickness from 0 to 140 feet, with up to 100 feet of saturated thickness. Well yields may be as high as 1,500 gpm. Recharge to the alluvial deposits is from precipitation, surface water infiltration, springs or seeps emanating from the Green River Formation, and subsurface discharge of bedrock aquifers into alluvial aquifers (Chevron 1982g).

Ground Water Quality

The ground water chemistry of both bedrock and alluvial aquifers is quite variable in the region. Generally, higher concentrations of total dissolved solids (TDS) have been observed regionally in the center of the Piceance Basin, and locally in discharge areas. TDS values for the Green River Formation range from 250 to 63,000 mg/l. Waters in the upper aquifer are typically of better quality than those in the lower aquifer (Coffin et al. 1971). The ground waters of the bedrock aquifers are generally a sodium bicarbonate type, although locally high concentrations of calcium, magnesium, and chloride occur (Weeks et al. 1974).

Total dissolved solids (TDS) in the alluvial aquifer increases down flow gradient with water quality analyses range from 250 mg/l TDS in recharge areas to as high as 25,000 mg/l in discharge areas (Weeks et al. 1974). The quality of the alluvial ground water is apparently affected by dissolution of minerals comprising aquifer material, recharge from hydrologically connected bedrock aquifers, and irrigation return flows. Near the headwaters of the principal drainages, TDS in the alluvial aquifers ranges from 250 to 700 mg/l and the waters are typically of a calcium/magnesium-bicarbonate type. The waters evolve to a sodium-bicarbonate type as ground water flows down gradient within the alluvial aquifers (Coffin et al. 1971).

3.4.2.2 Clear Creek Mesa and Associated Siting Activities

Ground Water Occurrence

Figure 3.4-4 presents the locations of the wells installed as part of the ground water environmental studies. Clear Creek site hydrologic testing indicates that the Upper Parachute Creek Member is water-bearing above the Mahogany Zone, as is the Lower Parachute Creek Member below the Mahogany Zone. No testing was performed on strata beneath the Parachute Creek Member. One well was drilled and completed in the Uinta Formation. Atypical of regional ground water occurrence in the Uinta Formation, this well was found to be dry, indicating that the Uinta Formation may be unsaturated at the site (Chevron 1982g).

Testing of the Upper Parachute Creek upper aquifer was performed only at the base of the unit, in a sandstone stratum known as the A Groove. Hydraulic conductivities ranged from 0.02 to 0.55 feet/day at two locations on the site.

Based on these values for hydraulic conductivity, approximate transmissivities of 0.07 and 85.80 square feet/day were calculated. This range of values represent a low transmissivity; this is atypical of regional transmissivity, which may be as high as 1,000 square feet/day (Chevron 1982g).

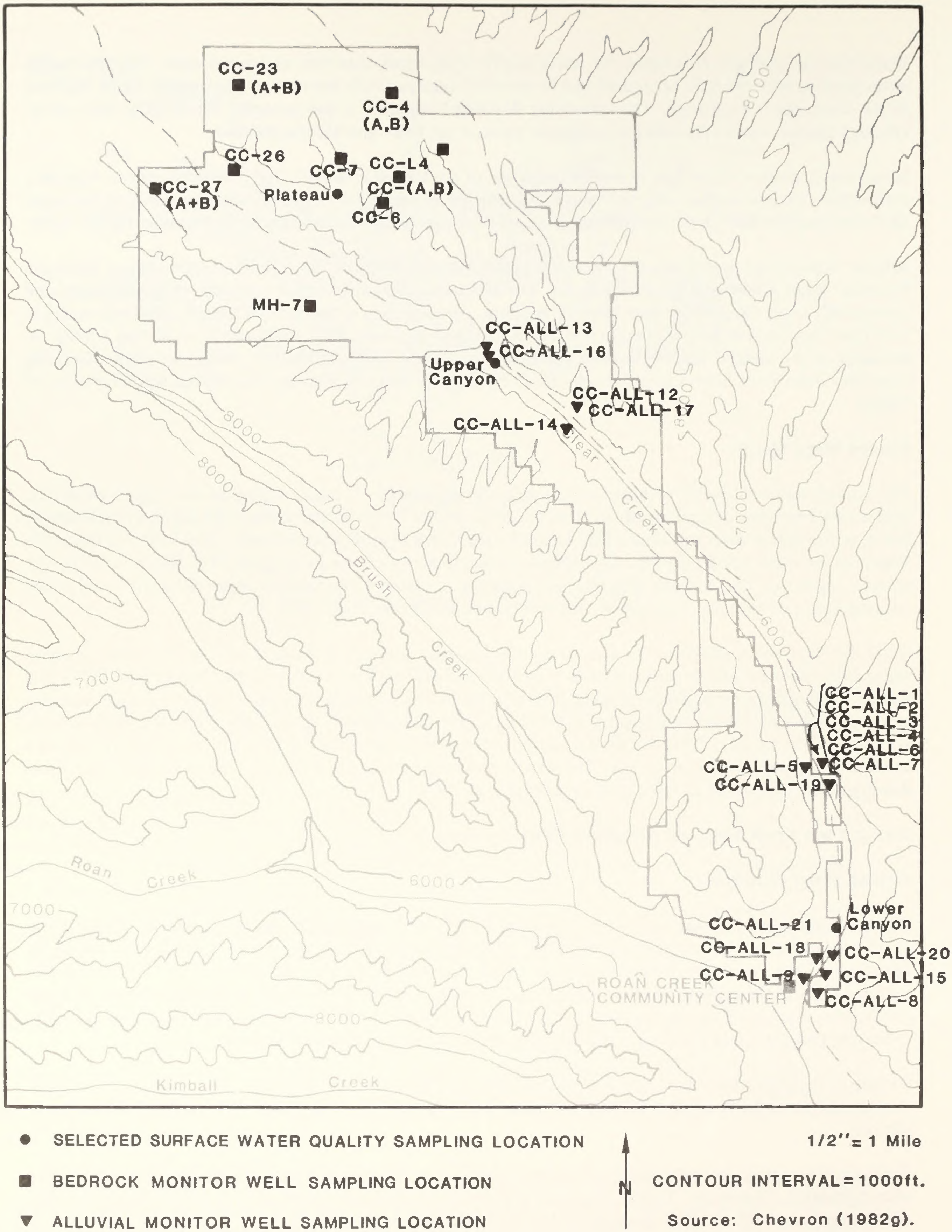


Figure 3.4-4 Generalized Location of Bedrock and Alluvial Wells and Selected Surface Water Stations

The hydraulic conductivities for the Lower Parachute Creek Member (lower aquifer) were derived from testing of the B Groove, a sandstone unit situated immediately below the Mahogany Zone. These values ranged from 0.0008 to 0.030 feet/day at three test locations, indicating that this stratum is lower in permeability than the A groove above the Mahogany Zone (Chevron 1982g, 1982w). Pressure head differences between the A and B Groove and flowing artesian conditions in one of the B Groove wells suggest that the Mahogany Zone may serve as a confining or semi-confining zone at some locations on the Clear Creek site. Field testing and measurements also indicate that A and B Groove aquifers may be connected at selected locations by fracture systems (Chevron 1982w).

The relationship between water levels and vertical head gradients shown in Figure 3.4-5 indicates that recharge to the Parachute Creek Member on the Clear Creek site follows the regional trend, with direct infiltration of precipitation as the dominant recharge mechanism. Recharge in this manner generally results in a strong vertical hydraulic gradient, and such is apparently the case on the plateau, as indicated in Figure 3.4-5.

Based on data collected from the A Groove, B Groove, and open holes drilled through the Mahogany Zone, the piezometric surface for this composite bedrock aquifer displays a significant gradient towards the Clear Creek drainage (Figure 3.4-6) (Chevron 1982g). Based on this relationship, recharge probably occurs from infiltration on Clear Creek mesa and the Piceance Basin and discharge occurs through evapotranspiration and through springs and seeps on the canyon walls.

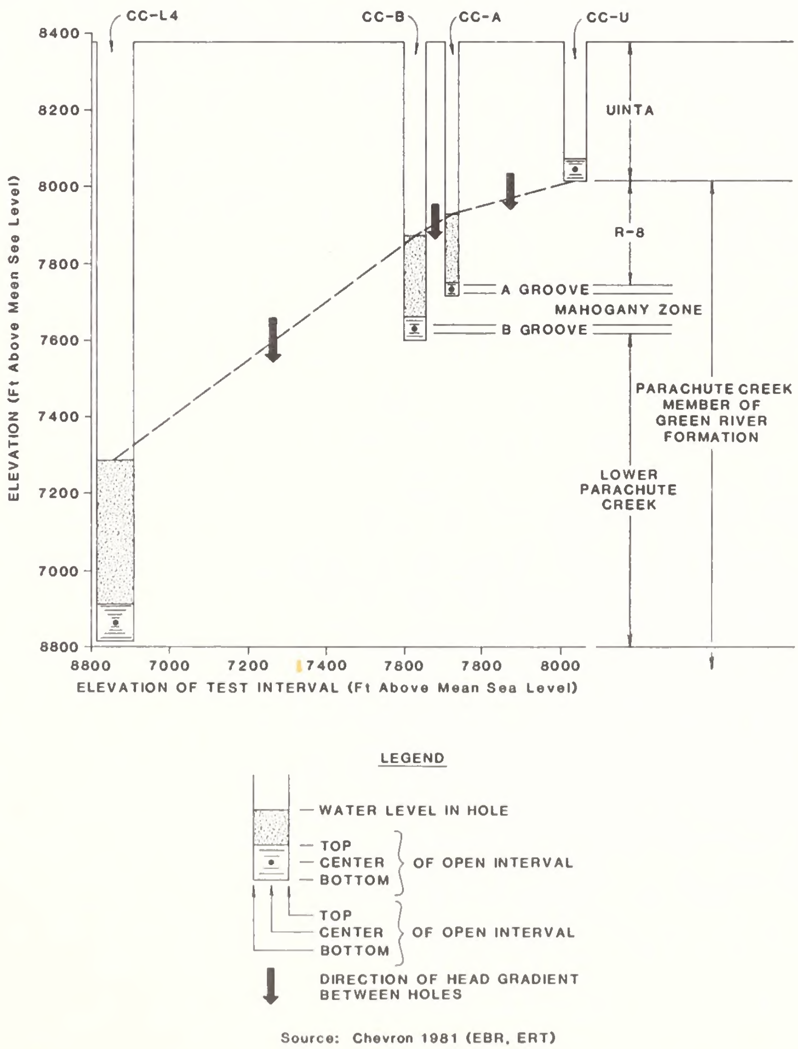


Figure 3.4-5 Water Levels and Vertical Head Gradients, Clear Creek Drainage

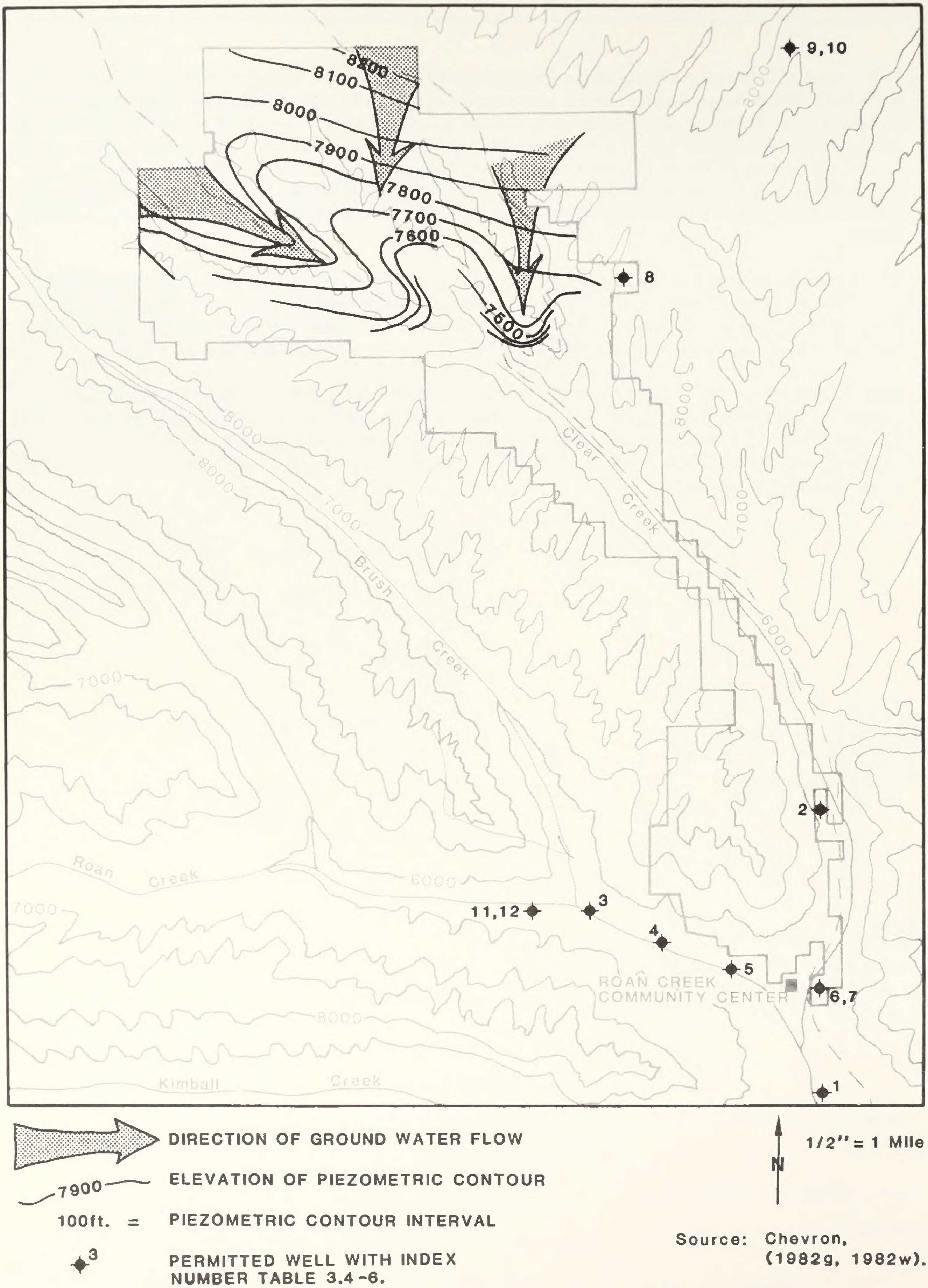


Figure 3.4-6 Generalized Direction of Ground Water Flow and Contours of Piezometric Head and Locations of Permitted Wells

The hydraulic properties of alluvial deposits at the Clear Creek site were investigated at locations in Clear Creek canyon (Figure 3.4-4). The transmissivity of alluvial deposits at these locations ranges from 16,300 to 61,920 square feet/day (Chevron 1982g, 1982w). The saturated thickness of the alluvial aquifer ranges from 48 to 72 feet.

Ground Water Quality

The water chemistry of the upper and lower Parachute Creek aquifer (Table 3.4-5) exhibits an increase in the concentration of dissolved solids with depth. Ground water of the bedrock units is typically of a sodium-bicarbonate type. High chloride concentrations were noted in the Lower Parachute Creek Member at an approximate depth of 1,500 feet below the top of the plateau (Chevron 1982g). TDS values of 440 mg/l in surface water in Willow Creek on top of the plateau increase to 550 mg/l in the A Groove, 680 mg/l in the B Groove, and 23,500 mg/l in the Lower Parachute Creek Member (Chevron 1982g). Calcium and magnesium concentrations display a decrease with depth, whereas sodium and bicarbonate increase. The saline nature of the Lower Parachute Creek Member is consistent with regional trends.

Table 3.4-5 AVERAGE WATER QUALITY RESULTS, CLEAR CREEK PROPERTY

	Bedrock Wells						
Parameter	CC-A A	CC-B B	CC-L4 LPC	CC-4(A) A	CC-4(B) B	CC-6(A) A	CC-7(B) B
FIELD							
pH	7.5	8.0	8.2	7.0	7.5	7.0	7.4
Conductivity (umhos/cm)	840	980	30,000	760	4,000	750	750
Alkalinity (mg/l)	425	660	15,000	440	4,000	400	500
Temperature (°C)	12	13	20	10	14	10	10
LABORATORY (mg/l)							
Total Dissolved Solids	550	680	23,500	540	3,000	540	540
Major Cations							
Calcium	23	6	5	58	12	55	12
Magnesium	21	11	4	34	17	41	18
Sodium	160	250	9,300	96	1,100	82	180
Potassium	2	0.8	60	0.3	0.6	0.3	0.2
Major Anions							
Chloride	6	—	6,000	2	2	2	—
Sulphate	85	6	2	81	40	90	25
Carbonate	390	600	11,000	400	2,800	390	470
Major Ions							
Fluoride	4.3	4.0	7.0	1.4	3.4	1.2	2.0
Kjeldahl Nitrogen	0.6	0.8	18	0.2	0.6	0.2	0.5
Boron	0.3	0.3	9	0.1	0.4	0.2	0.3
Aluminum	—	—	0.1	—	—	—	—
Barium	—	1.0	1.8	0.1	0.5	0.2	0.5
Copper	—	—	—	—	—	—	—
Iron	.06	0.2	1.0	0.5	0.23	0.1	0.15
Manganese	.02	0.01	0.3	—	—	0.01	—
Zinc	0.4	0.1	0.9	0.01	0.02	0.1	0.01
Organics Detected	BHC	Bis(2-ethyl hexyl)phtha late	Endosulfan	Aldrin Endosulfan BHC	BHC	Endosulfan	

Table 3.4-5 AVERAGE WATER QUALITY RESULTS, CLEAR CREEK PROPERTY (Continued)

	Alluvial Wells			Surface Water		
Parameter	CC-All-4 Canyon	CC-All-4 Canyon	CC-All-12 Canyon	Upland Plateau	Upper Canyon	Lower Canyon
FIELD						
pH	6.8	6.9	7.0	8.2	8.2	7.9
Conductivity (umhos/cm)	800	2,000	700	670	640	940
Alkalinity (mg/l)	400	600	400	N/A	N/A	N/A
Temperature (°C)	9	13	8	N/A	N/A	N/A
LABORATORY (mg/l)						
Total Dissolved Solids	600	1,700	550	440	410	620
Major Cations						
Calcium	70	130	53	64	55	72
Magnesium	45	125	41	30	33	49
Sodium	75	230	92	53	50	76
Potassium	2.2	3.9	4.0	1.2	1.3	2.6
Major Anions						
Chloride	12	23	10	1.8	1.8	11
Sulphate	140	750	130	90	90	150
Carbonate	360	540	380	300	285	370
Major Ions						
Fluoride	0.9	1.2	1.2	0.2	0.4	0.9
Kjeldahl Nitrogen	0.3	0.8	0.1	0.3	0.3	0.3
Boron	0.3	0.4	0.5	0.07	0.01	0.2
Aluminum	—	—	—	0.7	0.3	—
Barium	—	0.1	0.1	0.1	0.02	—
Copper	—	—	—	—	—	—
Iron	0.1	0.6	0.04	0.5	0.1	0.05
Manganese	—	0.05	—	0.03	0.01	—
Zinc	0.02	0.05	0.03	0.005	0.01	—
Organics Detected	Endosulfan BHC	—	Heptachlor BHC	4,4′ - DDD Heptachlor Aldrin BHC	4,4′ - DDE Endosulfan Aldrin BHC	—

Source: Chevron (1982g).

The water chemistry of the alluvial ground water is documented at three locations in Clear Creek canyon (Figure 3.4-4). The two upstream sampling points exhibit relatively similar characteristics, whereas the third location, near the confluence with Roan Creek displays a significant increase in several constituents. TDS values range from 575 mg/l in the upstream well to 1,700 mg/l at the downstream well (Chevron 1982g). The waters generally have moderate amounts of magnesium, calcium, and sodium (Table 3.4-5). A high sulfate concentration occurs at the downstream alluvial well, possibly due to the occurrence of gypsum in the Wasatch Formation, which is prevalent beneath the alluvium at this location.

Ground Water Use

An inventory of existing well permits indicates that only four wells (2, 6, 7, and 8) are located on CCSOP property (Table 3.4-6 and Figure 3.4-6) with an additional eight wells (1, 3, 4, 5, 9, 10, 11, and 12) located nearby. Of these wells, three are drilled in upland areas (one on the property) and nine are drilled into or through the

Table 3.4-6 EXISTING WELL PERMITS

Ref.	Permit Number	Owner	Range	Township	Sec.	1/4	1/4	Use	Date	Well Yield (gpm)	Total Depth (ft)	Water Level (ft)	Annual Appropri-ation (acre-ft)	Irri-gated Acres
21	5-23-006050F	Whatley, W.J.	98W	7S	10	NE	SW	Irrig.	08-25-64	1600	73	11	—	—
23	5-23-013813R	Pacific Oil Co.	96W	6S	22	NE	NW	Irrig.	01- -40	50	20	7	—	—
24	5-23-016373R	Altenbern, L.R.	98W	6S	30	NW	NW	Irrig.	06- -52	24	50	15	—	—
25	5-23-016374R	Altenbern, O.	98W	6S	32	SW	NW	Irrig.	05- -51	23	60	18	—	—
26	5-23-019455	Foothill Corp.	98W	6S	33	NE	SW	Domes.	04-30-64	20	59	25	—	—
27	5-23-013811R	Pacific Oil Co.	98W	6S	34	NE	SW	Irrig.	06- -49	900	500	10	—	—
28	5-23-013812R	Pacific Oil Co.	98W	6S	34	NW	SW	Irrig.	01- -40	100	70	40	—	—
29	5-23-076489	Johnson, I.C.	98W	5S	10	SW	NE	Stock	09-15-74	5	350	—	—	—
30	6-52-025815	Johnson, P.	98W	4S	25	NE	NW	Stock	11-30-65	20	83	60	—	—
31	6-23-025815	Johnson, P. & I.	98W	4S	25	NE	NW	Stock	11-30-65	20	83	—	—	—
36	5-23-009372F	Cullman, R. & R.	99W	6S	25	NE	SW	Irrig.	05-27-65	380	85	45	—	—
37	5-23-015864F	Cullman, R. & R.	99W	6S	25	NE	SE	Irrig.	10-17-51	500	75	39	—	—

Source: Chevron (1982g).

alluvial deposits of Roan and Clear creeks (three on the property). Well yields range from 5 gpm for the upland wells on the Clear Creek property to a maximum of 1,600 gpm from an irrigation well in the Roan Creek alluvium (Chevron 1982g).

Surface and Ground Water Interaction

Detailed investigations indicate that a direct connection between ground water and surface water may not occur in the middle and upper portions of Clear Creek canyon (Chevron 1982w). Results from alluvial pumping tests conducted at the Crusher Site, the Cottonwood Site, and the Main Site (between Buck and Scott Gulch) indicate that surface water flow in Clear Creek is not affected by prolonged pumping of ground water.

Water chemistry data are limited relative to the interaction between surface and ground water. Existing data indicate that springs and alluvial ground water are chemically very similar (Chevron 1982g). With the exception of one of the lowermost alluvial wells, the chemistry of the alluvial ground water and the surface water are also similar; TDS concentrations are uniformly in the range of 410 to 620 mg/l. As noted above, the water chemistry of the lowermost alluvial well may be attributable to gypsum in the Wasatch Formation.

3.4.2.3 Grand Valley and Associated Siting Activities

Ground Water Occurrence and Use

Ground water near the Fruita facility site appears to be restricted to deep bedrock and to shallow alluvial deposits and within thin sandstone stringers of the Mancos Shale. Alluvial deposits are principally limited to Big Salt Wash which is approximately 1 mile to the east, and in the Colorado River Valley 12 miles to the south. These valley fill deposits are comprised of stratified clay, sands, and gravels derived from surrounding sedimentary bedrock and glacial deposits. Existing published sources indicate that well yields of 5 - 100 gpm are typical from these unconsolidated deposits in some areas, but alluvium adjacent to the site is not considered as a significant source of water. Two existing irrigation wells have been documented as being completed in Colorado River alluvium within 15 miles of the site.

No wells have been documented as utilizing the alluvium of Big Salt Wash or the smaller Mack and Coyote washes which cross the project area. Saturated alluvial deposits occur in Big Salt Wash. These drainages probably contribute to the base flow of this perennial stream. Stream flow is utilized only for irrigation, and some ground water within the alluvium may have other indirect uses.

Small amounts of poor quality ground water also occur in the Mancos Shale in the area. Several hundred feet of this geologic unit underly the entire site and are comprised of calcareous and fissile shales. The Mancos Shale is not considered a significant source of ground water. Such water is used in isolated areas of the region for domestic and stock supplies. No such use is documented in the Grand Valley vicinity.

Additional ground water beneath the project area is found in the Dakota Formation, Salt Wash Member of the Morrison Formation, and the Entrada and Wingate sandstones. Use of these ground waters is undocumented in the area.

Ground Water Quality

The quality of ground water in the Fruita area is generally poor. The two wells completed in alluvial deposits of the Colorado River yield waters with TDS concentrations from 3,600 to 5,200 mg/l. Water in the Mancos Shale is also highly mineralized, with TDS values typically at or above 3,000 mg/l.

Waters in the deeper formations are generally softer, with TDS values ranging from 600 mg/l in the Entrada Sandstone to 1,500 mg/l or more in the Dakota Sandstone.

3.5 Topography, Geology, and Paleontology

3.5.1 Topography

3.5.1.1 Regional Setting

The CCSOP is located at the southwestern end of the Piceance Creek Basin, near the northeastern edge of the Colorado Plateau physiographic province. The Basin now exists (in relation to the surrounding landscape) expressed as a high plateau, known as the Roan Plateau. It has been deeply dissected by streams, forming steep, cliff-lined canyons.

3.5.1.2 Clear Creek Mesa and Associated Siting Activities

Clear Creek mesa consists of an upland area of moderate relief which grades into near vertical cliffs and very steep slopes. Resistant rock units outcrop along the major drainages. Talus slopes lie beneath the cliffs and locally between them, and extend to the valley bottoms. Elevations at the site range from a maximum of 8,535 feet, near the northwestern corner of the property, to a minimum of about 5,590 feet at the confluence of Clear and Roan creeks (Chevron 1982k). Slopes in the upland areas range up to 45 percent and average about 17 percent. The talus slopes are uniformly about 65-75 percent.

The proposed Roan Creek corridor follows the drainages of Clear and Roan creeks. The corridor climbs from about 4,940 feet at De Beque to about 8,000 feet elevation on Clear Creek mesa. The northern portion of the corridor, in the Clear Creek canyon, is bounded by steep slopes ranging from 65 to 75 percent. The canyon bottom is comprised of slopes of generally less than 15 percent. South of the confluence with Roan Creek, the valley bottom is gently sloping. The valley side slopes vary with location but are generally less than 40 percent. Relief diminishes to the south (Chevron 1982k).

Elevations along the Big Salt Wash corridor range from a maximum of 9,035 feet on the divide between Carr Creek and East Douglas Creek to a minimum of about 4,440 ft in the Grand Valley. Most of the route is over terrain of low to moderate relief. About 2.4 miles covers steep terrain at the head of Big Salt Wash. South of the Book Cliffs, the route crosses nearly flat terrain.

The Parachute Creek corridor ranges in elevation from a maximum of 8,548 feet on Sleepy Ridge to a minimum of 7,880 feet at the confluence of Wet Fork and the West Fork of Parachute Creek. Slopes are generally less than 30 percent. Many portions of the corridor follow ridge lines and stream valleys where there is little relief (Chevron 1982k).

The Upper Dry Fork reservoir area consists of a gently sloping valley bottom, flanked by moderate slopes ranging from about 15 percent to 40 percent. Small, near vertical ledges are present locally. The valley bottom at the dam site is at an elevation of 5,150 feet.

3.5.1.3 Grand Valley and Associated Siting Activities

The general area of the Grand Valley plant site is located within the Colorado River drainage at an elevation of about 5,100 feet. The area encompasses the Roan Plateau, a highly dissected plateau. The Roan Cliffs rise 2,000 feet above the valley floors. Southwest of the Roan Cliffs are the Book Cliffs, which stand approximately 1,000 feet above the Grand Valley. The face of these cliffs forms the northern topographic boundaries of the Grand Valley within the project area.

The Big Salt Wash reservoir area consists of a narrow, relatively flat stream valley bounded by steep cliffs and moderate slopes. The valley bottom at the dam site is at elevation of 5,340 feet.

3.5.1.4 Alternative Siting Activities

The topography of the alternative corridor and reservoir sites is as described for the Clear Creek mesa and Grand Valley areas. The majority of corridors will follow, at least in part, the alluvial valleys of the area.

3.5.2 Geology

3.5.2.1 Regional Setting

The CCSOP area is located at the southwestern end of an ancient lake-filled depression which existed during Eocene times. The basin formed in older sedimentary rocks by uplift at the basin margins and synclinal down warping at the center, and was filled with sediments which now constitute the Green River and Uinta Formations. The area was uplifted and deformed in Late-Eocene and Post-Eocene times, resulting in the folding, faulting, and fracturing of the sediments. With uplift, erosional processes began which have shaped the land to its present form.

The area is underlain by sedimentary bedrock units ranging from the Mancos Shale of Late-Cretaceous age through the Uinta Formation of Eocene to Late-Eocene age. Figure 3.5-1 is a stratigraphic column which shows the age and relationship of these units and describes the rocks which comprise the units. Additional, older geologic units are present in the subsurface but will not be affected by the project. The bedrock units are unconformably overlain by surficial deposits of Quaternary age at various locations throughout the project area. Alluvial deposits of alluvium, terrace deposits, and alluvial fans, and mass-wasting deposits of landslide debris, talus, and slopewash have been identified.

Late-Eocene and Post-Eocene deformation has resulted in the formation of folds, faults, and fractures in the Piceance Basin. Folds occur at several locations throughout the basin, and generally trend northwesterly. Faulting has occurred in the Douglas Creek arch area, the central parts of the basin, and the northeastern flank of the Uncompahgre Uplift, which forms the southwestern margin of the Piceance Basin. Prominent joint and fracture patterns in the brittle sediments of the Green River and Uinta Formations are best developed along the basin margins (BLM 1975).

The CCSOP area is located within a Zone 1 Seismic Risk Zone. A Seismic Risk Zone 1 is defined as a zone where distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 second; corresponding to Modified Mercalli Scale intensities V and VI (Chevron 1982k).

Other seismic considerations include potentially active faults which have been identified on the northeastern flank of the Uncompahgre Uplift. Late-Cenozoic (Quarternary) movement is associated with the nearest group of structures (Flume Canyon, Kodel's Canyon, and Redlands faults), located about 3 miles south of Fruita (Kirkham and Rodgers 1978). Recent studies (McGuire et al. 1982) have inferred a prominent graben in the central Piceance Basin as a possible causative structure for the 1882 earthquake. Based on reports published in local newspapers, these studies assigned an intensity of VIII (MM) at the crest of the Roan/Book cliffs plateau resulting from this event.

The Green River Formation is an important source of kerogen-rich marlstone, commonly known as oil shale. The oil shale occurs in the Parachute Creek and upper part of the Garden Gulch Members. Oil shale reserves representing 1,200 billion barrels of syncrude oil have been estimated to be present in the Piceance Basin (NPC 1974). Evaporitic minerals of halite (sodium chloride), nahcolite (sodium bicarbonate), and dawsonite (sodium aluminum carbonate) occur with the oil shale. The halite and nahcolite occur as interbeds and dispersed crystals, and are concentrated near the depositional center of the basin. Dawsonite occurs as disseminated crystals and is also concentrated near the basin center, but is more widespread than the other evaporite (Chevron 1982k). Oil and gas are produced from some locations in the Piceance Basin, from the basal part of the Green River Formation, the upper and middle parts of the Wasatch Formation, and other pre-Wasatch rocks (Chevron 1982k). Coal occurs in the Wasatch Formation and the Mesaverde Formation. The Mesaverde is mined for coal at several locations along the Piceance Basin (Speltz 1974).

System	Series	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).
Tertiary	Eocene	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 lucustrine 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).
Tertiary	Eocene	Green River Formation	Garden Gulch Member, 100'-1000'. Fresh water, lucustrine 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).
Tertiary	Eocene	Green River Formation	Douglas Creek Member, 100' (Roehler 1973a)-800'. Brown to buff-colored sandstone, with interbeds of limestone and minor shale (CSOC 1982a).
Tertiary		Wasatch Formation 180' (Roehler 1972a) - 3700' (CSOC 1982a) (Thins westward) (Cashion 1982a)	Shire Member, 600'-1800'. Gray and maroon varigated claystones and sandstone beds, with siltstone, sandstone and interbeds of thin coal and limestone near the middle part (Johnson 1975).
Tertiary		Wasatch Formation	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).
Tertiary	Paleocene	Wasatch Formation	Atwell Gulch Member, 700'-1850'. Gray claystone and siltstone, with some brown sandstone, carbonaceous shale and coal (Johnson 1975).
Tertiary	Paleocene		Ohio Creek Formation, 0'-230' (Roehler 1973a). Sandstone and conglomerate, present locally (Donnell 1961).
Cretaceous	Upper Cretaceous	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).
Cretaceous	Upper Cretaceous	Mesaverde Group	Mount Garfield Formation. Buff and gray, fine to medium-grained sandstone and gray shale. Lower part contains thick, persistent coal beds (Cashion 1973).
Cretaceous	Upper Cretaceous	Mesaverde Group	Sego Sandstone, <300'. Buff and light gray, fine-grained sandstone and gray shale. Intertongues with underlying Mancos Formation. Thins eastward (Cashion 1973).
Cretaceous	Upper Cretaceous		Mancos Shale, 4000'±. Dark gray to black marine shale with thin beds of sandstone intertongues with overlying Mesaverde Group (Cashion 1973).

Figure 3.5-1 Regional Stratigraphic Column of the Clear Creek Project Area

Sand and gravel are commercially developed from alluvial materials along the Colorado River valley in the Grand Junction and Fruita areas. Other similar deposits are present in a relatively continuous band adjacent to the Colorado river, but are of narrow extent within De Beque Canyon. Additional alluvial deposits and terrace gravels are present at other locations in the region such as along the Big Salt Wash, Roan Creek, and Clear Creek drainages (Cashion 1973). The potential of these deposits for commercial production of sand and gravel is unknown.

3.5.2.2 Clear Creek Mesa and Associated Siting Activities

Mine and Plant Site

The mine and plant site are underlain by the Uinta Formation and the lower Parachute Creek Member of the Green River Formation. Deposits of talus, alluvium, and alluvial fans mantle the bedrock units, primarily along Clear Creek (Johnson 1981).

Two gentle folds are present on Clear Creek mesa. The Crystal Creek Anticline is located in the northeastern part of the mesa and the Clear Creek Syncline is located in the southwestern part. Both folds trend northwesterly. Bedding ranges between 1° and 5°. Two dominant joint sets trend N70°E and north-south with dips of 82°SE and 90°, respectively. A third set trending N80°W and dipping 66°SW is present in the area around No Name Falls. Lineaments which may constitute faults are present at some locations (Chevron 1982k).

The major mineral resource on the Clear Creek mesa is oil shale. Up to nine kerogen-rich marlstone units have been identified on the mesa. The uppermost 3½ zones which are being considered for mining (399 vertical feet) contain about 17,679,000,000 tons of oil shale exceeding the present economic recovery limit of 15 gallons per ton (Chevron 1981a) and representing 7,814,000,000 barrels of syncrude oil. Additional reserves in the lower 5½ zones have not been quantified. Oil, gas, sand, and gravel deposits have not been shown to be present in the project area (Moore 1982a). No appreciable amounts of nahcolite, dawsonite, or halite were recognized on the property (Chevron 1982k).

Geologic hazards resulting from mass-wasting processes are present on Clear Creek mesa in the form of potential rockfalls and rockslides. The potential for slumping and earth flowage will be minimal (Chevron 1982k).

Corridors

The Roan Creek corridor is underlain at its southern end by the Atwell Gulch Member of the Wasatch Formation. The geologic units become progressively younger to the north, with the Parachute Creek Member of the Green River Formation the uppermost unit. Surficial deposits of alluvium and terrace gravels cover the bedrock over most of the southern part of the corridor (Johnson 1975, Cashion 1973). In the northern part of the corridor, the valley walls are mantled with talus and landslide deposits, some of which cover the valley bottom (Johnson 1977, 1981). No mineral resources have been identified within the proposed corridor; however, alluvial deposits related to the Colorado River valley (present near the southern end of the corridor) may be a likely source of sand and gravel. Alluvium and terrace gravel deposits in the Roan Creek valley may represent an additional low potential resource of sand and gravel. Gravel has been extracted from two locations within the corridor in small quantities for local use, probably as road base. Geologic hazards in the corridor appear to be present in the form of slope instability in talus and landslide deposits, rockfall, and debris avalanching beneath the steep cliffs along the valley walls; and debris flows on alluvial fan deposits (Johnson 1977). These hazards predominantly affect the northern (Clear Creek) portion of the corridor. Additional local hazards may be present in parts of the Roan Creek valley in the form of rockfall near ledges of Molina sandstone and slope instability in the Shire Member.

The Big Salt Wash corridor is underlain by the Uinta Formation on its northern end, and the Mancos Shale on the south. The route traverses the entire stratigraphic interval between these units (Figure 3.5-1). The most significant surficial deposits are alluvium along Big Salt Wash and alluvium and alluvial terrace deposits near the Colorado River.

The La Sal corridor is underlain entirely by the nearly flat lying Uinta Formation. Small portions of the route are covered by alluvium and colluvial deposits are probably also present at many locations, but have not been mapped. Deposits of oil shale underlie the pipeline route throughout its length and depth, and will not be directly affected by the pipeline. Geologic hazards such as faults and landslides are not present along the corridor (Chevron 1982b).

Reservoirs

The Upper Dry Fork reservoir site is underlain by the Molina and Shire members of the Wasatch Formation. Surficial deposits of terrace gravel and alluvium cover the bedrock over most of the site. The proposed damsite is located on a low northwesterly plunging anticline with dips less than 2°. Two northwesterly trending normal faults are present near the southwest end of the reservoir area on its flanks (Johnson 1975). No mineral resources are known to occur in this area. However, deposits of alluvium and terrace gravels are present, and may represent potential resources of sand and gravel. No geologic hazards have been identified in the area, but local areas susceptible to rockfall near ledges of Molina sandstone and slope instability in the Shire Member could be present.

The Big Salt Wash reservoir site is predominantly underlain by the Mount Garfield Formation, which consists of thick, cliff-forming sandstone units interbedded with slope-form shales. Thick persistent coal seams may also be present. Clinker from the burning of the coal seams and baked overburden materials appear at some locations. The valley bottom is underlain by the Mancos Shale over the downstream part of the reservoir area. The site lies just northwest of the axis of the Hunters Canyon Anticline. Bedding at the site dips 1-2° to the northeast. No faults have been mapped at the site.

3.5.2.3 Grand Valley and Associated Siting Activities

The geologic formations exposed within the Grand Valley area range in age from the Upper Cretaceous to Holocene. The oldest formation is the Manco Shale, which underlies the portion of the project area north of Fruita. The youngest deposits in the area are Quaternary alluvial, colluvial, and terrace deposits occurring along drainageways and toeslopes. The formations become increasingly younger north from Fruita.

The Grand Valley area is bounded by the Uncompahgre Arch southwest of Grand Junction, and the Piceance Basin to the northeast. The region, as a whole, is characterized by varying degrees of folding and faulting. The project area does not exhibit any significant localized deformation, nor have any faults been identified along the corridor alternatives.

The general area of the plant site and associated facilities contains extensive areas of Mancos Shale in various stages of erosion. Near the Colorado River, the Mancos surface has been developed primarily from floodplain erosion and depositional processes caused by the river and its tributaries. Additional geological features of the area near the Colorado River are numerous channels and areas of Quaternary terrace and alluvial deposits (Chevron 1982a).

The Grand Valley plant site would be placed on Mancos Shale. Some of the shale bedrock is overlain with alluvial-type deposits. The Garmesa Anticline, as mapped by the U.S. Geological Survey, crosses through the proposed plant site. The surficial expression of the anticline is minor (Chevron 1982a).

3.5.2.4 Alternative Siting Activities

Alternate corridor routes will cross various geologic units. Since the majority of proposed routes are at least partially within valley bottoms, the major unit crossed is Quarternary alluvial and colluvial deposits. Other areas of proposed corridors are on portions of the Green River and Wasatch formations. Minor areas of the Uinta formation are also present within potential corridor routes.

Four alternative reservoir sites are present in the Roan Creek valley. The Lower Dry Fork Reservoir area is geologically similar to the Upper Dry Fork site. The flat valley bottom is underlain by a relatively shallow deposit of alluvium, no more than 50 feet thick. The valley in this area is essentially free of alluvial fans and the sides of the valley are steep and consist of interbedded sandstone and shale. The reservoir area in the vicinity of Conn Creek (Upper Conn Creek and Lower Conn Creek reservoirs) has similar geological features. The valley bottom near these sites is underlain by a deposit of alluvium up to 130 feet deep along the western side of the valley. An alluvial fan up to 130 feet deep exists along the eastern side of the valley. The steep western wall of the valley consists primarily of shale.

3.5.3 Paleontology

3.5.3.1 Regional Setting

The Mancos Shale Formation contains marine invertebrates at many locations. Vertebrate fossils found within the Mancos include shark teeth, fish, and reptiles. Preservation of fossils in the Mancos is extremely good and fossils are likely to be found near the Book Cliffs (GRI 1980).

The lowermost unit of the Mesaverde Group, the Sego Sandstone, holds little potential for the occurrence of vertebrate fossils. Freshwater and marine fossils are reported from this unit, but it is unknown if these are vertebrates or invertebrates (GRI 1980). The Mount Garfield Formation has yielded fossils of reptiles from coal mines in nearby areas, and probably contains similar fossils in the study area. Depositional environments in this unit were highly variable, and ranged from marine to brackish and freshwater deposition (GRI 1980). The Hunter Canyon Formation has produced some vertebrate fossils; reptile (e.g., turtles) and mammal fossils may occur.

In the eastern portion of the study area, fossil vertebrates are common in the Atwell Gulch and Shire members of the Wasatch Formation (Kihm 1982). Numerous fossils of reptiles and mammals have been identified, and fossils of fishes, amphibians, and birds have been described. The Wasatch is thinner in the western portion of the study area. The reduced outcrop area, and the possibility that fossilization conditions were not favorable, reduce the potential for fossil occurrence here. However, in the eastern portion of the study area, the occurrence of fossils is probable in the Wasatch (GRI 1980). Fossils from the Molina Member and the Basal Ohio Creek Conglomerate have not been described in paleontological literature.

The Green River Formation is best known for fossil plants and insects, which appear to be mostly associated with the Parachute Creek Member (TRW 1981). The lowermost unit, the Douglas Creek Member, contains few fossils. Nondiagnostic mollusks have been noted in some of the limestone interbeds (Donnell 1961). The unit becomes more fossiliferous to the west, and fish, turtle, and crocodile remains have been reported in the Carr Creek area (Kihm 1982). The Garden Gulch member of the Green River Formation contains only rare fossils of fish scales and plants (TRW 1981). This unit is absent from the western portion of the study area. The Parachute Creek Member contains vast numbers of plant and insect fossils, some of which are very well preserved. Vertebrate fossils are scarce. Amphibians, lizards, small crocodilians, bats, birds, and small fish have been noted (Chevron 1982k).

Plant fossils are well known within the Uinta Formation. Insect and vertebrate remains have also been noted locally. Unidentified large mammal bones, possibly of Late Eocene age, have been reported. Since such fauna are not known in Colorado the occurrence may be significant (TRW 1981).

Mammoth teeth have been reported to occur within Pleistocene deposits in the region; however, no occurrences are known in the study area (GRI 1980). This appears to result primarily from poor exposure of the units and lack of scientific study. There is good potential for discovery of additional isolated specimens here, because fossils have been found elsewhere in such deposits and because of their favorable location for development (GRI 1980).

3.5.3.2 Clear Creek Mesa and Associated Siting Activities

No important fossil localities occur on Clear Creek mesa. One important locality of bird remains is located within the proposed Roan Creek corridor (McReynolds 1982). Additionally, several specimens have been collected from the Roan Creek drainage, north of De Beque, probably from the Garden Gulch Member (TRW 1981). It is possible that the locality may be within the service corridor. Footbones from a duckbill dinosaur have been reported from a hill near Ruby Lee Reservoir (GRI 1980).

3.5.3.3 Grand Valley and Associated Siting Activities

No important fossil localities are known within the areas affected by the Grand Valley alternatives.

3.5.3.4 Alternative Siting Activities

No important fossil localities are known within the areas affected by alternative reservoirs or corridors.

3.6 Soils

3.6.1 Regional Setting

Three physiographic types influencing soil characteristics occur in the project area: (1) upland plateaus, (2) canyon valleys having steep side slope and bottomlands, and (3) low semiarid lands. The Book Cliffs, Skinner Ridge, Kimball Mountain, Four A Ridge, Brush Mountain, Cathedral Bluffs, Big Ridge, and the Roan Plateau geographically are in the upland plateau type. Willow, No Name, Spring, Upper Clear, Carr, Parachute, Douglas, and Roan creeks are in the canyon valley type. The third physiographic type, low semi-arid lands, consists of such geographic areas as Big Salt Wash below Echo Lake and the Grand Valley. Soil characteristics for the physiograhic types are summarized in Table 3.6-1. The canyon valley type has been separated into side slope and bottomland areas. The information presented in Table 3.6-1 is based on data from Chevron (1981c, 1981d, 1982a) and SCS soil survey reports (SCS 1978, 1982).

3.6.2 Clear Creek Mesa and Associated Siting Activities

Data describing soil conditions, revegetation potential, prime farmland potential, erosion rates, physical and chemical soil characteristics, and volumes of topsoil material for the Clear Creek mesa area are presented in Table 3.6-2.

3.6.3 Grand Valley and Associated Siting Activites

Table 3.6-2 presents relevant soil conditions for soils occurring within the Grand Valley area.

3.6.4 Alternative Siting Activities

Relevant soil conditions for alternative siting activities are also presented in Table 3.6-2. Within Table 3.6-2 siting alternatives with similar soil conditions have been combined to avoid redundancy.

3.7 Aquatic Ecology

3.7.1 Regional Setting

Regional aquatic ecosystems include lakes (reservoirs), perennial streams, and intermittent streams. The lakes and perennial streams support populations of aquatic organisms. Depending on habitat conditions, specific lakes and streams within the region are more sensitive to potential impacts because of their value for recreational fishing, or because of the presence of state or federally listed threatened or endangered species. Intermittent

Table 3.6-1 GENERAL SOIL CHARACTERISTICS OF THE THREE PHYSIOGRAPHIC TYPES OCCURRING WITHIN PROJECT AREA

Physiographic Type	Soil Characteristics												
	Depth	Drainage	Parent Material	Surface Horizon Color	Texture[a]	Available Water Holding Capacity (in.)	Perm-eability	pH	Saline (>8 mmhos/cm)	Sodic (SAR >13)	Range in Elev. (ft)	Growing Season (days)	Mean Annual Soil Temp. (°F)	Mean Annual Precip. (in.)
Upland Plateaus	Shallow to Deep	Well to Exces-sive	Alluvium Residuum Colluvium	Dark	Loamy,[b] Loamy-Skeletal	Low	Moderate to Rapid	6.1 to 7.3	No	No	6,800 to 8,200	< 75	38 to 42	20[c]
Canyon Valleys														
Steep Side Slopes	Deep	Somewhat Exces-sive	Residuum Colluvium	Light	Loamy[d] Skeletal	Low or High	Moderate Rapid or Slow	7.9 to 8.4	Yes[b]	Yes[b]	5,800 to 7,200	95[c]	42 to 46	12 to 16
Bottom-lands	Deep	Well[d]	Colluvium Alluvium	Light	Loamy,[b] Loamy-Skeletal	Low to Moderate	Moderate to Rapid	7.4 to 7.8	No	No	5,000 to 6,500	95 to 135	42 to 49	12 to 16
Low Semi-Arid Lands	Shallow to Deep	Well and Poorly	Residuum Colluvium Alluvium	Light	Loamy Clayey	Low to High	Slow to Moderate	7.4 to 9.4	Yes[d]	Yes[d]	4,400 to 6,400	170[c]	54[c]	10 to 11

Source: Chevron (1981c, 1981d, 1982a), SCS (1978, 1982)

[a] Skeletal = greater than 35 percent by volume rock fragments
[b] In some areas
[c] Approximation
[d] Commonly

Table 3.6-2 SITE SPECIFIC INTERPRETIVE SOIL CONDITIONS

SITING	Physiographic Type	Major Soils	Dominant Soils	SOIL CONDITIONS				
				Water[a] Erosion Rate (tons/ac/yr)	Wind[a,b] Erosion Rate (tons/ac/yr)	Available[c] Topsoil Volume acre-ft	Average[d] Topsoil Replacement Depth (ft)	Prime Farmland (acres)
Clear Creek Mesa Surface Mine, Plant, and Spent Shale Sites	Upland Plateau	Storman, Irigul, Northwater, Silas Variant, Parachute, Rhone	Parachute	2.1	0.1	23,787	1.8	0
Roan Creek Corridor and Reservoirs	Canyon Valley (Bottomland)	Kobar Variant, Bitton, Nihill, Grobutte, Moyerson	Kobar Variant	2.7	1.5	23,930	1.2-1.8	0
LaSal Corridor	Upland Plateau	Parachute, Dateman, Irigul, Starman, Rhone, Northwater	Parachute	2.1	1	325	1.4	0
Big Salt Wash Corridor	Upland Plateau	Northwater, Irigul, Parachute, Dateman, Bankard, Glenberg,	Parachute/ Bankard	2.1/0.5	0.1/9	7,214	1.1	0
Big Salt Wash Reservoir	Canyon Valley (Bottomlands)	Bankard, Glenberg, Haverson	Bankard	0.5	9	95	0.5[e]	205
Fruita Plant Site	Low Semi-Arid Lands	Fruita, Avalon, Persaya, Chipeta	Fruita	5.8	<1	12,015	3.8	0
Alternative Access Corridors to Fruita Site	Low Semi-Arid Lands	Billings, Ravola, Chipeta	Billings	1.3	<1	2,950	2.3	288
Fruita Site to SOPS Pipeline	Low Semi-Arid Lands	Persayo, Fruita, Avalon	Persayo	38.5	4	84	2.2	0
Rangely A/B Corridors	Upland Plateau	Tisworth, Starman Vandamore, Abor	Tisworth/ Starman	7.1/2.6	1/<1	3,286/222	1.6/0.8	4.2

Table 3.6-2 SITE SPECIFIC INTERPRETIVE SOIL CONDITIONS (Continued)

				SOIL CONDITIONS				
SITING	Physiographic Type	Major Soils	Dominant Soils	Water[a] Erosion Rate (tons/ac/yr)	Wind[a,b] Erosion Rate (tons/ac/yr)	Available[c] Topsoil Volume acre-ft	Average[d] Topsoil Replacement Depth (ft)	Prime Farmland (acres)
Overland Corridor	Canyon Valley (Bottomland)	Glenberg, Haverson, Nihil	Glenberg	6.5	1	4,898	2.1	up to 400
Buck and Sheep[f] Gulch Corridors	Canyon Valley (Bottomlands)	Lolo, Grobutte Kobar Variant Bitton, Nihil	Grobutte	17.7	<1	112	1.8	0
Deer Creek Corridor	Canyon Valley	Starman, Irigul	Starman	2.2	<1	424	.06	up to 40
Parachute Creek Reservoir and Corridor	Canyon Valley (Bottomlands)	Pena, Arvada	Pena	22.4[e]	<2	4,420	1.8	0
Dry Gulch Spent Shale Site	Low Semi-Arid Lands	Fruita, Avalon[g] Persayo, Chipeta	Avalon[g]	13.8	2	6,040	2.0	0
Canyon Spent Shale Sites	Canyon Valley (Side Slopes)	Torriorthents	Torriorthents	250[h]	3[h]	1,009	0.2	0

Source: Chevron (1981c, 1981d, 1982a, 1982b); SCS (1978).

[a] Of the dominant soils in a undisturbed condition.
[b] Under native vegetation.
[c] Topsoil may include parts or all of soils A, B, or C, horizons provided it meets the proper CMLRB criteria.
[d] Available topsoil volumes divided by the total potential affected acreage.
[e] Worst case assumed.
[f] Only partial soils data were available.
[g] Only those components of the alternative that are in addition to the Proposed Action are addressed.
[h] Worst case estimate based on highly variable soil conditions.

streams do not support important fisheries due to seasonal flows. However, they may be important during periods when water is present. Characteristics of the aquatic ecosystems in the region which may be directly impacted by project development are presented in Table 3.7-1.

The Colorado River is the major river within the region. In the recent past, it has provided habitat for 24 fish species (Table 3.7-2), but presently the bonytail chub (*Gila elegans*) is believed to be extinct in the upper reaches of the Colorado River (Miller et al. 1982). Federal and/or state classified endangered species still occurring in the river include the Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*).

Physical habitats of the upper Colorado River vary greatly by geographic area and water volume (Miller et al. 1982). Conditions range from wide, shallow (1-2 feet) riffle areas to relatively narrow, deep (60-92 feet) canyon pools. Historic habitat conditions in the Colorado River no longer exist because of water development projects. Such projects have dramatically reduced peak flows, thereby altering sediment transport mechanisms within the river (Chevron 1981m; Miller et al. 1982). The Colorado River has become shallower, wider, and warmer, fluctuating more on a daily and less on a seasonal basis, than was the case prior to water development projects (Miller et al. 1982). Water flow alterations appear to be benefitting introduced fishes while having deleterious effects on the native endangered species. Water quality in the Colorado River is not presently limiting resident aquatic organisms. Values of primary water quality characteristics (i.e., dissolved oxygen, pH, conductivity, temperature) fall within the Colorado Department of Health (CDOH 1982) suggested guidelines for warmwater life forms.

The Colorado River near Loma reportedly contains the Colorado River squawfish, a federally listed endangered species. Recent studies (Miller et al. 1982) suggest that Colorado River squawfish are spawning within an area in the Colorado River between Loma and Black Rocks. Individuals have been caught as far upstream as Palisade, Colorado (Miller et al. 1982).

The humpback chub is also a federally listed endangered species which occurs in the Colorado River. Large populations are located approximately 20 river miles below Loma with some individuals being found as far upstream as Palisade (Behnke and Benson 1980).

Historically the bonytail chub was probably the most abundant species in main river-channel habitat of the Colorado River (Behnke and Benson 1980). Genetically pure populations are apparently restricted to Lake Mohave in the Lower Colorado River Basin (Miller et al. 1982). Hybrid specimens have been recently collected from the Grays Canyon/Desolation Canyon area of the Green River, but no significant numbers are thought to occur in the Upper Colorado River Basin.

The razorback sucker, a Colorado listed endangered species, has been collected in the Colorado River at a water diversion site upstream near De Beque (Valdez 1982), as far upstream as Rifle (Miller et al. 1982), and in the vicinity of Loma. Only adult razorback suckers have been recovered recently, suggesting that there is limited or no natural reproduction of this species. However, razorback suckers have been observed congregating (thought to be prespawning behavior) in two potentially affected portions of the Colorado River, the Walter Walker Wildlife Management Area gravel pit near Grand Junction and the Clifton Pond gravel pit near Clifton, Colorado (Miller et al. 1982).

Particular streams (other than the Colorado River) which may be directly affected by implementation of project alternatives are described in the following sections.

3.7.2 Clear Creek Mesa and Associated Siting Activities

Portions of Clear Creek, Willow Creek (East and West Fork), Mud Springs, No Name Creek, West Fork Parachute Creek, and Roan Creek occur within areas potentially affected by project activities at the Clear Creek mesa site. These streams may be affected by water development, mine and processing facilities construction, and project operations. In addition, either Kimball Creek, Conn Creek, or Dry Fork Creek may be affected by

Table 3.7-1 REGIONAL CHARACTERIZATION OF STREAMS BY DRAINAGE

Drainage/Stream or Lake	Stream Flow	Stream/Lake Classification[a]	Fishery Potential	Threatened and/or Endangered Fish Present	Potential Number of Fish Species Present
Colorado River (Utah State Line) to DeBeque	Perennial	1-Highest Valued Fishery	high	yes	24
Colorado River (DeBeque to Rifle)	Perennial	2-Highest Priority Fishery	high	maybe[b] (undocumented)	20
/Roan Creek	Perennial	3-Moderate Fishery	low-moderate	yes[c]	6
/Clear Creek	Perennial	3-Moderate Fishery	low-moderate	yes[c]	3
/East Willow Creek	Perennial	Unclassified	low	no	1
/West Willow Creek	Perennial	Unclassified	low	no	1
/No Name Creek	Intermittent	Unclassified	none	no	-
/Mud Springs Creek	Intermittent	Unclassified	none	no	-
/Kimball Creek	Perennial	3-Moderate Fishery	low-moderate	no	2
/Brush Creek	Perennial	3-Moderate Fishery	low-moderate	yes[c]	5
/Carr Creek	Perennial	3-Moderate Fishery	moderate-high	no	3
/Conn Creek	Perennial	4-Limited Fishery	low	no	-
/Dry Fork Creek	Perennial	4-Limited Fishery	low	no	-
/Blanc Canyon Wash	Intermittent	Unclassified	none	no	-
/Parachute Creek	Perennial	3-Moderate Fishery	low	no	-
/West Fork Parachute Creek	Perennial	3-Moderate Fishery	low-moderate	yes[c]	-
/East Salt Creek	Perennial	4-Limited Fishery	low	maybe[d] (undocumented)	-
/Corral Canyon	Intermittent	Unclassified	none	no	-
/Barrel Canyon	Intermittent	Unclassified	none	no	-
/Bear Canyon	Intermittent	Unclassified	none	no	-
/Big Salt Wash	Perennial	4-Limited Fishery	low	maybe[d] (undocumented)	d
/Coyote Wash	Intermittent	Unclassified	none	no	-
/Little Salt Wash	Perennial	4-Limited Fishery	low	maybe[d] (undocumented)	d
/Reed Wash	Perennial	Unclassified	low	maybe[d] (undocumented)	6
/Mack Wash	Intermittent	Unclassified	none	no	d
/Grand Valley Canal	Perennial	Unclassified	low	maybe[c] (undocumented)	d
White River (near Rangely)	Perennial	1-Highest Valued Fishery	low	yes	9
/Douglas Creek	Perennial	4-Limited Fishery	low	no	1
/East Douglas Creek	Perennial	3-Moderate Fishery	low-moderate	no	2
/West Douglas Creek	Perennial	4-Limited Fishery	low	no	1
/Cathedral Creek	Perennial	3-Moderate Fishery	low	no	1
/Lake Creek	Perennial	1-Highest Valued Fishery	moderate	yes	3
/Willow Creek	Perennial	-	-	yes[c]	-
/East Fork	Perennial	1-Highest Valued Fishery	moderate	yes[c]	2
/Soldier Creek	Perennial	-	-	yes	-
Mack Mesa Reservoir	Lake	1-Highest Valued Fishery	high	no	8
Highline Lake	Lake	Unclassified	low-moderate	no	9
Ruby Lee Reservoir	Lake	Unclassified	low	no	-
Echo Lake	Lake	Unclassified	low	no	-

Source: Chevron (1981e,f,l,m, 1982a,b); BLM (1980, 1982); Carlson et al. (1979).

[a] Based on EPA (1979a) stream classification map of Colorado.
[b] Based on historical distribution of native species (Behnke and Benson 1980; Joseph 1978).
[c] Cutthroat trout are reported to occur, but endangered subspecies was not confirmed.
[d] Fish species found in the Colorado River including endangered species may temporarily frequent the lower reaches of these streams since they connect directly with the Colorado River.

Table 3.7-2 RESIDENT FISHES OF THE COLORADO RIVER FROM DE BEQUE TO THE COLORADO-UTAH STATE LINE

Common Name	Scientific Name	Endangered Status[a]	Current Source[b]	Historic Status	Status
CATOSTOMIDAE					
White Sucker	*Catostomus commersoni*	---	I	common	---
Bluehead Sucker	*Catostomus discobolus*	---	N	common	common
Flannelmouth Sucker	*Catostomus latipinnis*	---	N*	common	common
Razorback Sucker	*Xyrauchen texanus*	E-C	N*	rare	common
CENTRARCHIDAE					
Green Sunfish	*Lepomis cyanellus*	---	I	uncommon	---
Bluegill Sunfish	*Lepomis macrochirus*	---	I	uncommon	---
Largemouth Bass	*Micropterus salmoides*	---	I	uncommon	---
Black Crappie	*Pomoxis nigromaculatus*	---	I	uncommon	---
COTTIDAE					
Mottled Sculpin	*Cottus bairdi*	---	N	common	common
CYPRINIDAE					
Carp	*Cyprinus carpio*	---	I	common	---
Humpback Chub	*Gila cypha*	E-F,C	N*	rare[c]	locally abundant in canyons
Bonytail Chub	*Gila elegans*	E-F,C	N*	extinct	common
Roundtail Chub	*Gila robusta*	---	I	common	---
Red Shiner	*Notropis lutrensis*	---	I	common	---
Sand Shiner	*Notropis stramineus*	---	I	common	---
Fathead Minnow	*Pimephales promelas*	---	I	common	---
Colorado Squawfish	*Ptychocheilus lucius*	E-F,C	N*	rare	common
Speckled Dace	*Rhinichthys osculus*	---	N	rare	common
CYPRINODONTIDAE					
Plains Killifish	*Fundulus zebrinus*	---	I	uncommon	---
ESOCIDAE					
Northern Pike	*Esox lucius*	---	I	sporadic	---
ICTALURIDAE					
Black Bullhead	*Ictalurus melas*	---	I	common	---
Channel Catfish	*Ictalurus punctatus*	---	I	common	---
POECILIDAE					
Mosquito Fish	*Gambusia affinis*	---	I	uncommon	---
SALMONIDAE					
Brown Trout	*Salmo trutta*	---	I	sporadic	---

Source: CDOW (1981).

[a] E = endangered
C = Colorado list
F = Federal list
[b] I = introduced
N = native
* = endemic
[c] Locally abundant, but generally restricted to Black Rocks and Westwater Canyons (Miller et al. 1982)

reservoir construction and water diversion. The upper (mesa) portions of Clear Creek and Willow Creek were found to contain rainbow trout (Chevron 1981e). However, these fish may not be a naturally reproducing population. Hybridized forms of cutthroat trout, one subspecies of which is listed as endangered by Colorado, have been found in the West Fork of Parachute Creek (Chevron 1982a). Because of their small size and access problems, the above-mentioned streams provide limited opportunities for recreational fishing.

That portion of Clear Creek which extends from its descent from the mesa to its confluence with the Buck, Doe, Deer Park Gulch complex, is subject to intermittent flow and thus has limited value as aquatic habitat (Chevron 1981e). Flow is also intermittent in both Brush and Clear creeks just before their confluence with Roan Creek, the result of irrigation water diversions (Woodling 1977). However, cutthroat trout have been found in lower

Clear Creek when flow was present (Chevron 1981e). Although perennial flow exists between Deer Park Gulch and the lower portion of Clear Creek, fish found there are usually limited to mottled sculpin, bluehead sucker, and speckled dace (Chevron 1981e).

Roan Creek, above its confluence with Clear Creek, contains hybridized cutthroat, rainbow, and brook trout (Chevron 1981e). Below the Clear Creek confluence, aquatic habitat is limited by water quality and occasional dewatering (Woodling 1977). However, juvenile trout and cutthroats were found there in October 1981 (Chevron 1981e).

3.7.3 Grand Valley and Associated Siting Activities

The four lake aquatic ecosystems located in the vicinity of the Grand Valley plant site include Mack Mesa Reservoir, Highline Lake, Echo Lake, and Ruby Lee Reservoir. The first two water bodies collectively provide both coldwater and warmwater fisheries (Chevron 1982a). Mack Mesa Reservoir is classified as having Class 1 warmwater fishery potential (EPA 1979a). No viable fishery is believed to exist in Echo Lake (Smith 1982) or Ruby Lee Reservoir. Ruby Lee Reservoir has completely dried up during some years (Chevron 1982a). Gamefish species found in Mack Mesa Reservoir and Highline Lake include rainbow trout, channel catfish, black crappie, walleye, green sunfish, and largemouth bass (Chevron 1982a; CDOW 1982b). The CDOW has reportedly stocked Mack Mesa Reservoir with rainbow trout; Highline Lake has been stocked with rainbow trout, channel catfish, and northern pike (Chevron 1982a). It is doubtful that a trout fishery could exist in these reservoirs without stocking by CDOW. The majority of fish found in these two reservoirs are non-gamefish species including red shiner, white sucker, carp, and flannelmouth sucker (Chevron 1982a). No threatened or endangered fish species reside in these reservoirs.

No specific information is available concerning aquatic resources in Big Salt Wash and Little Salt Wash. However, regional studies indicate that these streams are likely to contain populations of warmwater fish species similar to those found in Reed Wash. These species include the flannelmouth sucker, white sucker, carp, green sunfish, roundtail chub, and speckled dace (Chevron 1982a). Other species which may occur during all or part of the year include those fish found in the Colorado River (Table 3.7-1).

3.7.4 Alternative Siting Activities

Alternative corridor routes include the drainages of several streams tributary to the White River: East Fork Creek, Lake Creek, Willow Creek, Soldier Creek, Cathedral Creek, East Douglas Creek, and Douglas Creek (see Table 3.7-1). The White River has a species composition similar to the Colorado River. Species found in the White River include the Colorado River squawfish, which has been found in the White River above the confluence with Piceance Creek.

East Fork Creek, Willow Creek, Soldier Creek, and Lake Creek contain populations of cutthroat trout, brook trout, and rainbow trout and the streams have been classified by EPA (1979a) as having Class 1 fishery value. The cutthroat trout residing in these streams resemble the Colorado River cutthroat trout (*Salmo clarki pleuriticus*), classified as threatened in Colorado. The physical characteristics of these fish indicate that hybridization with rainbow trout has occurred (Behnke 1977), but the fish are still regarded as relatively pure strains (BLM 1983).

In addition to the streams previously discussed, other perennial streams potentially impacted by various alternative corridors include Brush Creek, Carr Creek, Kimball Creek, and the Grand Valley Canal. Brush Creek contains brook and cutthroat trout (Woodling 1977) and is considered to have a moderate potential for fisheries (EPA 1979a). Carr Creek has excellent habitat conditions and contains rainbow trout, cutthroat trout, brook trout, and mottled sculpin. Based on limited observations, the stream appears to receive heavy fishing pressure (Chevron 1981e). No information is available regarding fish in Kimball Creek and the Grand Valley canal. However, Kimball Creek is characterized by poor habitat conditions resulting from high concentrations of dissolved solids (Chevron 1982a). The Grand Valley canal, because of its connection with the Colorado River and proximity to Reed Wash, is likely to contain a subset of fish species found in those water bodies.

3.8 Terrestrial Ecology

3.8.1 Regional Setting

The terrestrial biotic environment directly influenced by the CCSOP includes portions of the Roan Plateau and the Grand Valley physiographic provinces of western central Colorado. Vegetation of the region is typical of the Great Basin and Rocky Mountain regions and is representative of much of the semiarid landscape of western Colorado and eastern Utah (Kuchler 1975). Plant species which occur in the project area are derived from the flora of the desert southwest at lower elevations and from the Rocky Mountain flora at higher elevations. The rare plants of this part of Colorado are primarily derived from the desert flora which moved, in geologic time, through the valley bottoms into the mountains (Weber 1965). Wildlife of the region is typical of the Colorado Plateau and the Rocky Mountain forest ecoregions (Bailey 1978).

Vegetation

Cold desert shrubland, steppe, and riparian woodland vegetation occurs along the Colorado River. From the valley bottoms created by the Colorado River and its tributaries, cliffs and steep talus slopes rise to the southern margin of the Roan Plateau. Within this zone, vegetation is strongly influenced by slope stability, steepness, and orientation, and the effects of these factors on water availability. The talus slopes and cliffs which characterize this area are important as nesting habitat for raptors and other birds.

Shrubland vegetation of various types dominate the landscape on valley bottoms and slopes and on the plateau. Below an elevation of 8,000 feet, forest vegetation is restricted to riparian areas, north-facing slopes, and leeward slope positions with persistent spring snow. Composition of vegetation varies through distinct responses of plants to a regional relief of 4,500 feet, landforms ranging from cliffs to nearly level valley bottoms, complex sedimentary geology and soil development, climatic variation controlled by topography and elevation, and the historical impact of domestic and wildlife grazing use.

As elsewhere in Colorado, change in vegetation along the altitude gradient provides useful information on local ecosystems. With the exceptions of grasslands and riparian woodlands, the major regional vegetation types fall within four climatic zones (Graham 1937). An outline of the vegetation zones and types of native vegetation within each zone is presented in Table 3.8-1.

Table 3.8-1 VEGETATION ZONES IN WEST-CENTRAL COLORADO

Vegetation Zone	Altitude Range
MIXED DESERT SHRUB	4,500-5,500 feet
Shadscale Shrubland	
Greasewood Shrubland	
Sagebrush Shrubland	
JUNIPER PINYON	5,500-7,000 feet
Pinyon Juniper Woodland	
Barren Areas (cliffs and talus slopes of the Roan Plateau are within this zone)	
SUBMONTANE SHRUB	7,000-8,000 feet
Sagebrush-snowberry Shrubland	
Mixed Shrubland	
MONTANE	Above 8,000 feet
Douglas fir Forest	
Aspen Forest	

Source: Graham (1937).

Differences exist between north- and south-facing slopes in the amount of sunlight received, soil development, and capacity to retain moisture. Due to these differences, the vegetation typical of each zone occurs at higher elevations on south-facing slopes and at lower elevations on north-facing slopes. Vegetation dominated by sagebrush is common in each zone. The composition of the various major vegetation types, particularly Sagebrush Shrubland and the Mixed Shrublands, is highly variable within the topography of the region. Table 3.8-2 identifies major species components of the prominent vegetation types of the region, the relationships of vegetation units to topography, and the relative extent of each type within the Piceance Basin (Chevron 1981g,h; Chevron 1982a,b; Terwilliger et al. 1974).

Wildlife

Baseline investigations conducted for the CCSOP area indicate that 70 mammal species, 241 bird species, 17 reptile species, and 7 amphibian species are known from, or expected to occur within, the region. Nearly two-thirds of these species (211) occur in association with aquatic or riparian habitats. Rivers, streams, ponds, and reservoirs which support such habitats are limited in extent within the region (Chevron 1981i). Wildlife species characteristic of each habitat type are listed in Table 3.8-3.

Mammals. Five big game species occur within the project area: mule deer, elk, mountain lion, black bear, and pronghorn. Mule deer are the most abundant and widely distributed of the large mammals in the region. The Piceance Basin herd is commonly regarded as the largest known migratory population of mule deer in North America. The abundance and productivity of mule deer in this region may be attributed to the extent of mountain shrublands and broken terrain which are optimal habitat for deer within the climatic regime characteristic of the area.

Elk are also year-around, migratory residents of the area. The elk population of the Piceance Basin has increased in size and range during the past 20 years, and elk are now widely distributed among the upper elevations of the basin. Areas in close proximity to timber, water, and broken terrain (especially aspen stands) are preferred by elk in this region. Elk calving occurs throughout the plateau shrublands and forests of the Roan Plateau, including Operator's Clear Creek property (Chevron 1982a).

At one time, northwest Colorado was considered to be among the best habitat for mountain lions in the United States (Cary 1911). This region is still has the greatest abundance of mountain lions in Colorado (Armstrong 1972). Mountain lions are highly mobile and range throughout the project area year-round, although areas of cliffs and broken terrain are their preferred habitat (Russell 1978). Mule deer are considered to be the principal prey of the mountain lion; hence, lions can be expected to occur anywhere in the range of deer within the project area. Portions of Clear Creek mesa may lie within the home range of one or more lions.

Black bears are common in the timbered and brush-covered portions of the region between 6,000 and 9,000 feet. Bears range widely throughout the uplands of the area during spring, summer, and fall. During these seasons, black bears may utilize portions of the CCSOP area, although no bear sitings were made during baseline surveys (Chevron 1981i, 1982a).

Pronghorn were reintroduced to the Grand Valley and now occur in small bands among grassland and shrubland habitats below the Book Cliffs. The area utilized by pronghorn year-around includes the proposed Grand Valley plant site. The size of this herd has remained essentially static at approximately 50 animals during recent years (Ellenberger 1982).

A variety of medium-sized mammals, including small game, large rodents, and predators, inhabit the region. Cottontails are perhaps the most common small game species within the region and occur primarily in plateau mixed shrub and plateau sagebrush habitats. Snowshoe hares and white-tailed jackrabbits are less common and prefer wooded habitats of the uplands. Large rodents, including porcupine, marmot, and muskrat, may be found in or near stands of aspen and oak, rock outcrops, and watercourses, respectively. Beaver also inhabit perennial portions of creeks of the region. Coyote and weasel are common predators of the region and occur in nearly all habitats. The bobcat is also common but tends to prefer rough, broken terrain and rimrock. Other

Table 3.8-2 CHARACTERISTICS OF VEGETATION TYPES

Vegetation Unit	Dominant Species		Physiographic Position	Relative Extent Within[a] Piceance Basin and Exclusive of Grand Valley
Non-zonal Vegetation				
Riparian Woodland	Narrow-leaved Cottonwood Box Elder Locust River Birch Willows	*Populus angustifolia* *Acer negundo* *Robinia neomexicana* *Betula fontinalis* *Salix amygdaloides* *Salix exigua*	Riparian Woodlands occur as narrow strips of trees along valley streams. Slopes are typically less than 20 percent.	Probably less than 1 percent
Grassland	Indian Ricegrass Bluebunch Wheatgrass Big Sagebrush	*Oryzopsis hymenoides* *Agropyron spicatum* *Artemisia tridentata*	Grasslands occur on ridgetops and steep hillsides.	Probably less than 1 percent
Agriculture	Alfalfa, various improved hay grasses, corn and wheat		Agricultural lands are limited to irrigated valley bottoms.	Probably less than 1 percent
Mixed Desert Shrub Zone				
Shadscale Shrubland	Shadscale Indian Ricegrass	*Atriplex confertifolia* *Oryzopsis hymenoides*	This type occurs on all aspects on alkaline soils along the valley bottoms. Slopes are generally less than 40 percent.	0.1 percent
Greasewood Shrubland	Greasewood	*Sarcobatus vermiculatus*	Greasewood Shrubland occupies alkaline soils along the valley bottoms.	4 percent
Sagebrush Shrubland	Big Sagebrush	*Artemisia tridentata*	Sagebrush Shrubland occupies alluvial soils in gently sloping valley bottoms.	Sagebush & Sagebrush-Snowberry together represent 32 percent.
Juniper Pinyon Zone				
Pinyon-Juniper Woodland	Pinyon Pine Utah Juniper	*Pinus edulus* *Juniperus osteosperma*	This type occurs on xeric, south-facing slopes.	35 percent
Barren Areas			Barren areas include cliffs and talus slopes and typically occur on south and west aspects.	4 percent

Table 3.8-2 CHARACTERISTICS OF VEGETATION TYPES (Continued)

Vegetation Unit	Dominant Species		Physiographic Position	Relative Extent Within[a] Piceance Basin and Exclusive of Grand Valley
Submontane Shrub Zone				
Mixed Shrublands	Utah Serviceberry Gambel Oak Mountain Mahogany Mountain Snowberry Big Sagebrush Elk Sedge	*Amelanchier utahensis* *Quercus gambelii* *Cercocarpus montanus* *Symphoricarpos oreophilus* *Artemisia Tridentata* *Carex geyeri*	Mixed shrublands occupy slopes of all aspects within the zone and with modified composition, slopes of all aspects at lower elevation.	20 percent
Sagebrush-Snowberry Shrubland Shrubland	Big Sagebrush Mountain Snowberry Bitterbrush Utah Serviceberry	*Artemisia tridentata* *Symphoricarpos oreophilus* *Purshia tridentata* *Amelanchier utahensis*	Plateau Sagebrush Shrubland is the most widespread type on the plateau, occurring on all aspects.	See Sagebrush
Montane Zone				
Douglas-fir Forest	Douglas-fir	*Pseudotsuga menziesii*	This conifer type occurs on various slope aspects in the Douglas Pass area. It is restricted to steep north-facing slopes at lower elevations.	Together with Aspen Woodlands, less than 5%
Aspen Woodland	Aspen	*Populus tremuloides*	Aspen stands occur on north-facing steep slopes, in shallow drainages, and in areas of winter snow accumulation.	See above

[a] Source: Terwillger et al. (1974).

Table 3.8-3 WILDLIFE SPECIES TYPICALLY PRESENT IN EACH HABITAT TYPE IN THE VICINITY OF THE CLEAR CREEK SHALE OIL PROJECT, GARFIELD AND MESA COUNTIES, COLORADO

Habitat Type	Mammals	Birds	Reptiles and Amphibians
Mixed Shrublands	Mule Deer	Chukar	Prairie Rattlesnake
	Elk	Blue Grouse	Western Smooth Green Snake
	Nuttall's Cottontail	Raptors	Northern Sagebrush Lizard
	Long-tailed Weasel	Green-tailed Towhee	Woodhouse's Toad
	Deer Mouse	MacGillivray's Warbler	Northern Whiptail
	Least Chipmunk	Virginia's Warbler	Boreal Toad
	Golden-mantled Ground Squirrel	Dusky Flycatcher	
		Blue-gray Gnatcatcher	
Sagebrush-Snowberry Shrubland	Elk	Sage Grouse	Desert Short-horned Lizard
	Mule Deer	Mourning Dove	Prairie Rattlesnake
	Coyote	Green-tailed Towhee	
	Badger	Golden Eagle	
	White-tailed Jackrabbit	Prairie Falcon	
	Least Chipmunk	Red-tailed Hawk	
	Deer Mouse		
Aspen Woodland	Elk	House Wren	Wandering Garter Snake
	Mule Deer	Mountain Bluebird	Woodhouse's Toad
	Coyote	Sharp-shinned Hawk	
	Southern Red-backed Vole	Cooper's Hawk	
	Long-tailed Vole	Blue Grouse	
	Deer Mouse		
	Least Chipmunk		
Sagebrush Shrubland	Mule Deer	Green-tailed Towhee	Desert Short-horned Lizard
	Coyote	Chipping Sparrow	Northern Sagebrush Lizard
	Long-tailed Weasel	Brewer's Sparrow	Prairie Rattlesnake
	Badger	Golden Eagle	Great Basin Spadefoot
	Desert Cottontail	Red-tailed Hawk	
	Deer Mouse	American Kestrel	
	Least Chipmunk		
Riparian Woodland	Elk	Yellow Warbler	Wandering Garter Snake
	Mule Deer	Warbling Vireo	Boreal Toad
	Raccoon	Sharp-shinned Hawk	Blotched Tiger Salamander
	Deer Mouse	Cooper's Hawk	Western Smooth Green Snake
	Golden-mantled Ground Squirrel	Great Horned Owl	
		MacGillivray's Warbler	
	Long-tailed Weasel	Hermit Thrush	
Douglas-fir Forest	Elk	Sharp-shinned Hawk	Wandering Garter Snake
	Mule Deer	Red-tailed Hawk	Boreal Toad
	Porcupine	Great Horned Owl	
	Long-tailed Weasel	Blue Grouse	
	Least Chipmunk	Golden-crowned Kinglet	
	Red Squirrel	Yellow-rumped Warbler	
	Southern Red-backed Vole	Mountain Chickadee	
Pinyon-Juniper	Mule Deer	Mountain Bluebird	Great Basin Spadefoot
	Rock Squirrel	Black-billed Magpie	Woodhouse's Toad
	Least Chipmunk	Black-throated Gray Warbler	Northern Plateau Lizard
	Pinon Mouse		Northern Tree Lizard
		Raptors	Northern Whiptail
			Prairie Rattlesnake
Aquatic	Beaver	Mallard	Boreal Toad
	Raccoon	Dipper	Leopard Frog
	Muskrat	Common Snipe	Blotched Tiger Salamander
	Water Shrew	Spotted Sandpiper	

Table 3.8-3 WILDLIFE SPECIES TYPICALLY PRESENT IN EACH HABITAT TYPE IN THE VICINITY OF THE CLEAR CREEK SHALE OIL PROJECT, GARFIELD AND MESA COUNTIES, COLORADO (Continued)

Habitat Type	Mammals	Birds	Reptiles and Amphibians
Cliffs	Mountain Lion Bobcat Ringtail Bushy-tailed Woodrat Bats	Golden Eagle Red-tailed Hawk Prairie Falcon Peregrine Falcon White-throated Swift	Prairie Rattlesnake Northern Whiptail

Source: Chevron (1981i; 1982a,b).

predators of the region include gray fox, badger, striped skunk, ermine, raccoon, and ringtail. The kit fox could also occur in desert shrubland and xeric grassland habitats in the vicinity of the Grand Valley upgrading/retort site (Armstrong 1972).

Approximately 34 species of small mammals, including shrews, bats, and rodents, inhabit the region. Shrews occur primarily in association with aquatic habitats. As many as 12 species of bats may inhabit rock crevices, cliffs, and coniferous woodlands, and utilize those areas in close proximity to water. Gophers, voles, mice, squirrels, and woodrats are most abundant in valley shrubland and grassland habitats while the greatest diversity of these species occurs in upland aspen stands (Chevron 1981i).

Birds. Birds of the region are typical of the Colorado Plateau. The majority of species are passerines (songbirds) which occur in association with shrublands. Gamebirds which occur include more than 29 waterfowl species (Chevron 1981i, 1982a) and four species of upland gamebirds. The area lies in the Upper Colorado River Basin which is not considered to be a major waterfowl breeding or wintering area (Chattin 1964; Bellrose 1980). Densities of breeding waterfowl in the region are relatively low compared to other regions within the Pacific Flyway (Evans 1964). Ducks, geese, and swans are more common as migrants and winter residents than as breeders. Six species — the Canada goose, mallard, green-winged teal, cinnamon teal, common merganser, and red-breasted merganser — are known to breed in the area; 12 species are migrants in the area, 5 are strictly winter residents, 5 are accidentals (out of their normal range), and 1, the ring-necked duck, is a permanent resident not known to breed within the area (Chevron 1982a). Of the four species of upland game birds which occur within the project area, the mourning dove is the most widely distributed and can be found in most habitats of the region during spring, summer, and fall. Blue grouse also occur in a wide variety of habitats. This species prefers aspen and shrub habitats during summer and conifers during winter. The sage grouse has a distribution which closely corresponds to that of the plateau sagebrush habitat type within the region. Skinner Ridge, Brush Mountain, and Kimball Mountain are described as important year-round habitat for sage grouse (Chevron 1982a). Thirteen sage grouse leks were identified within the project area during baseline studies (Chevron 1982a). These leks, and sagebrush habitat surrounding each of them, are sensitive to surface disturbance. Suitable habitat for chukars within the region consists of arid, rocky and brushy bottomlands and valley slopes.

Nine species of wading birds (heron and ibis) are known to occur within the area. Five of these are accidentals and one, the white-faced ibis, is strictly a migrant (Kingery and Graul 1978). Three species are known to breed in the area: the great blue heron, black-crowned night-heron, and snowy egret. Only the great blue heron is a year-round resident of the project area (Kingery and Graul 1978).

Raptors common in the region include the prairie falcon, red-tailed hawk, sharp-shinned hawk, American kestrel, great horned owl, bald eagle, and golden eagle. Enderson (1977) concluded that prairie falcons and golden eagles were the most common cliff nesting raptors in the region. Densities of these two species nesting in the Book Cliffs may be as high as any area of comparable size in Colorado (Enderson 1977). Aspen, conifer, and cliff habitats are important as nesting locations for raptors within the area. The short-eared owl and the burrowing owl, a species of high federal interest, may also occur in association with grassland habitats in the vicinity of the Grand Valley plant site.

Reptiles and Amphibians. Nine amphibians and 17 species of reptiles are known to occur within the region (Chevron 1982a). All of the amphibian species are considered common in Colorado (Hammerson and Langlois 1981) and require riparian habitats or stock ponds for reproduction. Reptiles are distributed throughout all habitats within the area. Although several of the species which occur are considered uncommon within Colorado, none of them are listed as threatened or endangered by USFWS or the Colorado Division of Wildlife (CDOW) (Chevron 1982a).

Species of Interest. Golden eagles are common throughout the Project Area where at least 16 nests have been identified (Chevron 1982a). At least six of these nests were active during baseline studies (Chevron 1982a). Although golden eagles are not federally or state listed as threatened or endangered, they are protected under the federal Eagle Protection Act which prohibits harrassment or taking of eagles or their nests. Cliffs with ledges and overhangs are potential golden eagle nesting habitat and occur throughout the region.

Migratory birds of high federal interest (USFWS 1980) which are known from the area, or which may potentially occur include: the great blue heron, Cooper's hawk, golden eagle, peregrine falcon, prairie falcon, ferruginous hawk, osprey, burrowing owl, sandhill crane, long-billed curlew, Lewis woodpecker, Williamson's sapsucker, black swift, band-tailed pigeon, and western bluebird (Kingery and Graul 1978).

Five species of terrestrial vertebrates which are known from the region are listed by the Colorado Natural Heritage Inventory (CDNR 1981b) as species of special concern. These species are considered as "significant elements of natural diversity" (CDNR 1981b) and include the white-tailed prairie dog, canyon mouse, sagebrush vole, pale leopard lizard, and western yellowbelly racer. These species could potentially occur in a variety of grassland and shrubland habitats throughout the region.

Threatened and Endangered Species

Plants. One federally listed threatened plant species, four plant species which are official candidates for federal threatened or endangered status, and four species listed by the Colorado Natural Heritage Inventory (CNHI) as plant species of special concern are known to occur within the project area (Chevron 1981g, 1981h, 1982a, 1982m; USFWS & USFS 1979; CDNR 1982).

Rare or endemic plants occur within the desert shrub zone or on the cliffs or talus slopes of the Roan Plateau. The names and status of the plants within each of these areas are summarized in Table 3.8-4. For all of the candidate threatened or endangered plants, the USFWS has stated that listing is probably appropriate (USFWS 1980). Of the candidate species, sufficient biological information (for listing) was thought to be available for one species (Category 1). However, distribution and abundance data recently compiled by the CNHI regarding the Category 1 species *Phacelia submutica* suggests that the population of this species is larger and more widespread than previously recognized (CDNR 1982). Additional biological information is sought by USFWS for three species (Category 2). Only federally listed species are protected under the Endangered Species Act of 1973. However, the USFWS has stated its intent to avoid impacts to candidate plant species (USFWS 1982). The additional CNHI "plant species of special concern" which occur in the region are either endemic to Colorado or endemic to western Colorado and portions of eastern Utah. The CNHI-listed species do not have legal status and may are not be under consideration by the USFWS for protection.

Wildlife. Three federally listed endangered wildlife species are known to occur within the region: the bald eagle, peregrine falcon, and whooping crane.

The bald eagle is a common winter resident (October-April) along the Colorado River from De Beque west to the Colorado-Utah state line (Chevron 1982a). No critical or essential habitat for the bald eagle has been designated

Table 3.8-4 PLANT SPECIES WITH FEDERAL OR STATE STATUS

Scientific Name	Status[a]	Common Name
Endemic Desert Plants		
Sclerocactus glaucus	Threatened	Uintah Basin Hookless Cactus
Phacelia submutica	Candidate Category 1	Phacelia
Astragalus asclepiadoides	CNHI list	Milkweed Milkvetch
Cirsium perplexans	CNHI list	Thistle
Endemic Plants of Moist Cliffs		
Aquilegia barnebyi	Candidate Category 2	Barneby Columbine
Sullivantia hapemanii var. purpusii	CNHI list	Sullivantia
Endemic Plants of Talus Slopes		
Astragalus lutosus	Candidate Category 2	Dragon Milkvetch
Festuca dasyclada	Candidate Category 2	Fescue
Thalictrum heliophilum	CNHI list	Meadow Rue

[a] Source: CDNR (1982); USFWS (1980, 1982)

within the region by the Secretary of the U.S. Department of the Interior or by the Colorado Division of Wildlife. Mature cottonwood trees adjacent to open waters supporting rough fish are preferred by this species as hunting and resting perches. The area of highest bald eagle concentration during winter occurs between Fruita and Westwater Canyon along the Colorado River (Fisher et al. 1981).

Peregrine falcon sightings have been recorded throughout western Garfield County (CDOW 1977), and the Division of Wildlife has designated portions of the Clear, Roan, and Parachute creek drainages (Figure 3.8-2) as essential habitat for this species (CDOW 1978). At least two eyries are located within the region: one in De Beque Canyon near Cameo which was last active in 1978, and a second located in the Parachute Creek drainage which was last active in 1974 (Craig and Enderson 1981). Peregrine nesting habitat generally consists of cliff complexes below 9,000 feet elevation in proximity to water and areas where prey (medium-sized birds) are present and vulnerable such as riparian, agricultural, pasture, meadow, or grassland areas. Craig et al. (1978) concluded that cliff complexes in the lower Roan Creek drainage provided a relatively poor nesting substrate for peregrine falcons. Potential nest sites in this area are limited due to the erodibility of the shale substrate (Green River Formation) which does not permit maintenance of many stable ledges suitable as peregrine nest sites (Craig et al 1978).

Whooping cranes have been observed in the Grand Valley region in the company of greater sandhill cranes during spring and fall migrations. No sightings of whooping cranes on the ground have been recorded in the project area. The CDOW has not designated any essential habitats within the area for the whooping crane or the greater sandhill crane (CDOW 1978).

The historic range of the black-footed ferret included prairie dog towns located throughout the lowlands along the Colorado River floodplain. Since 1970, at least three reports of ferrets have been recorded from Rio Blanco and Delta counties on the periphery of the regional study area (Chevron 1982a). Recent sightings of ferrets in Grand County, Utah (Cisco and Cresent Junction) and near Mack, Colorado greatly increase the potential for their occurrence within the Project Area (Bolwahnn 1983). No critical or essential ferret habitat has been designated within the area.

The river otter and greater sandhill crane are both listed as endangered species in the State of Colorado and may potentially occur within the region. Although river otters have been reintroduced to Colorado, their present range does not lie within the project area. Sandhill cranes are occassionally observed feeding near stock ponds between the Highline Canal and the Book Cliffs during spring migrations (BLM No Date).

Sensitive Habitats

Although no critical habitats for threatened or endangered species have been identified within the region by the Secretary of the Interior, sensitive wildlife habitats do occur within the area of interest. Sensitive habitats provide nesting, foraging, or other seasonal requirements for important wildlife species and therefore represent areas of high sensitivity to disturbance. Locations of several of these areas are shown on Figures 3.8-1 and 3.8-2. Essential habitat for the American peregrine falcon illustrated in Figure 3.8-2 represents an area designated by the CDOW (1978) as "absolutely necessary for the maintenance or recovery" of this species. Other sensitive habitats within the area include bald eagle winter concentration areas (Fisher et al. 1981), raptor nesting areas, white-tailed prairie dog towns, and critical mule deer and elk winter ranges (CDOW 1977).

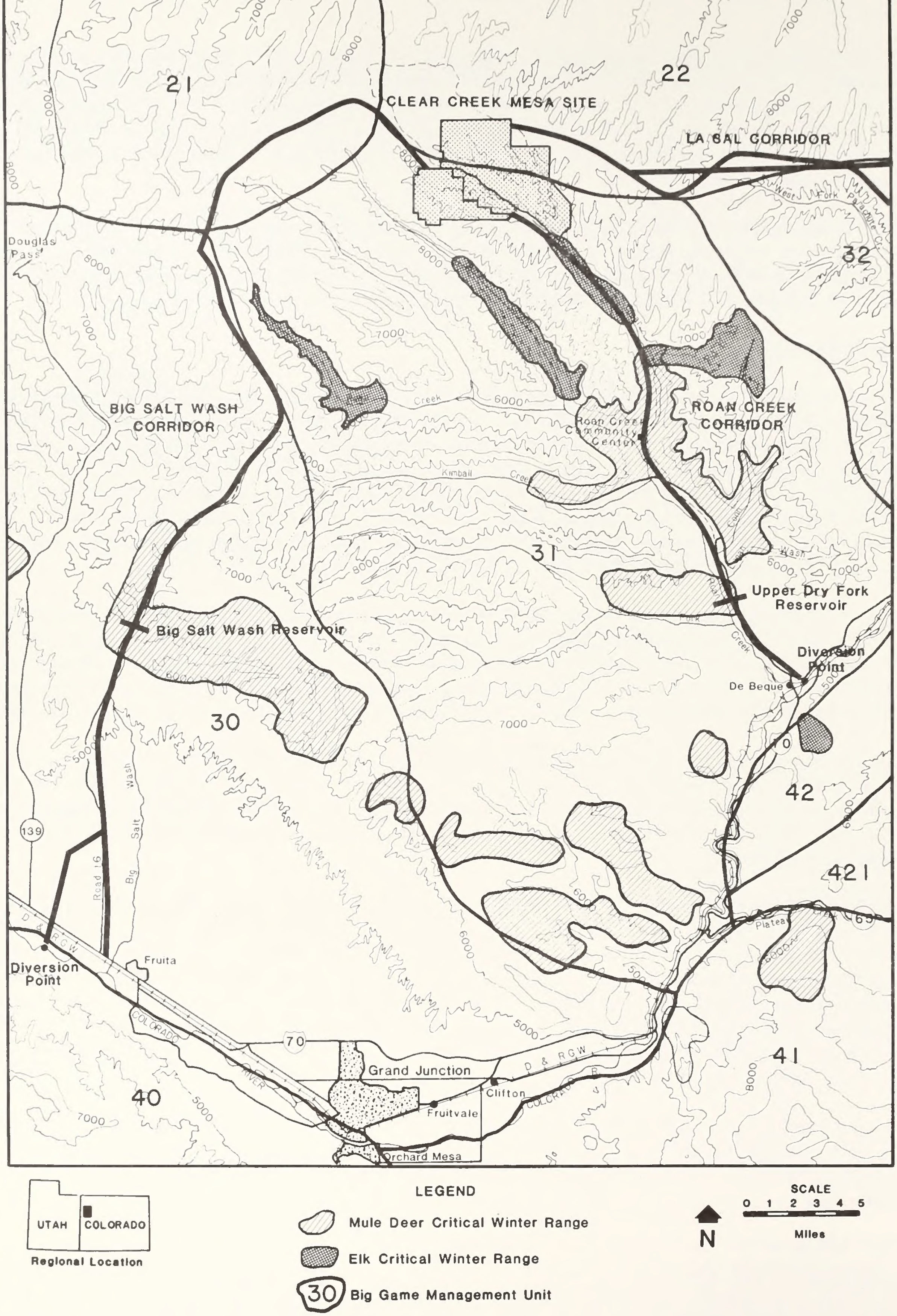
Four rookeries of the great blue heron are located in the riparian woodlands along the Colorado River between De Beque and Fruita (Chevron 1982j); however, none of them lies within the area of proposed project activities (Chevron 1982j). Since herons are sensitive to human activity during nesting (Graul 1981), continued use of these rookeries depends upon maintenance of adequate solitude and protection from human activities. Although this species is not listed as threatened or endangered it is considered to be of high federal interest (USFWS 1980).

In addition to sensitive areas previously described, four habitat types within the region are of special importance to wildlife due to their limited extent and value as sources of cover and forage for wildlife. These are aspen woodlands, aquatic habitats, riparian woodlands, and cliffs. While none of these habitat types is unique to the project area, the pattern of their distribution is an important determinant of the abundance and diversity of wildlife in the region.

Although limited in extent within the area, riparian habitats also support a diverse vertebrate fauna due to the layered vegetation canopy characteristic of riparian areas. Although site-specific data are not available for riparian woodlands and shrublands along the Colorado River, well-developed stands in the floodplain probably support the greatest vertebrate diversity and density of all habitats within the region. Several classes of wetlands, as defined by the USFWS, occur within the riparian areas of the Colorado River and its tributaries. Riverine Rock Bottóm, Unconsolidated Bottom, Streambed, Aquatic Bed, Rocky-Shore Wetlands, Palustrine Persistent Emergent, and Scrub-Shrub Wetlands occur within stream channels of the region. Except along the Colorado River itself, wetlands are not extensive.

Aspen forests support the greatest diversity and density of breeding birds of all habitats sampled during baseline studies (Chevron 1981i). Small mammal species diversity was also greatest in the aspen type (Chevron 1981i). Blue grouse, mule deer, and elk are among the species which utilize aspen stands heavily during the snow-free seasons.

Aquatic habitats of the region include the Colorado River, tributary streams, stock ponds, and numerous seeps and springs. At least 88 wildlife species known to occur within the region are dependent upon aquatic habitats for food, cover, or reproductive requirements. The availability of free water attracts many additional species. The distribution of some species is strictly limited by aquatic habitat (Bissell 1978; Kingery and Graul 1978; Hammerson and Langlois 1981).



Source: BLM (1980a).

Figure 3.8-1 Location of Big Game Critical Winter Ranges and Management Units

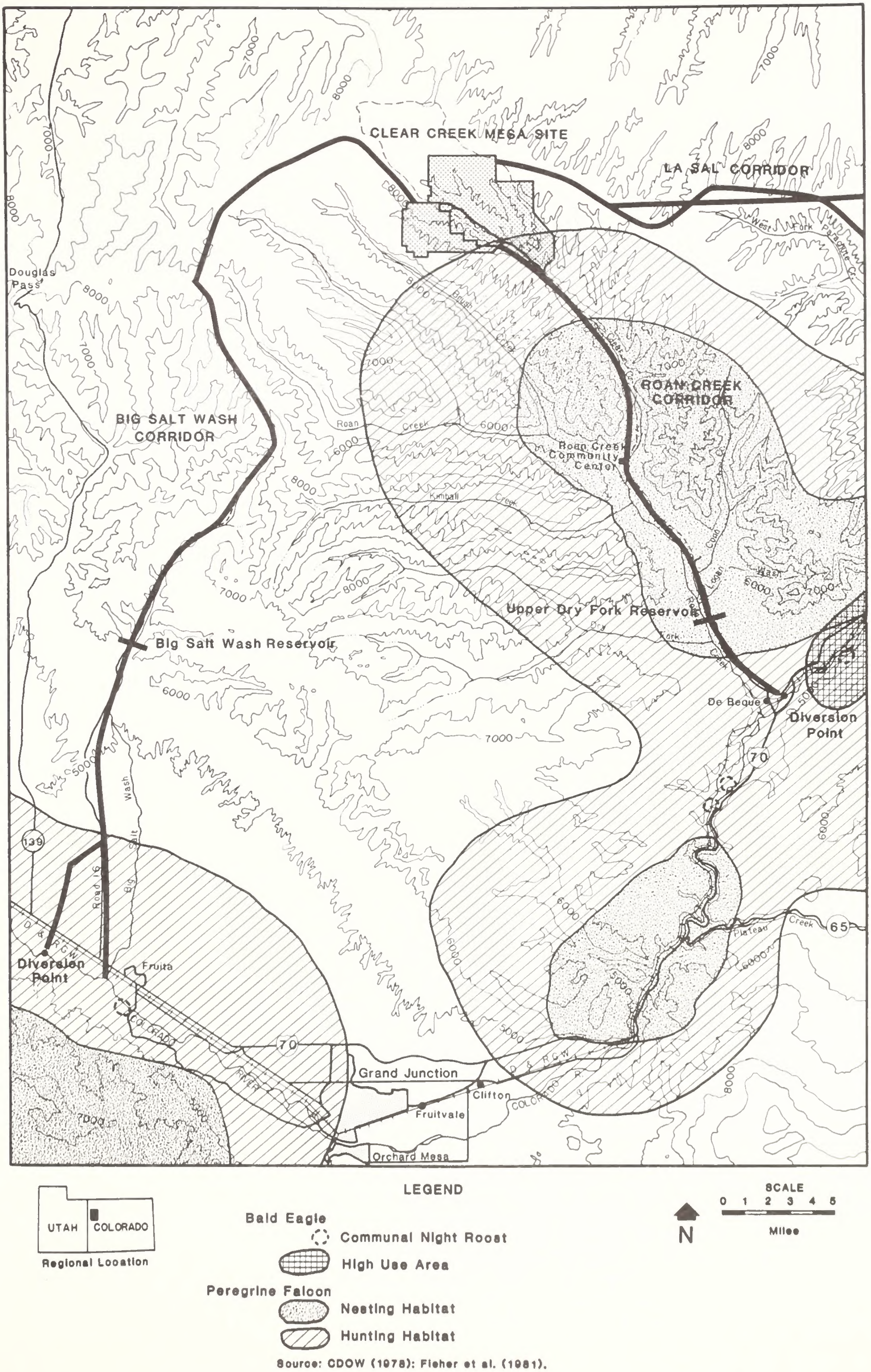


Figure 3.8-2 Locations of Essential Habitat for the Peregrine Falcon and Bald Eagle Winter Concentration Areas

Cliff habitats are extensive and widespread throughout the region. Cliffs are especially important as raptor nesting areas, particularly for golden eagles, red-tailed hawks, and prairie falcons. Mountain lions and bobcats also utilize caves and crevices among cliffs (Bissell 1978) for denning sites.

Uses of Vegetation and Wildlife Resources

Settlement of the region began around 1880 (Vories 1974). Livestock grazing pressure since that time has disturbed the vegetation, especially along valley bottoms, watercourses, and ridgetops. The Grand Valley agricultural areas support diversified farms with orchards, corn, wheat, and production of alfalfa and improved grass hay. However, most of the project area is characterized by livestock operations with irrigated areas devoted solely to alfalfa and grass hay production. Annual production of irrigated pastures ranges from 4 to 8 tons per acre. Productivity of the extensively utilized rangelands of the region, expressed in terms of the numbers of acres required to support one cow-calf unit for a single month, ranges from two to ten acres per animal unit month (AUM). Actual stocking rates reported by local ranchers (Chevron 1981g) are between 10 and 20 acres per AUM. Inaccessibility of forage due to the impenetrability of shrubland stands and slope instability and steepness may account for this reduced utilization.

The mule deer population of the area represents a significant recreational resource. The 1981 deer harvest for Garfield and Mesa counties accounted for 14 percent of the state harvest (CDOW 1982a). In addition, the region supports an expanding elk population which has been increasing its size and range during the past 20 years. The 1981 elk harvest for Garfield and Mesa counties was 10 percent of the state harvest (CDOW 1982a).

Mountain lions and black bears are common and are also hunted in the project region. During 1981 the mountain lion and black bear harvests in Garfield and Mesa counties were 7 and 19 percent of the statewide harvests, respectively (CDOW 1982a).

More than 15 waterfowl species and six species of upland gamebirds are hunted in the project area. The four upland game birds which are most heavily hunted in the region are sage grouse, blue grouse, mourning dove, and chukar. Mourning doves are the most widely harvested species in the area (CDOW 1981). Wild turkey, pheasant, and Gambel's quail also occur within small game management unit 58; however, harvest of these species within the project region is relatively low. Ducks and geese are also hunted throughout the region. Mallards, green-winged teal, blue-winged teal, gadwall, and pintail are most prevalent of the ducks taken, while the Canada goose is the most commonly taken goose in Unit 58 (CDOW 1981).

Of the small game mammals present in the region, cottontails are the most heavily harvested. Furbearers trapped in the region include beaver, muskrat, bobcat, weasels, gray fox, and ringtail. Coyotes are also trapped and shot as varmints.

3.8.2 Clear Creek Mesa and Associated Siting Activities

Between the Colorado River near De Beque and the Clear Creek mesa of the Roan Plateau, all major regional vegetation types (Table 3.8-1) as well as irrigated agricultural lands are encountered. The most extensive vegetation units are Sagebrush-Snowberry Shrubland, Mixed Shrubland, agricultural lands, Sagebrush Shrubland, Aspen Woodland, Pinyon-Juniper Woodland, and Shadscale Shrubland. Riparian Woodland, Grassland, Greasewood Shrubland, Barren Lands, and Douglas-fir forest are present over smaller areas (Chevron 1981g,h).

Chevron (1982m) has positively identified populations of one federally listed threatened plant taxon (*Sclerocactus glaucus*), four plant taxa which are candidates for threatened or endangered status (*Aquilegia barnebyi, Astragalus lutosus, Festuca dasyclada,* and *Phacelia submutica*), and two CNHI-listed plant species of special concern (*Astragalus asclepiadoides* and *Sullivantia hapemanii* var. *purpusii*) within potentially affected portions of the Roan Creek drainage, Clear Creek drainage, and the Clear Creek mesa. One additional CNHI-listed plant taxon, *Cirsium perplexans,* has been tentatively identified and another species (*Thalictrum heliophilum*) recently listed by CNHI is expected to occur in the project area based on habitat and range information (CDNR 1982). Habitats supporting these plants include cliffs and talus slopes of the Green River Formation, an unnamed soil unit on an ancient pediment surface at 5,400 feet, and Moyerson soils, also at lower elevations, which are derived from the Wasatch Formation.

Utilization of the Clear Creek mesa area by deer occurs primarily during late spring, summer, and early winter. Seasonal migrations of deer in the Roan Creek drainage primarily consist of an altitudinal drift in response to patterns of snow accumulation during winter and plant phenology during spring. Well-defined migration corridors have not been identified and the extent of seasonal deer movements are poorly understood at present (Chevron 1982a). Critical winter range for mule deer (Chevron 1981i) occurs throughout the lower Roan Creek drainage (Figure 3.8-1). As a result of the affinity of deer for this area during periods of snow accumulation and spring green-up, deer-auto collisions occur regularly during winter and spring along roads in the bottomlands of the study area.

Elk distribution in the area is also regulated primarily by snow accumulation during winter and the timing and extent of the new plant growth during spring. The upper Roan Creek valley is considered to be critical elk winter range for the Roan Creek herd (Figure 3.8-1). This area consists of mosaic of conifer, aspen, sagebrush and mountain shrub habitats and is one of three areas designated by CDOW as critical winter range within the Roan Creek drainage. Elk calving occurs throughout the plateau shrublands and forests of the Roan Plateau including the CCSOP property (Chevron 1982a).

The CDOW has designated pinyon-juniper and sagebrush habitat within and adjacent to the Big Salt Wash corridor as critical winter range for mule deer (Figure 3.8-1). This area roughly encompasses the southeast aspect above Big Salt Wash from Ruby Lee Reservoir to the confluence of Post Canyon and Big Salt Wash. This critical winter range represents one of several critical winter ranges which occur in canyon and foothill areas throughout the Book Cliffs (Figure 3.8-1).

Golden eagles commonly occur throughout the area. Four golden eagle nests were located among cliffs of the Clear Creek mesa, including one active nest. Thirty-one additional raptor nests (active and inactive) were located in cliffs of the area searched during the Clear Creek baseline studies (Chevron 1981i). Red-tailed hawks and prairie falcons are among the cliff nesting raptors which are likely to occur in the Clear Creek area.

Bald eagles are commonly observed in riparian habitat along the Colorado River in the vicinity of De Beque during winter. Densities of wintering bald eagles at De Beque are relatively low in comparison to other reaches of the Colorado River within the region (Fisher et al. 1981).

At least five active sage grouse leks have been identified on Clear Creek mesa (Chevron 1981i). The location and level of use of leks is dynamic from year to year in this region (Gumber 1982).

Although only 7 percent of the area is agricultural land, preliminary data indicate that these irrigated areas account for approximately 69 percent of forage production and probably in excess of 80 percent of forage utilization by livestock within the potentially affected area. Both cattle and sheep operations are present. Grazing of the plateau areas is limited by season (June through September) and by accessibility of certain vegetation types. Underutilization and superior range condition is prevalent on the plateau whereas more intensive utilization and reduced percentage composition of desireable forage species is evident in the rangelands of the Roan and Clear Creek valleys (Chevron 1981i).

3.8.3 Grand Valley and Associated Siting Activities

The Grand Valley plant site and associated corridors are characterized by the typical low-elevation vegetation of the region. Agricultural land, Sagebrush Shrubland, Greasewood Shrubland, Shadscale Shrubland, and Pinyon-Juniper Woodland are prominent in these project areas. Smaller areas of Riparian Woodland and all of the other regional vegetation types are also included (Chevron 1982a).

Shadscale and xeric grassland habitats in the vicinity of the Grand Valley site are suitable for at least five mammalian species which are not likely to occur elsewhere in the project area. The most notable among these species are the pronghorn and the white-tailed prairie dog, potential prey of the endangered black-footed ferret. Two additional species, the kit fox and the valley pocket gopher, could also occur in the Grand Valley area (Chevron 1982a).

The presence of flat water habitats at Highline Reservoir and Ruby Lee Reservoir, in addition to riverine habitat along the Colorado River, significantly influences the composition of the avifauna of the Grand Valley site. Twenty-two shorebird and waterfowl species may utilize these areas but are not likely to occur elsewhere in the project area. The osprey, a migratory bird of high federal interest, may also occur as a migrant (Kingery and Graul 1978).

Gamebirds, the ring-necked pheasant and Gambel's quail, may occur in association with the xeric shrubs and grassland communities or agricultural areas in the Grand Valley. The short-eared owl and the burrowing owl, a species of high federal interest, may also occur in association with grassland habitats of the Grand Valley site.

Presence or absence of candidate or listed threatened or endangered plants has not been established for the area. There are no known populations of such plant species. A population of one CNHI plant taxon of special concern, milkweed milkvetch (*Astragalus asclepiadoides*), has been identified at the Grand Valley plant site.

The area between Fruita and Westwater Canyon is a winter concentration area for bald eagles and receives relatively heavy use (Fisher et al. 1982). An eagle roost has been identified near Gilsonite, in the vicinity of an alternative diversion Point C near Loma. No critical or essential bald eagle habitat has been designated by USFWS or CDOW.

Potential habitat for the black-footed ferret occurs in the vicinity of the Grand Valley upgrading facility and corridors associated with it. White-tailed prairie dog colonies which occur in the grassland and agricultural habitat types are less than 2 hectares in extent (Chevron 1982a); therefore, the occurrence of ferrets is unlikely (Hillman et al. 1979). No critical or essential ferret habitat has been designated within the area.

Whooping cranes may pass through the area during spring and fall migrations in association with flocks of greater sandhill cranes. Although greater sandhill cranes (state listed endangered) have been sighted at Highline Reservoir during migration (Chevron 1982a), no whooping cranes have been sighted with them.

Golden eagles nest in the Book Cliffs southeast of the Big Salt Wash corridor and are common throughout the area surrounding the Grand Valley site. Three active and three inactive golden eagle nests were located in this area during baseline surveys conducted in 1981 (Chevron 1982a). Three additional active nest sites and several inactive nest sites have been identified by USFWS (Lockhart 1983).

Regional and site-specific data concerning other migratory birds of high federal interest were not available, and therefore the status of the prairie falcon, Cooper's hawk, ferruginous hawk, merlin, and western bluebird is not known. A site-specific analysis conducted for the Dorchester Coal Company PRLA (BLM 1981b) listed the prairie falcon as a common nester and the Cooper's hawk as a nester. The ferruginous hawk was listed as a scarce migrant, the merlin as an uncommon winter resident and no nesting was noted in the area for these species or the western bluebird.

Mule deer and elk are hunted within Game Management Unit 30, which encompasses the Grand Valley site. Pronghorn range throughout the agricultural, grassland and salt brush habitats in the Grand Valley but occur in low densities and are not hunted in the area. Black bear and mountain lion also range throughout the foothills and mountains north of the Grand Valley site and are hunted in Game Management Unit 30.

Land use within the area includes cultivation of corn and wheat as well as irrigated hay production at elevations below 4,800 feet. Grazing is the primary agricultural use of the land at higher elevations.

3.9 Visual Resources

3.9.1 Regional Setting

The project area is located within the Colorado Plateau Physiographic Province characterized by broad, open, irrigated valleys adjacent to arid topography and sparsely vegetated cliffs rising to brush-covered, gently rolling plateaus. Vegetation and landform color, structure, and pattern constitute the dominant visual features of the province. With the exception of drainage bottoms, water is scarce. Color is dominated by the gray-green of sagebrush, green of mountain brush, and the yellows and tans of the exposed cliff faces. Line in the plateau areas and valley bottoms is horizontal and curving; line in the cliff areas is linear vertical and horizontal (Chevron 1981b).

The dominant landscape features in the project area include the Book Cliffs to the west and southwest, the Roan Plateau and Cliffs in the center, Cathedral Bluffs to the northeast, and the Colorado River drainage to the south and southeast. Canyons cut by Parachute Creek, Roan Creek, and associated tributary drainages are also dominant landscape features.

Cultural modifications are, for the most part, restricted to the valley bottoms or areas immediately adjacent to the bottoms. These include the communities of De Beque, Battlement Mesa, Parachute, Fruita, Mack, and Grand Junction; ranches, farms, orchards, and associated activities; general access roads and Interstate Highway 70; and the Denver and Rio Grande Western Railroad. Ranch and jeep roads, fences, and stock tanks occur on the plateaus, but do not dominate the landscape. Oil shale mining and associated facilities within the Parachute Creek drainage have become significant visual features in that area.

The project area can be separated into six landscape character types: Plateau, Mountain and Valley Floodplain, Mountain Brush Highlands, Cliff and Canyon Floor, Foothill, and Piceance Creek Floodplain (Chevron 1981b, 1982a, 1982b). The following site descriptions include landscape characterization, scenic quality, sensitivity, and visual resource management (VRM) classes by facility site location. Evaluations are based on studies conducted using the BLM Upland Visual Resource Management process explained in BLM Manual 8400 (BLM 1978).

3.9.2 Clear Creek Mesa and Associated Siting Activities

Mine and Plant Sites

The Clear Creek mesa mine and plant sites occur within the Plateau landscape character type, representing the highest elevations of the project area (greater than 7,600 feet). The sites are characterized by mountain brush-covered, gently sloping and rolling, spherical-shaped landforms. Line is curvilinear; color is dominated by the grays and greens of vegetation and is affected by the seasons. Exposed landform is yellow, tan, and brown. Texture is insignificant. Cultural modifications such as jeep roads, fence lines, and cattle trails occur, and impart horizontal and curvilinear lines to the landscape. The scenic quality of the sites ranges from low to moderate, but is strongly influenced by adjacent topography and views. The site is seldom seen by the general public, but receives seasonal use by hunters and off-road recreationists. The mine and plant sites lie within VRM Class IV (Chevron 1981b).

Corridors

The Roan Creek corridor includes the Mountain Valley and Floodplain, Cliff and Canyon Floor, and Arid Foothill landscape character types. The Clear Creek canyon portion is characterized by steep to vertical cliffs and talus slopes rising 1,500 feet to the mesa tops. Line is vertical as exhibited by avalanche runs and horizontal as a result of exposed shale beds. Color is dominated by the yellows, tans, and browns of soil and rock. The canyon floor imparts horizontal curvilinear lines and exhibits the greens and yellows of riparian vegetation. The striking contrast of the area has resulted in a high scenic quality evaluation. Due to limited access by the general public, viewer sensitivity is low. The high scenic quality evaluation however, has resulted in VRM Class II designation (BLM 1982d). The Roan Creek portion of the corridor is characterized by a flat irrigated valley adjacent to moderate to steep brush covered slopes. Line is horizontal and curving. Color varies with slope and aspect and includes the grays and greens of vegetation and brown and gray of exposed soil. Cultural modifications exist as roads and ranch structures. Scenic quality of the type is moderate to low. Since the area can be observed from public access roads and the I-70 corridor, viewer sensitivity is high. The corridor area falls within VRM Classes II and III (BLM 1982d).

The La Sal pipeline corridor lies within the Plateau landscape character type, and is comparable to the Clear Creek mesa site described above. Scenic quality and sensitivity of the corridor are low; the site falls within VRM Class IV (Chevron 1982b).

The Big Salt Wash corridor includes the Plateau, Mountain Brush Highland, and Mountain and Valley Floodplain landscape character types. Scenic quality and viewer sensitivity vary with location. The Colorado River to Book Cliffs portion has the greatest sensitivity, while the Book Cliffs to Clear Creek mesa portion has higher scenic quality.

Reservoirs

The Roan Creek reservoir sites lie within the Mountain and Valley Floodplain character type. The sites are characterized by flat irrigated valley bottoms adjacent to rolling foothills. The color of the valley bottoms is dark green; hillsides are light green and brown. Line in the valley bottom is linear; it is curvilinear in the hillsides. Scenic quality of the sites is moderate. The sites can be observed from moderately used public access ıoads and sensitivity is moderate. The sites fall within VRM Class II.

The Big Salt Wash reservoir site lies within the Mountain Brush Highlands character type. The site is characterized by steep to gently rolling slopes. Vegetation is comprised of sagebrush, pinyon pine, and juniper. Colors range from mottled gray to light green, dark green, white, and yellow. Texture is moderately coarse to coarse. Line, as exhibited by the rolling landscape, is typically curvilinear and horizontal. Cultural modifications are minor and exist as ranch access roads, fence lines, and stock structures. Access to the site is by a ranch acees road; thus, the site is seldom seen by the general public and sensitivity is low. Scenic quality is moderate and the site lies within VRM Class III (Chevron 1982a).

3.9.3 Grand Valley and Associated Siting Activities

The Grand Valley plant site lies within the Mountain and Valley Floodplain character type. The site is comprised of flat to gently sloping terrain sparsely vegetated with low shrubs and grasses. Natural line is curvilinear and horizontal; natural color is gray, tan, and brown. Scenic quality of the Grand Valley site is moderate to low. The area is observed from low use public access roads and sensitivity is moderate. The site falls within VRM Class III (Chevron 1982a).

3.9.4 Alternative Siting Activities

The Rangely corridor includes the Plateau and Mountain Brush Highland landscape character types. Scenic quality, viewer sensitivity, and management classes vary with location. The Clear Creek mesa to Douglas Pass road portion is of low sensitivity and low scenic quality, while the Douglas Pass road corridor is of high sensitivity and moderate scenic quality.

Alternative corridors associated with the Grand Valley plant site occur in the Mountain and Valley Floodplain character type. Scenic quality and viewer sensitivity are moderate.

The Stove/Buniger, Munger, and Garvey canyon spent shale disposal areas lie within the Mountain Brush Highlands character type described for the Big Salt Wash corridor and reservoir. The Dry Gulch site lies within the Mountain and Valley Floodplain type described for the Grand Valley plant site.

3.10 Cultural Resources

3.10.1 Regional Setting

Archaeology

The archaeological setting of northwestern Colorado, including the project area, can be constructed from previous archaeological research and the baseline study conducted for the CCSOP. Excavation data in this region are rare, however.

Most archaeological remains in northwest Colorado are from the hunting and gathering cultures. The earliest inhabitants lived and survived in the region by collecting wild plants, and by pursuing wild game animals and killing them for meat, hides, and other uses (Chevron 1981j). The Llano, Folsom, Plano, Desert Archaic and Ute-Shoshone cultures inhabited the area from about 11,000 B.C. to 1770 A.D.

Climatic fluctuations were one of the major influences on the environment of early man in what is now northwest Colorado. Following the Pleistocene epoch (a time of glaciation which ended about 8,000 years ago), three major climatic periods are hypothesized (Anters 1955; cited in Chevron 1981j). Some periods were warmer and drier than even the present (drought) conditions. Others showed increased moisture, interspersed with droughts. Such conditions naturally influenced the availability of various plants and wildlife for the hunting and gathering cultures.

The seasonal nature of economic activities for prehistoric peoples in the Piceance Creek Basin was reconstructed by Grady (1980; cited in Chevron 1981j) and is described below. It is applicable to the Clear Creek area.

> Lowland marshes and main river drainages were occupied during the spring when the first edible foods became available. High plateau areas were exploited in the summer for faunal and storable vegetal resources. The high country snows which occurred in the fall forced both human and animal populations to lower elevations where late ripening crops such as pinyon nuts and juniper berries were harvested and stored. The winter months were spent in sheltered valleys. This pattern of resource exploitation and seasonal movement is thought to have begun in the Archaic period and survived into the Historic period. For hunting and gathering groups following this existence, an extensive knowledge of plants and their seasonal availability, as well as animal behavior, was required.

Recently, archaeologists working in the Battlement Mesa, Inc. area, about 20 miles northeast of De Beque, unearthed the oldest pithouse known in Colorado. Known as the Kewclaw site, it is located on a prominence overlooking the Colorado River. The dugout structure is a roughly circular, basin-shaped depression. The Kewclaw site was occupied during the Late Archaic period, pre-dating the well-known pithouses of Mesa Verde by more than a thousand years. The presence of the pithouse may imply a more settled lifestyle for these early people than was formerly thought (Grand River Institute 1982).

History

The history of the Clear Creek area is familiar to students of Western history in the Rocky Mountain states. The recurring theme — potential booms that never materialized — is apparent from 1760 to the present (Athearn 1976; cited in Chevron 1981j). Traditional development patterns for this area have occurred, notably (1) early exploration; (2) fur trade; (3) increased interest and accelerated exploitation; (4) dispossession of Indian lands; (5) encroaching white settlements; and (6) a mix of economic activities, including railroads, ranching, agriculture, and mining. The arid climate and isolation delayed development of this area compared to other parts of Colorado. The following historical sketch is summarized from baseline reports (Chevron 1981j).

Spanish explorers first visited the region in the 1760's. Franciscan friars, hoping to establish a trade route and gain the friendship of the Indians, traveled from Sante Fe northwest through western Colorado in 1776-1777 in a roundabout route to California. The explorers traveled up Roan Creek and over to the White River, but had to turn back as winter approached and thus returned to Santa Fe.

Spanish trappers and traders continued to deal with the Indians in the early 1800's. Euro-American fur traders also operated on Colorado's western slope, until the beaver supply was depleted and fashions in Europe changed (from beaver hats to silk) about 1830. The United States Government, however, sponsored expeditions to explore and map the area about this time, and the Fremont, Powell, and Hayden expeditions added to the knowledge about the terrain, vegetation, Indians, and weather.

Indian wars occurred as a consequence of the frequent incursions by whites onto Indian lands for exploration, mining, and agricultural purposes. Conflicts with the Ute tribe in northwest Colorado in the 1870's resulted in removal of the Utes to northeast Utah by 1881.

Following Indian removal, the crossing of the railroad from Leadville down the Colorado River valley spurred white settlement in the 1880's. In fact, a minor land boom, prompted by the railroad, the Homestead Act of 1862, and the Desert Lands Act of 1876, occurred in the Parachute Creek valley about 1890. Settlement in the Clear Creek area did not take place rapidly, and no homestead records are shown for the Clear Creek study area for the period 1880-1920. Only two homesteads for the Clear Creek area are known, dated 1920 and 1921, and one was relinquished after one year.

The railroads brought additional activity to the confluence of Roan Creek and the Colorado River, however, and the town of De Beque (named after an early settler) was incorporated in 1890. Ranching and agriculture were established. The usual competition for rangeland existed between cattlemen and sheepmen. Range wars caused the deaths of some stock, and probably a few men. Leasing of federal rangeland, established by the Taylor Grazing Act of 1934, eased the situation to some extent.

Farming, particularly fruit growing, was also a notable activity. Orchards were established very successfully by 1883. Grazing and livestock raising contributed to the agricultural base, all relying on critical water for irrigation.

Some coal mining occurred in the early 1900's and oil shale exploration, test production, and oil and gas activity took place. An early oil shale boom in 1916-1920, followed by a fluctuating interest in oil shale over the next 60 years, has led us to the present time.

3.10.2 Clear Creek Mesa and Associated Siting Activities

The cultural resources field survey for the Clear Creek mesa site was conducted by a team from the Laboratory of Public Archaeology (LOPA), Colorado State University, Fort Collins (Chevron 1981j), during field seasons in 1980 and 1981. About 17,400 acres, including the proposed plant site, were involved in the 100 percent pedestrian survey (Class III). Of these, approximately 9,200 acres were not surveyed due to steep grades, dense vegetation and unstable talus slopes. The Roan Creek reservoir sites were subjected to a 100 percent field survey (approximately 1,540 acres) by LOPA to the proposed reservoir's second stage high water level elevation of 5,360 feet. The 6.5 miles of pipeline corridor (250 feet wide) from the reservoir to the Colorado River were surveyed by LOPA at the Class III level (Chevron 1981k). In addition, a Class III survey of 4,000 acres in the Roan Creek valley between Dry Fork and Conn Creek was undertaken by Centuries Research of Montrose, Colorado in 1981 (Chevron 1982n).

On Clear Creek mesa, 19 cultural sites (16 archaeological, 3 historical) were recorded, representing the Archaic, Ute, Fremont, and Euro-American periods. As the archaeological background section would suggest, most prehistoric sites are related to hunting, gathering and food processing, and fall into two broad categories open prehistoric camps and open lithic sites (the latter relating to production of stone tools). The other historic sites were remains of homestead foundations with attendant artifacts.

At the reservoir sites and corridor, the LOPA survey located 11 prehistoric and 9 historic sites. These sites also were composed of open lithic assemblages, open prehistoric camps, sheltered prehistoric architecture (such as natural rock overhangs), or historic homesteads and their remains.

The Centuries Research survey in the Roan Creek valley yielded 13 archaeological and historical sites and 24 isolated finds not previously recorded. In addition, the area contained ten previously recorded sites and three isolated finds. Of the prehistoric sites, short-term camps predominated, while one-third were classified as stone chipping sites. Historical sites were predominantly related to ranching and farming in the 1980's.

Roan Creek was also probably a major transportation corridor. Few prehistoric remains are present, however, even along the recorded Ute trail. Three historic sites have been noted: the Roan Creek Community Center, Roan Creek School, and a homestead.

The La Sal pipeline and transmission line route (east from Clear Creek mesa to Davis Point) considered for detailed study in the EIS yielded a few prehistoric and historic sites, and some isolated finds. Generally, little survey work has been done here, and site density is expected to be low due to exposure of the ridge tops to severe weather and the distance from water (Chevron 1982b).

For reasons of confidentiality and to prevent disturbance and vandalism, maps and detailed descriptions of the various sites are not given here.

3.10.3 Grand Valley and Associated Siting Activities

The cultural resources survey of the Fruita upgrading site and vicinity yielded three ranch site locations (the former Gamesa ranch) and three stone cairns. The ranch was an ambitious farming and ranching effort which operated from about 1911 to 1920. Only building foundations, cisterns, and abandoned irrigation canals remain (Chevron 1982t).

The corridor south of the Fruita upgrading site has had no systematic cultural survey. The Big Salt Wash probably served as a transportation corridor. One open camp has been recorded by BLM along the wash. Generally, the northern half of the Big Salt Wash corridor (traveling north, then east to Clear Creek mesa) has yielded negative cultural resource surveys. Other historic routes and a historic site also exist here. Otherwise, site density is probably low due to lack of water, shelter, and exploitable resources. Cultivation has affected most other potential sites in the currently irrigated portion. These effects may be negligible (e.g., plowing over a subsurface cultural layer), but such sites usually lose some significance (Chevron 1982a).

3.10.4 Alternative Siting Activities

Cultural resources investigations in or adjacent to the alternative corridors considered for detailed study in this EIS yielded 23 known cultural resources: 14 prehistoric and 9 historic (Chevron 1982a). Relatively low site densities and sites consisting primarily of lithics (stone artifacts and chipping flakes) were identified. Less frequent were rock shelters, rock art, and Ute wickiups. Numerous trails were also identified.

The Rangely pipeline route alternatives, notably Rangely A, contain the most extensive cultural resources in the areas considered for the project. About 10-12 miles of the Rangely A route are contained within the Canyon Pintado Historic District, listed on the National Register of Historic Places. Much work has been performed in this area to identify the numerous (190) archaeological sites (Creasman 1979). These consist mainly of petrographs, sheltered or open camps, and architectural and open lithic sites. The Rangely B route has had little cultural resources work. One small survey yielded two rock shelters and a rock art site. On the east side of the Cathedral Bluffs, in the Piceance Creek Basin, cultural resources work has been done for proposed oil shale developments (Chevron 1982b). However, this area would probably not be affected by project development.

According to the BLM Meeker office (Meacham 1982), a number of studies of cultural resources have been done in the region, concentrating on the Piceance Creek Basin. Specific studies have been performed for federal oil shale lease tracts C-a and C-b, and for the Multi-Mineral development. These are too numerous to cite and discuss here, but details can be obtained from the above reference.

One other study deserves special mention regarding alternative corridors for the CCSOP. Newkirk and Roper (1982) discuss development of a predictive model (Class II stratified random sample) for the location and nature of cultural sites in a previously unsurveyed area in the Piceance Creek Basin. It might be used for CCSOP during evaluation of sites prior to construction or prior to conduct of detailed Class III field surveys.

When alternative sites are specifically identified by the Operator for construction, site file searches and cultural resource field surveys will be undertaken as necessary in advance of construction as directed by BLM and the Colorado State Historic Preservation Officer (SHPO). These will ensure adequate development of mitigation measures for direct and indirect adverse effects on cultural resources.

3.10.5 Cultural Resource Sites Considered Eligible for Inclusion in the National Register of Historic Places

Three prehistoric sites on the proposed Clear Creek mesa site are considered eligible by BLM for inclusion in the National Register of Historic Places (NRHP). Table 3.10-1 compares SHPO, LOPA, and BLM eligibility determinations on the sites on the Clear Creek mesa. Further consultations may occur with the SHPO on eligibility matters.

These sites have three major attributes:

1. Abundant and potentially significant cultural remains on the surface, or potential for subsurface remains.

2. A promising location environmentally (i.e., near to exploitable resources, such as chipping stone, water, or wild game, or sheltered from the elements).

3. A promising location in terms of excavation potential (i.e., deposits deep enough to yield significant information).

Table 3.10-1 RECOMMENDATION ON CULTURAL RESOURCE SITE ELIGIBILITY CLEAR CREEK MESA PROPERTY

Site#	SHPO[a]	LOPA[b]	BLM
5GF646	No	Likely/Test	No
5GF647	No	Likely/Test	No
5GF648	No	Probably Not/Test	No
5GF649	Test	Probably Not/Test	No
5GF650	No	No	No
5GF651	Yes	Likely/Test	Yes
5GF652	No	No	No
5GF653	No	Probably Not/Test	No
5GF655	No	No	No
5GF656	Yes	Likely/Test	Yes
5GF657	Yes	Likely/Test	Yes
5GF658	No	No	No
5GF659	No	No	No
5GF660	Test	Likely/Test	No
5GF661	No	No	No
5GF662	No	Probably Not/Test	No
5GF663	No	Not Likely/Test	No
5GF664	No	Not Likely/Test	No
5GF665	No	No	No

[a] Source: Townsend (1982).
[b] Source: Chevron (1981j).

The remaining sites are not considered eligible for inclusion in the NRHP. For the reservoir/corridor area, 13 sites were considered eligible by LOPA for nomination to NRHP. Seven of these are questionable, with further clarification needed. Seven other sites were considered ineligible to NRHP, with no further work deemed necessary (Chevron 1981k).

The Fruita plant site, containing remains of the Garmesa ranch and the stone cairns, does not, in BLM's opinion, contain sites which qualify for inclusion in NRHP. LOPA agrees, but the SHPO disagrees with this evaluation. These matters are in the process of resolution.

As reported by Chevron (1982a), the corridor south of the Fruita plant site contains one NRHP eligible open camp (unknown affiliation) and one historic site likely to be eligible.

The other alternative project corridors (except Rangely and La Sal) contain eight eligible or likely eligible sites, including a Ute wickiup, rock art, and Euro-American historic structures. Rangely A, as previously mentioned, contains many significant sites in the Canyon Pintado Historic District as designated by NRHP. Rangely B and the La Sal routes have undergone brief studies, but generally contain few eligible sites and promise a low site density. The above findings are reported by Chevron (1982a; 1982b).

Consultations among the BLM, SHPO and the researchers making the above eligibility determinations are currently in process.

3.11 Land Use, Recreation, and Wilderness

3.11.1 Land Use

3.11.1.1 Regional Setting

The regional land use study area for the purposes of this EIS includes the Clear Creek mine and plant site and associated corridors planned for the Proposed Action, and Clear Creek, Fruita I, and Fruita II alternatives, and a surrounding one-mile buffer zone.

Historic Land Uses

Prior to 1850, the major theme of northwest Colorado's history included early exploration (1750-1776) and fur trading (1776-1840), leading to settlement in the late 1800's. Beginning in the late 1870's, settlers began moving into west-central Colorado (TRW 1981).

The open-range cattle industry boomed from the late 1860's to the late 1880's, at which time it became the dominant industry. By the 1890's, changes were occurring due to competition for land from agricultural development and sheep raising.

Çoal and oil shale mining became prevalent in the late 1880's. Although coal mining was not a major contributor to the area's economy, oil shale activity showed promise during in the early twentieth century. The lack of technology for extracting the oil shale, combined with other factors such as fraudulent claims, poor working conditions, and discovery of additional oil and gas resources, led to the decline of the oil shale industry after 1924. In the 1970's, the search for domestic sources of oil led to renewed interest in oil shale development. By the early 1980's, no shale oil was being marketed from west-central Colorado, but two commercial projects were underway (TRW 1981).

Present Land Uses

Land uses in northwest Colorado range from urban development to rangeland. The region is predominantly rural and includes sparsely populated towns such as Rifle, De Beque, Parachute, Palisade, Fruita, and Mack.

Grand Junction is the most urban and densely populated town within the study area and is the main economic activity center within the region. Presently, as in the past, agriculture and ranching are the dominant land uses in the study area. Agricultural production in Garfield and Mesa counties is a small portion of the state total, estimated to be over $27 million in 1981 for crops (USDA 1982), but it is a significant contributor to the economic activity of the counties. Mesa County has 52,000 acres of prime farmland (as defined by the U.S. Soil Conservation Service) and there are 11,500 acres of prime farmland in Garfield County. Mesa County is also unique in that it supports the majority of the state's orchards.

About 7 percent of the project area (approximately 2,055 acres) is agricultural, primarily used as cropland. Rivers provided early settlers a reliable source of water for cultivation. Therefore agricultural lands are mainly confined to the river valleys (see Appendix Figure D). Within the project area, prime farmlands are restricted to the Grand Valley near Fruita and the White River near Rangely (SCS 1979). Approximately 497 acres of designated prime farmland occur within the project area.

Although the majority of the project area is topographically diverse (ridges, plateaus, and valleys), livestock and sheep production remain practical in some areas. Cattle graze the plateaus on or adjacent to the project area from June through September at stocking rates ranging from 10 to 20 acres/cow. The number of cattle and calves reported from Garfield and Mesa counties for 1982 was 105,000 (USDA 1982). The total number of stock sheep was 53,000 for both counties.

Access to the plateau grazing areas include trails up Clear Creek, Brush Creek, and trails from the Piceance Basin. The Clear Creek trail originates near the confluence of Willow Creek and Clear Creek and continues up the south side of Clear Creek canyon to the plateau. Historically, this trail has been used to operate and maintain cattle businesses.

Ranching operations have evolved using public land and interspersed private and state lands. In many cases, ranchers are very dependent on BLM land because of the small size or seasonal use constraints of their own properties.

The land use map (Appendix D) is divided into three categories: (1) agriculture, (2) rangeland, and (3) residential. The following are descriptions of the land use mapping units.

1. Agricultural (approximately 7 percent) - Irrigated land used for pastureland, hayland, or cropland, including lands designated as prime farmland. These lands may include occasional ranch or farmhouses, and associated ranch or farm structures.

2. Rangeland (approximately 93 percent) - This category covers a majority of the study area and includes any areas which can be grazed by animals, both domestic and wild, not including agricultural or inaccessible areas.

3. Residential (less than 1 percent) - Inhabitated areas, including small communities within the study area (De Beque, Parachute, Fruita).

Wildlife habitat, as discussed in Section 3.8, is primarily coexistent with rangeland and was not mapped separately. Critical winter range for elk and mule deer is shown in Figure 3.8-1. Recreation areas occur within the region, but not within the project area. They are shown in Figure 3.11-1.

3.11.1.2 Clear Creek Mesa and Associated Siting Activities

The Clear Creek mesa site is privately owned and is predominantly rangeland/wildlife habitat. Sagebrush-Snowberry Shrubland is the major vegetation type on the site. Average vegetation productivity is approximately 1,000 pounds/acre (Section 3.8). Among the more economically and recreationally important game species located on the site are mule deer and elk which are actively hunted during the fall months. There are no agricultural properties on the site. The closest residence is approximately 4 miles west-southwest of the center of the Clear Creek mesa site.

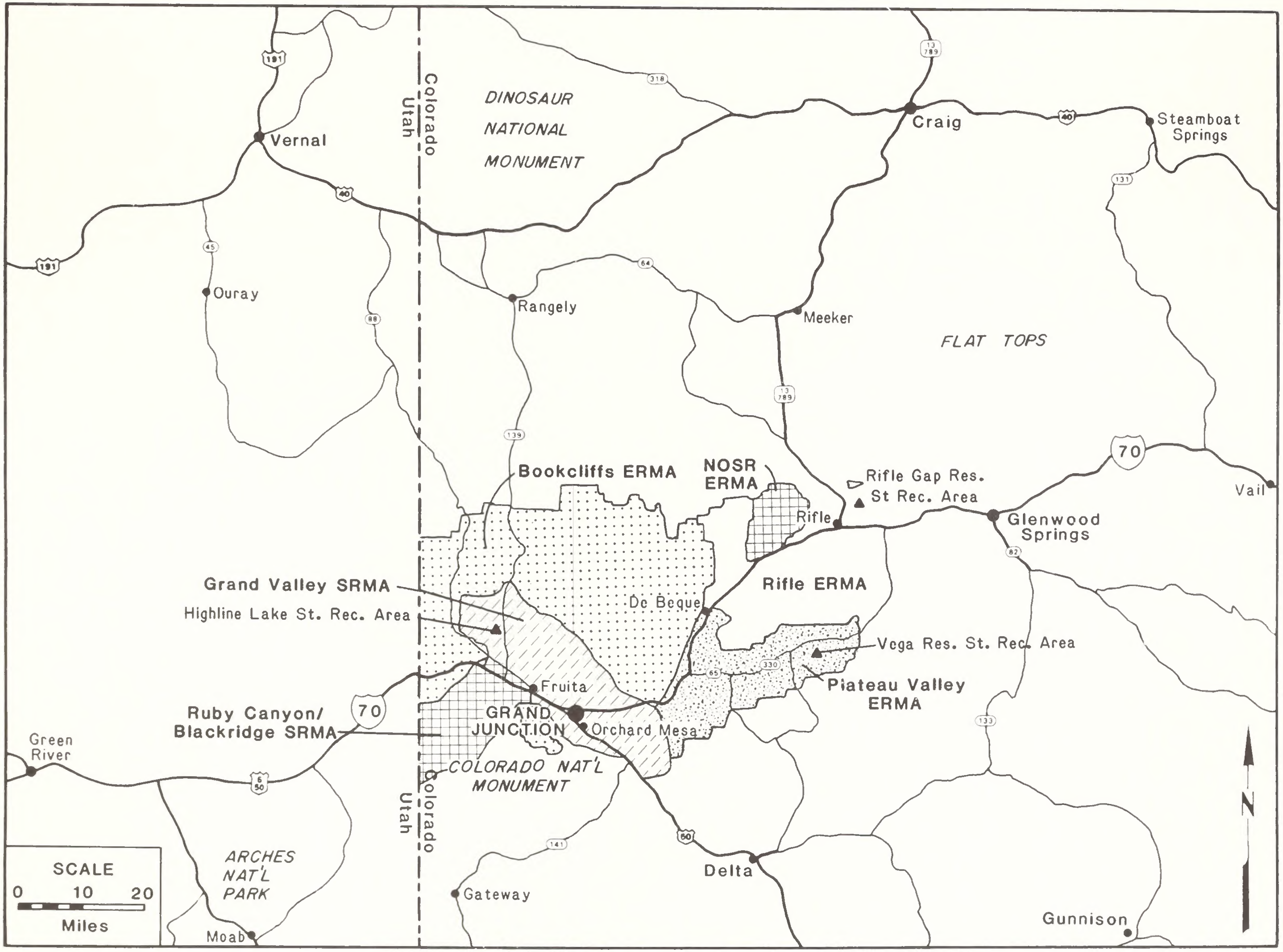


Figure 3.11-1 Regional Map of Northwestern Colorado Showing Recreational Areas

3.11.1.3 Grand Valley and Associated Siting Activities

Existing land use on the Grand Valley alternative plant site is limited to grazing by livestock. Several small stock ponds exist on the site to increase water availability for livestock. Average production from vegetation is less than 1,500 pounds/acre (BLM 1980a).

The site, owned by the Operator, contains ephemeral streams that form the headwaters of Mack Wash. The latter stream flows into Highline Reservoir at Highline Lake State Recreation Area, about 3.5 miles southwest of the property. Ruby Lee Reservoir is located at the northern edge of the property.

One ranch house is located within 0.25 mile of the eastern site boundary. This is the only residence within 1 mile of the site.

3.11.1.4 Alternative Siting Activities

Land uses at the alternative site locations are predominantly rangeland. Vegetation types include Sagebrush Shrubland, Mixed Shrublands, Pinyon-Juniper Woodland, Aspen Woodland, agricultural land, Douglas-fir Woodland, Shadscale Shrubland, Greasewood Shrubland, and Riparian. Distribution of each type is controlled by topography, soils, and moisture availability.

3.11.2 Recreation

3.11.2.1 Regional Setting

The recreation study area for the purposes of this EIS includes areas (e.g., wilderness areas, national monuments, national forests, and similar areas) located within 2-3 hours driving distance from potential CCSOP employee's residences.

Generally, recreational resources in the region consist of developed recreation sites and dispersed recreation areas such as the open space/natural areas which provide wildlife habitat for the region's big game species. Hunting is the most important recreational use of the mountainous portions of the Piceance Basin. Nearby areas contain one of the largest mule deer herds in the west, in addition to large numbers of elk. Hunters from all over the country come to this area in the fall, making an important contribution to the regional economy (Chevron 1981i). Fishing for warm-water species and trout in the mountain streams is common, but not of the same quality as in other parts of the state (BLM 1980b). The Colorado River passes through this region and is a major rafting and fishing resource. There are four-wheel drive and limited hiking and camping activities throughout the region.

3.11.2.2 Existing Community Recreation Facilities

Recreational facilities within the Grand Valley urban area consist of various public parks and community centers, and private facilities such as athletic clubs and health clubs. Municipalities within the Grand Valley area are experiencing increased demand for recreational facilities. Many towns have developed recreation master plans and are developing new parks and recreation centers.

The city of Rifle has received Oil Shale Trust Fund money for a community center ($1.5 million) and for outdoor recreation ($0.2 million). Development of the community center has been delayed until a recreation district can be formed.

3.11.2.3 Existing Outdoor Recreation Opportunities

Outdoor recreation opportunities in the area include hunting (big game, small game, and waterfowl), fishing, snow and water skiing, boating, camping, hiking, off-road vehicle use, snowmobiling, and sightseeing. Lands with recreational value are divided into regions by the Colorado Division of Parks and Recreation, and into Recreation Management Areas (RMAs) by the U.S. Bureau of Land Management (1979b). RMAs are further divided into Special Recreation Management Areas (SRMAs) and Extensive Recreation Management Areas (ERMAs). RMAs, as determined by the BLM, are areas where recreation is the dominant activity and public participation is high. SRMAs are recreational areas where multiple use activities (e.g., grazing, mining, timber production) may conflict with recreational activities. ERMAs include all RMAs which are not SMRAs.

The recreation study area is located in the Colorado Divison of Parks and Recreation Region 11 and encompasses two SRMAs, Ruby Canyon/Black Ridge and Grand Valley, and four ERMAs, Book Cliffs, Naval Oil Shale Reserve, Rifle, and Plateau Valley. On a percentage basis, Region 11 ranks second in the state in total activity days for developed camping and snowmobiling. The five top activities in this region include bicycling, developed camping, picnicking, swimming, and fishing. Swimming ranks as the highest need in the region followed closely by bicycling, four-wheeling, and lake boating (BLM 1980b). Table 3.11-1 presents outdoor recreation participation characteristics for Region 11.

The following is a description of each of the above RMA's within Region 11. The RMAs locations are shown on Figure 3.11-1.

Special Recreation Management Areas (SRMAs)

Ruby Canyon/Black Ridge. Ruby Canyon/Black Ridge SRMA is important due to its accessibility and proximity to Grand Junction, the largest city in western Colorado. This SRMA provides boating, fishing, hunting, hiking, nature study, camping, and off-road vehicle use. The Ruby Canyon area attracts boaters from throughout the state, and Black Ridge contains the largest concentration of arches in Colorado. The Colorado National Monument is located within this SRMA; it provides areas for picnicking, sightseeing, and other recreational activities.

Grand Valley. Excellent year-round opportunities for off-road vehicle racing, hiking, target shooting, and horseback riding are available in this area adjacent to the largest urban area of western Colorado. Highline Reservoir State Recreation Area is located within this SRMA. It provides many activities such as boating, fishing, and water skiing.

Extensive Recreation Management Areas (ERMAs)

Naval Oil Shale Reserve. The most important use of this ERMA is big game hunting. Hunting for blue grouse, camping, and off-road vehicle use are also popular. Although fish are present in some streams, limited fishing occurs.

The BLM has only custodial surface management responsibilities on the Naval Oil Shale Reserve. The Department of Defense has jurisdiction and must approve all management actions that involve the Naval Oil Shale Reserve.

Book Cliffs. This large setting provides hunting, trail related off-road vehicle use, snowmobiling, wild horse viewing, and firewood cutting. The entire area is being rapidly developed for oil and gas; such development is creating access where none existed in the past. Hiking along the Book Cliffs is in close proximity to Grand Junction. The Little Book Cliffs Wild Horse Area is the only dedicated wild horse range in Colorado and provides a unique recreation opportunity. Island Acres is a state recreation area within this ERMA which provides for camping and recreational activities.

Rifle. This ERMA surrounds the towns of Rifle and Parachute, which are growing as a result of regional oil shale development. This rapid growth will result in increasing demands on public lands to meet the recreation needs of the population.

Glenwood Springs is a year-round resort area attracting many people to its natural hot sulfur springs. A major ski resort is presently being planned for the Rifle area.

Table 3.11-1 OUTDOOR RECREATION PARTICIPATION CHARACTERISTICS FOR REGION 11, 1979-80

Activity	Resident Participation Percentage	Resident Per Capita Participation Rate	Resident Participant Participation Rate	Resident & Non-Resident Total Activity Days	Projected Resident & Non-Resident Activity Day Percent Increase/ Decrease 1980-85
Picnicking[a]	79.6 (1)[b]	8.12 (5)	10.20 (7)	1,585,501 (9)	23.1 (1)
Swimming[a]	61.2 (3)	8.65 (7)	14.13 (10)	1,472,942 (6)	31.4 (2)
Bicycling[a]	42.9 (5)	25.65 (1)	59.79 (4)	2,892,956 (4)	35.0 (2)
Motorcycling	22.4 (2)	6.42 (2)	28.66 (8)	806,830 (5)	12.2 (6)
Four-Wheeling[a]	45.8 (3)	9.76 (3)	21.31 (4)	846,257 (9)	25.6 (3)
Football-Soccer-Rugby	14.3 (9)	4.75 (4)	33.22 (2)	369,660 (6)	20.3 (2)
Softball-Baseball	16.3 (12)	4.65 (9)	28.53 (2)	414,631 (5)	32.5 (2)
Tennis	30.6 (3)	4.85 (7)	15.85 (9)	548,584 (7)	25.2 (3)
Day Hiking on Trails	53.1 (5)	8.40 (4)	15.82 (6)	1,060,338 (9)	22.4 (2)
Golf	12.2 (4)	2.24 (5)	18.36 (5)	249,090 (6)	30.1 (5)
Camping (Developed)	36.7 (4)	4.07 (3)	11.09 (5)	933,767 (9)	15.7 (6)
Camping (Back Country)[a]	57.1 (2)	5.06 (3)	8.86 (10)	2,560,989 (2)	10.0 (7)
Sailing	4.1 (6)	0.18 (5)	4.39 (4)	0 (8)	0 (8)
Lake Boating	30.6 (5)	3.47 (4)	14.60 (2)	373,288 (8)	59.0 (2)
Water Skiing	14.3 (7)	1.53 (5)	10.70 (5)	201,080 (4)	14.0 (3)
Fishing[a]	61.2 (3)	8.70 (8)	14.22 (12)	1,122,827 (7)	23.0 (2)
Nature Study[a]	34.7 (5)	8.73 (3)	25.16 (5)	1,049,581 (4)	44.4 (4)
Hunting	34.7 (3)	5.30 (1)	15.27 (5)	699,863 (3)	20.8 (5)
Horseback Riding	24.5 (6)	6.23 (6)	25.43 (7)	629,800 (8)	14.5 (3)
Cross-Country Skiing	19.4 (5)	1.83 (4)	9.43 (4)	252,881 (3)	22.3 (1)
Downhill Skiing	27.7 (5)	3.04 (4)	10.97 (4)	543,939 (4)	22.1 (3)
Snowmobiling	19.1 (4)	1.51 (4)	7.92 (5)	145,801 (2)	22.2 (2)
Ice Skating	12.8 (6)	0.36 (8)	2.81 (9)	40,030 (8)	25.4 (3)
All Activities	95.8 (1)	133.45 (3)	139.30 (3)	18,800,635 (6)	24.7 (1)

Source: CDPOR (1981).

[a] High ranking regional need activity
[b] ( ) Regional Statewide Rank

Plateau Valley. This ERMA provides for many recreational activities, including hunting, camping, and hiking. Vega State Recreation Area is within this ERMA and provides recreational activities such as fishing, swimming, and boating (BLM 1979c).

3.11.3 Wilderness

3.11.3.1 Regional Setting

The wilderness study area for the purpose of this EIS extends from Mack eastward to Glenwood Springs, northward to the Flattops and south to the Colorado National Monument (Figure 3.11-2). This area includes designated wilderness areas (areas formally designated by Congress as part of the National Wildnerness Preservation System) and areas under wilderness review (both recommended and not recomended). Table 3.11-2 lists these areas. They are also shown on Figure 3.11-2.

Some important characteristics in determining wilderness classification include natural characteristics (topography and vegetation, and imprints of man), opportunities for solitude, and opportunities for primitive, unconfined recreation.

Table 3.11-2 AREAS UNDER WILDERNESS REVIEW AND DESIGNATED WILDERNESS AREAS IN VICINITY OF THE CLEAR CREEK SITE

Areas Under Wilderness Review		Designated Wilderness Areas
BLM Recommended	BLM Not Recommended	
Demaree Canyon	South Shale Ridge	Flat Tops
Little Book Cliffs Wild Horse Area	Bangs Canyon	
Black Ridge Canyons		
Black Ridge Canyons West		
Colorado National Monument (under proposal)		

3.11.3.2 Areas Under Wilderness Review

Areas (units) under wilderness review are within the BLM wilderness program and are undergoing or have undergone inventory, study, and reporting phases. These units either qualify as wilderness study areas (recommended) or for certain reasons do not qualify (not recommended). All have undergone a review (BLM 1980b). Following is a description of each of the recommended areas. These descriptions are adapted from documents prepared by the U.S. Bureau of Land Management (1980b), U.S. National Park Service (1971), and U.S. Forest Service (1978).

Demaree Canyon. This area is located approximately 25 miles northwest of Grand Junction in Garfield and Mesa counties. All land within this 21,050-acre unit is public land administered by the BLM. The entire unit is leased for oil and gas. Grazing occurs in the area under BLM permit. The surrounding lands are predominately public with some private land along the northern and eastern boundaries.

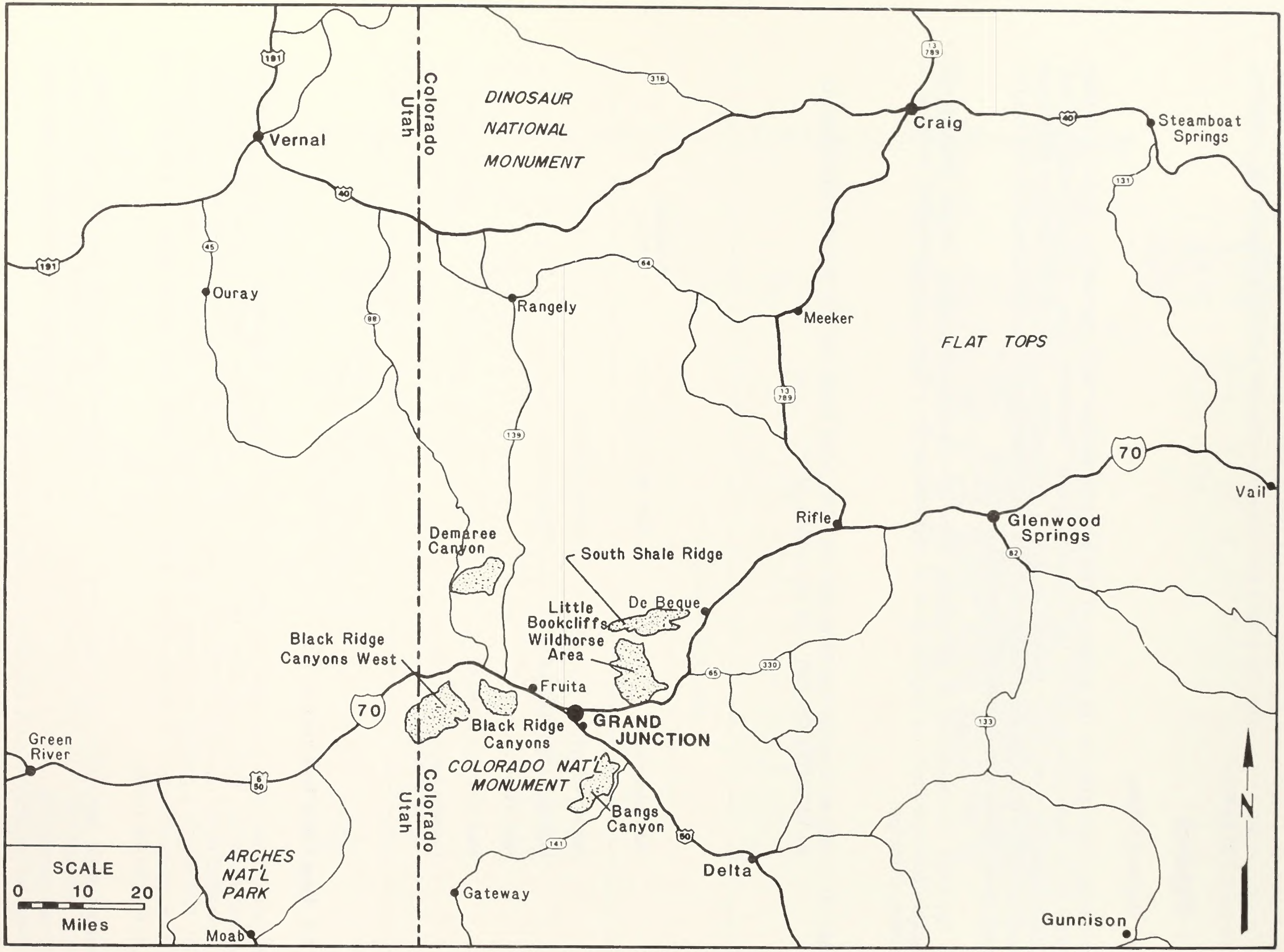


Figure 3.11-2 Regional Map of Northwestern Colorado Showing Wilderness Study Areas

Opportunities for primitive recreation are limited found in the unit, with hunting the primary recreational opportunity. Other activities such as hiking, camping, and wildlife observation could take place but are limited due to the rugged terrain.

Little Book Cliffs Wild Horse Area. This area is located approximately 3 miles north of Grand Junction (Mesa County) and contains 26,525 acres of public lands administered by the BLM. About one-quarter of the area is under lease for livestock grazing. All of the unit is under oil and gas leases. Two coal leases exist within the unit. The majority of the unit coincides with the Little Book Cliffs Wild Horse Area, an area managed to protect a herd of 65-100 wild horses.

Outstanding opportunities for several different types of primitive recreation exist within the Little Book Cliffs Wild Horse Area. The unit's size, topographic diversity, scenic beauty, the presence of a wild horse herd, and numerous different canyon systems all work to create opportunities for horseback riding, hiking, backpacking, photography, scenic viewing, and the viewing of wild horses.

Black Ridge Canyons. This area is approximately 10 miles west of Grand Junction (Mesa County) and is of 18,150 acres of public land administered by BLM. None of the unit is under oil or gas lease, although all of the unit is currently under grazing permits. A series of mining claims are located in the southeastern corner of the unit. There are approximately 3,140 acres along the Colorado River which are withdrawn for reclamation and water power projects.

The unit contains outstanding opportunities for primitive recreation. Topographic diversity, unusual landforms (e.g. arches, spires, and windows), and intermittent waterways all provide high appeal to the day hiker. Opportunities for rafting down the Colorado River are excellent. Several other types of primitive recreation which can also occur within the unit include horseback riding, deer hunting, fishing, bird watching, scenic viewing, and the study of archaeological and paleontological sites.

Black Ridge Canyons West. This area is located approximately 15 miles west of Grand Junction (Mesa County, Colorado; Grand County, Utah). All lands within this 54,290-acre unit at the Colorado-Utah state line are public lands administered by the BLM. None of the unit is currently under oil and gas leases. No leases occur in the Colorado part of the area as a result of a BLM Management Framework Plan decision which emphasized the protection of the area's recreational and scenic values. No mining claims or rights-of-way are known to exist in the unit. To the north and south of the unit lie a mixture of public and private lands.

Opportunities for primitive and unconfined recreation exist with the Black Ridge Canyons unit based on outstanding scenery and landscape variety, interesting geologic features, three major canyons, the Colorado River, and cultural and paleontological resources. These opportunities include backpacking, hiking, scenic viewing, rafting, photography, and horseback riding (BLM 1980b).

Colorado National Monument. The west entrance to the Colorado National Monument is located 3 miles south of Fruita. The east entrance is 3 miles west of Grand Junction. The Rim Rock Drive, a scenic highland road, links the two entrances. Major access routes to the monument are Interstate 70 and U.S. Highways 6, 24, and 50 from Grand Junction; and Interstate 70, and U.S. 6 and 50 from Fruita.

The preliminary wilderness proposal of 7,700 acres encompasses the central and northeastern portions of the monument, excepting the major portion of Monument Mesa. Approximately 45 percent of the monument is thus proposed as wilderness. The proposal includes Monument, Ute, Red, Columbus, and Gold Star Canyons, which are major canyons draining into the Grand Valley. Colorado National Monument's most significant resource is its colorful and picturesque display of geological formations.

3.11.3.3 Designated Wilderness Areas - Flat Tops

The present 235,230-acre Flat Tops Wilderness became a part of the National Wilderness Preservation System on 15 December 1975, through Public Law 94-146.

It is located in the northwestern portion of Colorado, within the White River and Routt National Forests. Portions of the wilderness lie in the counties of Rio Blanco, Garfield, and Eagle. The Flat Tops is approximately 170 miles west of Denver, and 140 miles northeast of Grand Junction.

The dominant feature of the Flat Tops Wilderness is the White River Plateau, a flattened, lava-capped dome. The perimeter of this plateau is sharply defined by sheer volcanic escarpments, below which lie gently rolling benches and deep drainage valleys that shelter scenic lakes, streams, and forests. The most impressive feature of the Flat Tops Wilderness area is Trappers Lake (USFS 1978).

The extensive area of beetle-killed spruce in the area is responsible for two distinguishing features of the Flat Tops: (1) the seemingly limitless acres of silver-grey forest greatly enhances the feeling of vastness one perceives when in the wilderness; and (2) the spruce-fir regeneration which is replacing the dead forest provides a unique opportunity for studying the process of ecological succession. Approximately 141,000 visitor days were reported for the area in 1981 (USFS undated).

3.12 Socioeconomics

3.12.1 Regional Setting

Since many of the social and economic impacts of the CCSOP would affect not only Garfield County but neighboring Mesa County, the description of social and economic baseline conditions takes into account both counties. Included in this section are profiles of the historical background of Garfield and Mesa counties and discussions of population and demographics, economic conditions, housing, public facilities and services, and financial conditions of local governments as of May 1982. For the most part, this section was constructed from the baseline socioeconomic study conducted by Briscoe, Maphis, Murray, and Lamont, Inc. (BMML 1982) for the CCSOP.

3.12.2 Background

The history of the Western Slope has been influenced by the Ute Indians, Spanish explorers, French fur trappers and traders, some mining activity, railroads, and farming and ranching. Historical events are discussed further in Section 3.10, Cultural Resources.

Coal has been produced in the region for railroads and Pueblo steel mills for decades. Farming and ranching increased after the Homestead Act, and hay production became profitable with the introduction of irrigation. Publicity from visits by Theodore Roosevelt to the area in the early 1900's also encouraged tourism in the region (OTA 1980).

Garfield and Mesa counties have recently witnessed dramatic change. Garfield County's economy has begun to show substantial dependence on tourism and recreation. This activity is reflected in steady growth rates in the county's retail trade and service sectors. Mesa County's economy is more diverse than Garfield County's. Retail trade and services dominate but, because Grand Junction is a regional center, these economic sectors serve a broader base than tourism and recreation.

Oil shale development has exerted a strong influence on the two counties. The direct effects have been in the west Garfield County area from Rifle to Parachute. Development has increased county services, expenditures, and revenues. Construction activity increased 66 percent between 1980 and 1981. The effect in Mesa County has been more indirect — housing, commercial offices, and services for direct and secondary employment have increased.

Ranching, mining, and recreation are the principal economic activities in the two counties. Small, rural, agriculturally-based communities predominate. Traditional agrarian attitudes and values have historically prevailed among area residents. The social situation is changing, particularly since the beginning of the last oil shale "boom". As the area becomes increasingly urban, traditional values are being challenged. The services available and problems experienced increasingly resemble those in other urban areas.

An analysis of key issues in the two counties indicates that residents generally favor oil shale development, yet wish to maintain their quality of life (BMML 1982). Various efforts to plan for growth have been instituted throughout the region. The Cumulative Impact Task Force (CITF) and the Colorado Joint Review Process (see Section 1.1.2) are attempts to ensure that the area will be prepared for oil shale growth. The CITF is a cooperative venture of state and local governments and industry to develop tools to assess potential social and economic impacts from major developments in northwestern Colorado. As a part of its growth management effort, Garfield County has instituted a special use permit as part of its zoning code for major development projects. Mesa County is in the process of developing requirements for a similar permit.

Perceived social and economic issues in the region include: (1) housing, especially for the elderly on fixed incomes; (2) community facilities and services; (3) problems of the elderly and youth; and (4) adequacy of public financing for needed services.

3.12.3 Population

The following discussion summarizes population data and identifies demographic trends for Garfield and Mesa counties from 1950 to 1980.

Table 3.12-1 presents Bureau of Census data for Garfield and Mesa counties. Between 1950 and 1960, there was virtually no growth in Garfield County, while Mesa County's population grew by 30 percent. This rapid growth in Mesa County reflected energy development (primarily uranium and oil and gas), and expansion of Grand Junction as a regional trade center. Growth in Mesa County leveled off between 1960 and 1970 and growth rates for Garfield and Mesa Counties lagged behind state averages. Some municipalities in the counties actually had declining populations during this period (BMML 1982).

Between 1970 and 1980, population in Garfield and Mesa counties grew rapidly (52 and 50 percent, respectively) and exceeded the statewide average of about 31 percent and the national average of 11.4 percent. This population growth reflects several factors including energy development, growth in recreation and tourism, and general diversification of the economic base.

Individual communities close to major energy projects exhibited more dramatic population growth in the 1970's than the county aggregates. Between 1970 and 1980, for example, De Beque's population grew 80 percent; Rifle's 49 percent, and Silt's 113 percent. Population in Collbran and Fruita grew by more than 50 percent, with much of this growth concentrated in the final 3 years of the decade. Grand Junction's population exhibited steady growth, increasing from 20,170 in 1970 to 28,144 in 1980. It should be noted that percentage increments tend to overstate the magnitude of impact, since they are often computed (for these western Colorado communities) against very small population bases.

The male/female composition in Garfield County in 1970 was close to the state average, with females accounting for 50.4 percent of total population. By 1980, the male proportion increased to 50.9 percent. A similar shift is evident in Mesa County, where the percentage of male population increased from 48.9 percent in 1970 to 49.5 percent in 1980. These changes are probably attributable to increases in energy and construction activities in the two counties.

In 1970, the median age of residents of Garfield (30.0 years) and Mesa (30.2 years) counties was significantly higher than the state average (26.2 years). By 1980, the median age in the counties had converged with the state average. The decrease in median age in Garfield and Mesa counties is likely the result of the large number of younger in-migrants attracted by expanding economic opportunities, while the decrease in the state average parallels a nationwide trend.

The average number of persons per household in the two counties is similar to the state averages for 1970 and 1980. In 1970, both Garfield (2.98) and Mesa (2.97) counties were lower than the state average of 3.08 persons per household. Smaller family sizes are reflected in the 1980 figures; the state average dropped to 2.65, while the average household size in Garfield (2.77) and Mesa (2.75) counties declined less rapidly.

Table 3.12-1 POPULATION IN GARFIELD AND MESA COUNTIES, 1950-1980

Place	Pop. 1950 Census	Pop.[a] 1960 Census	Pop.[a] 1970 Census	Pop. Change 1960-70 (%)	Avg. Annual Growth Rate 1960-70 (%)	Pop.[b] 1977 Census	Pop. Change 1970-77 (%)	Avg. Annual Growth Rate 1970-77 (%)	Pop.[a] 1980 Census	Pop. Change 1970-80 (%)	Avg. Annual Growth Rate 1970-80 (%)	Pop. Change 1977-80 (%)	Avg. Annual Growth Rate 1977-80 (%)
Garfield County	11,625	12,017	14,821	23.3	2.1	18,800	26.8	3.5	22,514	51.9	4.3	19.8	6.2
Carbondale		612	726	18.6	1.7	1,644	126.4	12.4	2,084	187.0	11.1	26.8	8.2
Glenwood Springs		3,637	4,106	12.9	1.2	4,091	−0.4	—	4,637	12.9	1.2	13.3	4.3
Grand Valley (Parachute)		245	270	10.2	1.0	377	39.6	4.9	338	25.2	2.3	−10.3	−3.4
New Castle		447	499	11.6	1.1	543	8.8	1.2	563	12.8	1.2	3.7	1.2
Rifle		2,135	2,150	0.7	—	2,244	4.4	0.6	3,215	49.5	4.1	43.2	12.7
Silt		384	434	13.0	1.2	859	97.9	10.2	923	112.7	7.8	7.4	2.4
Unincorporated		4,557	6,636	45.6	3.8	9,042	36.3	4.5	10,754	62.1	4.9	18.9	6.0
Mesa County	38,974	50,715	54,374	7.2	0.7	66,848	22.9	3.0	81,530	49.9	4.1	22.0	6.8
Collbran		310	225	−27.4	−2.5	293	30.2	3.8	344	52.9	4.3	17.4	5.5
De Beque		172	155	−9.9	−0.9	264	70.3	7.9	279	80.0	6.1	5.7	1.9
Fruita		1,830	1,822	−0.4	—	2,328	27.8	3.6	2,810	54.2	4.4	20.7	6.5
Grand Junction		18,694	20,170	7.9	0.8	25,398	25.9	3.3	28,144	39.5	3.4	10.8	3.5
Palisade		860	874	1.6	0.2	1,038	18.8	2.5	1,551	77.5	5.9	49.4	14.3
Unincorporated		28,849	31,128	7.9	0.8	37.527	20.6	2.7	48,402	55.5	4.5	29.0	8.9
Six-County Region[c]	87,569	96,445	102,440	6.2	0.6	130,516	27.4	3.5	158,061	54.3	4.4	21.1	6.6
State of Colorado	1,325,089	1,753,947	2,209,596	26.0	2.3	2,625,308	18.8	2.5	2,889,964	30.8	2.7	10.1	3.3

Source: BMML (1982).

[a] Colorado State Demographics Office (1981).
[b] U.S. Bureau of the Census (1979).
[c] Includes Delta, Garfield, Mesa, Moffat, Rio Blanco, and Routt counties.

The population in Garfield and Mesa counties is predominantly white, although there was some decline in the proportion of whites in Mesa County between 1970 and 1980. In 1980, Hispanics represented 4.2 percent and 7.0 percent of the Garfield and Mesa populations, respectively. For the state as a whole, Hispanics comprised almost 12 percent of the total population in 1980.

In 1980, approximately 69 percent of Garfield residents over 14 years of age were married, while 65 percent of the same age group were married in Mesa County. In 1980, the percentage of Garfield and Mesa county residents who were married dropped to about 63 percent and 62 percent, respectively. This decline in the ratio of those married to total population followed statewide trends, where the percentage of those married declined to about 58 percent in 1970.

Data for 1970 median years of education completed for residents of Garfield and Mesa counties indicate that the "median attainment" was slightly more than completion of high school. The county averages were not significantly different from the statewide average (BMML 1982).

3.12.4 Economic Environment

There are three major indicators of historical economic activity — employment, income, and retail sales. The following profile provides insight into the past and current economic structure of Garfield and Mesa counties.

Employment

Garfield County's economy has been substantially dependent on tourism and recreation, particularly in the Glenwood Springs area. As shown in Table 3.12-2, the strength of this activity is reflected in steady growth rates in the retail trade and service sectors. Mining has never been a dominant source of employment in Garfield County. However, as commercial oil shale production commences, employment in the mining sector will increase substantially, particularly in the western portion of the county. Agriculture, an important contributor to the county's tax base, employed approximately 600 people as proprietor or wage earners in the 1970's. Major agricultural products in Garfield County are cattle and cash grain and hay. Construction activity has grown substantially, reflecting the rapid development of the Rifle and Parachute/Battlement Mesa area. The growth in these areas as a staging and residential basis for oil shale development is probably a major contributor to the 66 percent increase in construction activity in the county between 1980 and 1981 (BMML 1982). In 1981, nearly 90 percent of total residential construction in Garfield County was located in the Battlement Mesa (54 percent), Parachute (29 percent), and Rifle (5 percent) areas (BMML 1982).

Mesa County's economy is more diverse and complex than that of any other county on the Western Slope. The county is a regional economic center. According to local planners, 80-85 percent of the county's employment is located in the Grand Valley area (BMML 1982). Major sources of employment are government, services, retail trade, transportation and public utilities, manufacturing, construction, agriculture, and mining. Table 3.12-3 displays Mesa County's employment by industry. Mining-related activity grew rapidly during the 1970's, primarily in administrative capacities, reflecting Grand Junction's role as a regional and national headquarters for energy companies. Agricultural employment remained fairly constant, with a slight decline in the number of farm proprietors between 1974 and 1979 (−1.8 percent). Principal agricultural products in Mesa County are fruits and vegetables, livestock, cash grain, and hay. Construction has grown rapidly, with employment growing nearly 90 percent between 1974 and 1979.

Information on the labor force employment and unemployment rates for Garfield and Mesa counties are presented in Table 3.12-4. Between 1975 and 1981, Garfield County's labor force increased about 35 percent, while the labor force in Mesa County increased by almost 40 percent. Colorado's labor force increased by approximately 28 percent during the same period.

Unemployment in Garfield County has generally exceeded state averages. According to data published for November 1981, unemployment was 1 percentage point above the state average (4.7 percent vs. 3.7 percent). In Mesa County, unemployment rates have generally paralleled state averages; both rates were estimated to be 3.7 percent for November 1981.

Table 3.12-2 GARFIELD COUNTY EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES, 1974-79

Sector	Employment (Full and Part Time) 1974	1975	1976	1977	1978	1979	Average Annual % GROWTH 1974-79
Total Wage and Salary Employment	5,823	6,175	6,624	6,786	7,259	7,444	5.0
Farm	193	182	178	201	201	161	−3.1
Non-Farm	5,630	5,993	6,446	6,585	7,058	7,283	5.3
Private	4,599	4,869	5,264	5,372	5,816	6,007	5.5
Agricultural Services, Forestry, Fisheries, other	19	32	37	42	61	64	27.5
Mining	439	476	501	536	530	101	−12.1
Construction	541	550	651	629	734	856	9.6
Manufacturing	142	161	220	167	161	203	7.4
Non-Durable	55	60	74	81	83	83	8.6
Durable	87	101	146	86	78	120	6.6
Trans. & Public Utilities	400	496	520	543	544	654	10.3
Wholesale Trade	102	112	129	154	198	239	18.6
Retail Trade	1,380	1,359	1,621	1,754	1,842	2,017	7.9
Finance, Insurance & Real Estate	227	253	255	260	300	312	6.6
Services	1,349	1,430	1,330	1,287	1,446	1,561	3.0
Government	1,031	1,124	1,182	1,213	1,242	1,276	4.4
Federal, Civilian	167	172	173	180	188	197	3.4
Federal, Military	75	77	74	69	65	64	−2.8
State and Local	789	875	935	964	989	1,015	5.2
Number of Proprietors	1,402	1,440	1,483	1,581	1,626	1,684	3.7
Farm Proprietors	416	401	417	411	388	381	−1.6
Non-Farm Proprietors	986	1,039	1,066	1,170	1,238	1,303	5.7
TOTAL EMPLOYMENT	7,225	7,615	8,107	8,367	8,885	9,128	4.8

Source: BMML (1982) from Bureau of Economic Analysis (1981).

Income

Table 3.12-5 reflects the developments in personal income which took place in Garfield and Mesa counties between 1975 and 1979. In Garfield County, the major sources of personal income have been retail trade, services, government, transportation and public utilities, construction, and mining. Between 1975 and 1979, sectors experiencing the most rapid growth were retail trade, manufacturing, wholesale trade, transportation and public utilities, and construction.

In Mesa County, the leading sources of personal income have been services, retail trade, transportation and public utilities, construction, mining, manufacturing, and government. The mining sector expanded most rapidly (an average annual rate of almost 31 percent) during the 1975-1979 period. Other sectors which showed rapid growth were finance, insurance and real estate, construction, services, and government.

During the early 1970's per capita income figures in Garfield and Mesa counties lagged behind state and national averages. However, by 1977, Garfield County's per capita income figure ($6,657), exceeded the national ($5,751) average. Mesa County also continued to exhibit income averages ($6,385) below the state and national figures. Although recent data on per capita incomes in the counties are not yet available from the 1980 Census, it is likely that income has grown more rapidly since 1977 in Mesa and Garfield counties than in the state or nation as a whole (BMML 1982).

Retail Sales

Data on retail sales by class of business in Garfield and Mesa counties for 1975 and 1980 are presented in Table 3.12-6. Even discounting for inflation, retail sales rose dramatically in Garfield and Mesa counties between 1975 and 1980.

The retail sales data suggest that both counties have a fairly diversified and growing retail sales sector. Some of the recent growth in dollar volumes of sales can be attributed to inflation, particularly in sectors such as gas and electric utilities, gasoline, and real estate, where price increases have exceeded the general level of inflation. Also, a portion of the increase is due to population growth in the counties. Even when these factors are considered, however, the retail sectors of the counties appear to be healthy.

Table 3.12-3 MESA COUNTY EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES, 1974-79

Sector	Employment (Full and Part Time)						Average Annual % GROWTH 1974-79
	1974	1975	1976	1977	1978	1979	
Total Wage and Salary Employment	21,926	23,952	24,795	27,151	29,304	31,252	7.3
Farm	530	500	492	553	553	444	-3.1
Non-Farm	21,396	23,452	24,303	26,598	28,751	30,808	7.6
Private	16,316	18,126	18,804	21,448	23,473	25,411	9.3
Agricultural Services, Forestry, Fisheries, other	88	116	115	136	130	141	9.9
Mining	513	882	950	1,095	1,251	1,670	26.6
Construction	1,522	1,677	1,835	2,269	2,671	2,881	13.6
Manufacturing	2,252	2,267	2,378	2,565	2,593	2,669	3.5
Non-Durable	488	604	631	699	658	644	5.7
Durable	1,764	1,663	1,747	1,866	1,935	2,025	2.8
Trans. & Public Utilities	1,580	1,731	1,693	1,815	2,036	2,216	7.0
Wholesale Trade	742	1,128	1,254	1,424	1,435	1,583	16.4
Retail Trade	4,712	4,830	4,764	5,530	6,027	6,410	6.3
Finance, Insurance & Real Estate	683	769	843	940	1,085	1,197	11.9
Services	4,224	4,726	4,972	5,674	6,245	6,644	9.5
Government	5,080	5,326	5,499	5,150	5,278	5,397	1.2
Federal, Civilian	776	841	907	936	969	1,004	5.3
Federal, Military	260	268	265	247	228	227	-2.4
State and Local	4,044	4,217	4,327	3,967	4,081	4,166	0.6
Number of Proprietors	3,817	3,900	4,082	4,474	4,585	4,707	4.3
Farm Proprietors	1,403	1,349	1,404	1,383	1,304	1,280	-1.7
Non-Farm Proprietors	2,414	2,551	2,678	3,091	3,281	3,427	7.3
TOTAL EMPLOYMENT	25,743	27,852	28,877	31,625	33,889	35,959	6.9

Source: BMML (1982) from Bureau of Economic Analysis (1981).

Table 3.12-4 LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT FOR GARFIELD AND MESA COUNTIES, 1975-1981

	Total Labor Force				Total Employment				Non-Agriculture Wage Salary Employment			
Locality	1975	1977	1979	Nov. 1981	1975	1977	1979	Nov. 1981	1975	1977	1979	Nov. 1981
Garfield County	9,765	10,595	11,672	13,226	9,268	9,946	11,163	12,603	7,506	8,164	9,322	10,699
Mesa County	28,948	32,802	37,812	40,440	27,585	31,423	35,525	38,935	22,921	26,546	31,411	33,893
State of Colorado	1,162,083	1,258,262	1,412,070	1,482,680	1,101,096	1,199,718	1,366,666	1,426,132	962,732	1,058,341	1,219,924	1,283,106
	Agricultural Employment				**All Other Employment[a]**				**% Unemployment**			
Locality	1975	1977	1979	Nov. 1981	1975	1977	1979	Nov. 1981	1975	1977	1979	Nov. 1981
Garfield County	660	595	521	436	1,102	1,187	1,320	1,468	5.1	6.1	4.4	4.7
Mesa County	1,893	1,707	1,495	1,251	2,771	3,170	2,619	3,791	4.7	4.2	3.4	3.7
State of Colorado	47,658	43,067	37,659	31,600	90,706	98,310	109,083	111,426	5.2	4.7	3.2	3.7

Source: BMML (1982) from Colorado Division of Labor and Employment (1982).

[a] Includes self-employed, unpaid family, and domestic workers.

Table 3.12-5 PERSONAL INCOME BY MAJOR SOURCE (1,000'S OF DOLLARS) FOR GARFIELD AND MESA COUNTIES, 1975-1979

Item	Garfield County						Mesa County					
	1975	1976	1977	1978	1979	Average Annual % Change 1975-79	1975	1976	1977	1978	1979	Average Annual % Change 1975-79
Total Labor and Proprietors Income by Place of Work												
By Type												
Wage & Salary Disbursements	53,112	62,666	67,197	76,638	80,035	10.8	201,239	226,536	267,976	321,459	376,794	17.0
Other Labor Income	4,667	5,815	6,741	7,812	6,520	8.7	15,234	18,503	23,507	2,428	34,949	23.1
Proprietors Income	6,780	7,514	7,871	13,646	11,015	12.9	23,643	21,858	25,353	26,821	40,827	14.6
Farm	-1,515	-971	-1,801	2,253	-1,594	-1.3	4,762	2,726	2,484	-2,149	8,647	16.1
Non-Farm	8,295	8,485	9,672	11,393	12,609	11.0	18,881	19,132	22,869	28,970	32,180	14.3
By Industry												
Farm	-519	46	-554	3,651	-267	10.4	7,234	5,236	5,595	1,346	11,952	13.4
Non-Farm	65,078	75,949	82,363	94,445	97,837	10.7	232,882	261,661	311,241	376,362	440,618	17.3
Private	55,358	64,782	69,936	80,712	82,604	10.5	184,827	206,810	255,411	314,176	372,476	19.1
Ag. Serv., Forest., Fish., & Other	539	574	574	768	868	12.7	828	862	1,322	1,451	1,669	19.2
Mining	11,536	13,762	15,143	17,192	2,586[a]	-15.4[a]	13,824	14,709	19,882	33,256	41,188	31.4
Construction	7,053	10,265	9,712	11,626	14,607	20.0	24,404	27,689	36,810	46,626	54,424	22.2
Manufacturing	1,513	2,169	1,866	2,085	2,980	18.5	20,647	23,808	28,951	31,831	35,581	14.6
Transport. & Pub. Util.	6,960	8,181	9,481	10,302	14,399	20.0	25,540	28,599	33,394	40,314	48,528	17.4
Wholesale Trade	1,490	1,801	2,067	2,696	3,741	25.9	13,096	15,359	17,953	19,751	24,136	16.5
Retail Trade	11,143	12,917	14,271	15,943	19,385	14.8	38,512	38,825	45,982	53,615	62,521	12.9
Finance, Ins. Real Estate	2,788	2,922	3,301	3,932	4,335	11.7	7,739	9,477	11,846	15,307	18,160	23.8
Services	12,336	12,191	13,521	16,168	19,703	12.4	40,237	47,482	59,271	72,025	86,269	21.0
Government	9,720	11,167	12,427	13,733	15,233	11.9	48,055	54,851	55,830	62,186	68,142	9.1
Federal, civilian	2,650	2,757	2,898	3,122	3,459	6.9	13,138	14,728	16,265	18,034	19,434	10.3
Federal, military	152	160	174	176	183	4.7	543	587	626	634	665	5.2
State and Local	6,918	8,250	9,355	10,435	11,591	13.8	34,374	39,536	38,939	43,518	48,043	8.7

Table 3.12-5 PERSONAL INCOME BY MAJOR SOURCE (1,000'S OF DOLLARS) FOR GARFIELD AND MESA COUNTIES, 1975-1979 (Continued)

Item	Garfield County						Mesa County					
	1975	1976	1977	1978	1979	Average Annual % Change 1975-79	1975	1976	1977	1978	1979	Average Annual % Change 1975-79
Derivation of Personal Income by Place of Residence												
Total Labor and Proprietors by Place of Work	64,559	75,995	81,809	98,096	97,570	10.9	240,116	266,897	316,836	377,708	452,570	17.2
Less Personal Contrib. for Social Ins. by Place of Work	3,316	3,778	4,140	4,771	5,508	13.5	12,074	13,717	16,675	19,802	22,837	17.3
Net Labor & Proprietors Income by Place of Work	61,243	72,217	77,669	93,325	92,062	10.7	228,042	253,180	300,161	357,906	429,733	17.2
Plus Residence Adjustment[a]	3,378	3,997	6,199	8,487	31,063	174.1[a]	−320	601	1,539	227	2,965	—
Plus Dividends, Int. & Rent	22,253	24,306	26,816	30,648	35,682	12.5	48,316	58,001	69,124	78,896	91,668	17.4
Plus Transfer Payments	12,928	14,284	15,750	16,876	18,713	9.7	48,848	53,879	58,878	64,113	72,155	10.2
Personal Income by Place of Residence	99,802	114,804	126,434	149,336	177,520	15.5	324,886	365,661	429,702	501,092	596,521	16.4
Per Capita Income ($)	5,568	6,234	6,657	7,676	8,779	12.1	5,217	5,582	6,385	7,117	8,078	11.6

Source: BMML (1982) from Bureau of Economic Analysis (1981).

[a] This decline in mining income is due to accounting changes rather than economic factors.

Table 3.12-6 RETAIL SALES BY BUSINESS CLASS (1,000'S OF DOLLARS) FOR GARFIELD AND MESA COUNTIES, 1975-1980

Place/Year	Agriculture, Forestry, and Fisheries	Mining	Contract Construction	Manu-facturing	Transportation, Communication, Electric, Gas and Sanitary Services	Whole-sale Trade	Building Materials and Farm Equipment	General Merchandise	Food Stores	Auto Dealers and Service Stations
Garfield County										
1975	191	256	1,272	28,783	9,765	4,594	5,496	3,218	14,505	23,216
1980	702	938	7,755	5,723	33,352	29,700	13,632	7,614	41,180	61,811
Annual Percentage Change 1975-1980	29.7%	30.0%	43.6%	−12.5%	27.8%	45.2%	19.9%	18.8%	23.2%	21.6%
Mesa County										
1975	860	2,569	20,055	25,319	20,560	39,443	20,649	24,208	38,222	52,839
1980	1,262	16,481	44,756	62,507	53,138	134,485	54,975	55,758	111,728	181,956
Annual Percentage Change 1975-1980	8.0%	541.5%	17.4%	19.8%	20.9%	27.8%	21.6%	18.2%	23.9%	28.1%
State of Colorado										
1975	58,963	47,761	358,238	2,114,878	753,490	1,362,197	684,397	862,481	1,660,913	2,097,551
1980	92,518	182,979	651,355	3,210,263	1,909,398	2,772,333	1,503,986	1,696,414	3,139,001	4,645,014
Annual Percentage Change 1975-1980	9.4%	30.8%	12.7%	8.7%	20.4%	15.3%		14.5%	13.6%	17.2%

Table 3.12-6 RETAIL SALES BY BUSINESS CLASS (1,000'S OF DOLLARS) FOR GARFIELD AND MESA COUNTIES, 1975-1980 (Continued)

Place/Year	Apparel and Accessory Stores	Furniture and Home Furnishing Stores	Eating and Drinking Places	Misc. Retail Stores	Finance, Insurance and Real Estate	Hotels, Other Lodging Places	Services Other than Lodging	Government Facilities	Non-Class-ifiable	Total
Garfield County										
1975	2,777	2,493	6,638	11,369	378	4,062	5,685	0	200	124,900
1980	5,293	7,015	19,126	29,120	721	12,103	18,422	0	1	294,208
Annual Percentage Change										
1975-1980	13.8%	23.0%	23.6%	20.7%	13.8%	24.4%	26.5%	-	-	18.7%
Mesa County										
1975	10,909	9,770	14,919	29,105	345	4,979	17,049	0	818	332,618
1980	25,124	26,954	43,926	122,826	2,606	14,034	46,544	[a]	9	999,062
Annual Percentage Change										
1975-1980	18.2%	22.5%	24.1%	33.4%	49.8%	23.0%	22.2%	-	-	24.6%
State of Colorado										
1975	384,331	369,065	773,848	1,253,332	39,809	219,977	847,718	6,330	19,845	13,915,124
1980	669,017	798,342	1,716,376	3,466,801	152,239	441,331	1,851,640	17,297	9,168	28,925,472
Annual Percentage Change										
1975-1980	11.7%	16.7%	17.3%	22.6%	30.8%	14.9%	16.9%	22.3%	−9.0%	15.8%

Source: BMML (1982) from Colorado Department of Revenue (1975, 1980).

[a] Less than $500.

3.12.5 Housing

Housing Stock

The total number of housing units in the state, the two counties, and selected municipalities for 1970 and 1980 are identified in Table 3.12-7. During the decade, total housing units increased by almost 72 percent in Mesa County and almost 69 percent in Garfield County, compared to about 58 percent for the state.

The three municipalities where the housing stock expanded at lower rates than the population, Collbran, De Beque, and Parachute, are also those towns where the housing stock increased least in absolute numbers during the period. It is quite possible that the housing industry did not respond to the demand in these municipalities.

Table 3.12-8 shows additional residential units (single-family, multi-family, and mobile home units) according to building permit applications for April 1980 through 1981. In summary, these figures show a higher production of single-family homes in Mesa County than Garfield County. Multi-family units were constructed in much greater numbers in Garfield County, probably to meet the construction schedules, income levels, and more temporary needs of construction workers in the oil shale industry. Much of this growth occurred in Battlement Mesa, a planned unit development, built on county land adjacent to the town of Parachute. Battlement Mesa's infrastructure is designed to eventually serve 25,000-54,000 people. Battlement Mesa has new streets, utilities, schools, a recreation center, housing, and stores constructed in a coordinated and planned environment.

Table 3.12-7 TOTAL HOUSING UNITS FOR GARFIELD AND MESA COUNTIES, THEIR MUNICIPALITIES, AND THE STATE, 1970-1980

	1970	1980	Increase 1970-80 (Number)	Increase 1970-80 (%)	Population Increase 1970-80 (%)	1980 % Vacant Units
Garfield County	5,537	9,345	3,808	68.8	51.9	12
Carbondale	264	830	566	214.4	187.0	13
Glenwood Springs	1,574	2,160	586	37.2	12.9	10
Grand Valley (Parachute)	120	144	24	20.0	25.2	10
New Castle	200	255	55	27.5	12.8	6
Rifle	803	1,370	567	70.6	49.5	14
Silt	155	357	202	130.3	112.7	6
Unincorporated	2,421	4,229	1,808	74.7	62.1	12
% Unincorporated	44%	45%	-	-	-	-
Mesa County	18,982	32,573	13,591	71.6	49.9	8
Collbran	113	159	46	40.7	52.9	15
De Beque	82	136	54	65.9	80.0	20
Fruita	635	1,025	390	61.4	54.2	8
Grand Junction	7,626	12,706	5,080	66.6	39.5	7
Palisade	351	657	306	87.2	77.5	11
Unincorporated	10,175	17,890	7,715	75.8	55.5	8
% Unincorporated	54%	55%	-	-	-	-
Colorado	757,070	1,194,253	437,183	57.7	30.8	9

Source: BMML (1982) from U.S. Bureau of the Census (1971, 1981).

Table 3.12-8 ESTIMATED BUILDING ACTIVITY FOR GARFIELD AND MESA COUNTIES, APRIL 1980 TO OCTOBER 1981

	Single Family	Multi-Family	Mobil Home	Total	Equivalent[a] Annual Rate
Garfield County[b]	180	350	330	860	573
Carbondale	6	46	—	52	35
Glenwood Springs	42	47	—	89	59
Grand Valley (Parachute)	2	207	39	248	165
New Castle	2	24	1	27	18
Rifle	57	541	265	863	642
Silt	23	14	8	45	30
	312 (18%)	1,229 (54%)	643 (28%)	2,184 (100%)	1,522
Mesa County	169	12	129	310	207
Collbran	5	2	8	15	10
Clifton area	370	336	232	938	625
De Beque	2	4	6	12	8
Fruita	69	18	27	114	76
Grand Junction[c]	1,022	779	435	2,236	1,491
Palisade	17	22	23	62	41
	1,654 (45%)	1,173 (32%)	860 (23%)	3,687 (100%)	2,458

Source: BMML (1982) from Colorado West Area Council of Governments (1982).

[a] The annual rate calculates the rate of housing development equivalent to 12 months based on the figures in the other columns which represent an 18-month period.
[b] Includes Battlement Mesa.
[c] Includes Redlands.

Housing Conditions

Census data is one important indicator of the condition of housing for areas as large as Garfield and Mesa counties. These data show which housing units have complete plumbing for exclusive use and which do not. Table 3.12-9 identifies those units lacking adequate plumbing. In De Beque, 6 percent of the housing units have less than adequate plumbing, followed by Parachute at 3.5 percent, and the unincorporated areas of Garfield County at 2.7 percent.

These figures appear significant in percentage terms and do indicate where some housing was inadequate at the time of the census. However, in absolute numbers, De Beque had eight inadequate housing units and Parachute had five. These numbers are less than the number of vacancies in 1980 for De Beque (27) and Parachute (15).

Another indicator of housing conditions is the number of persons living in crowded units. The census defines a crowded housing unit as one with over 1.01 persons per room. Once again, De Beque (4 percent) and Parachute (7 percent) have relatively high percentages of substandard units. However, several other places, including Rifle (4 percent) and Fruita (3 percent), also show higher percentages of crowded units than the state as a whole (2 percent).

Table 3.12-9 YEAR-ROUND HOUSING UNITS WITH AND WITHOUT COMPLETE PLUMBING FOR EXCLUSIVE USE FOR GARFIELD AND MESA COUNTIES, 1980

	Total Year-Round Housing Units	Total Lacking Complete Plumbing For Exclusive Use	Percent Lacking Complete Plumbing For Exclusive Use
Garfield County	9,208	174	1.9
Carbondale	829	3	0.4
Glenwood Springs	2,149	43	2.0
Parachute (Grand Valley)	144	5	3.5
New Castle	248	2	0.8
Rifle	1,359	9	0.7
Silt	352	2	0.6
Unincorporated	4,127	110	2.7
Mesa County	32,265	545	1.7
Collbran	159	2	1.3
De Beque	134	8	6.0
Fruita	1,025	9	0.9
Grand Junction	12,692	249	2.0
Palisade	657	12	1.8
Unincorporated	17,598	265	1.5
State of Colorado	1,168,681	21,029	1.8%

Source: BMML (1982) from U.S. Bureau of the Census (1981).

Housing Costs

Table 3.12-10 provides data on owner-occupied housing values for communities within the two counties and the state. Estimates of median values can be compared for 1970 and 1980. With the exception of De Beque, median prices in the two counties have increased at substantially higher rates than for the state. This relative price picture probably reflects a low base price in 1970 and strong demand through the decade. However, even with these rates of change, median house prices for many of the rural towns are still low compared to state figures.

Table 3.12-11 displays median rental prices for 1970 and 1980 for the state, the two counties, and their municipalities. Rental prices increased during the decade at rates greater than those for the state for all of the places listed except Parachute. As with housing values (Table 3.12-10), 1980 rental prices increased substantially in the area though the actual rental prices in some specific communities, such as Collbran, De Beque, and Parachute, were below the median for the state.

The affordability of housing is a critical concern for low and middle income groups in the two counties. Affordability was expressed as a critical issue in the region by and for groups such as seniors, public employees, and single parents. Seniors on fixed incomes are directly affected by inflation and are not in a situation to take advantage of potentially expanding economic development.

3.12.6 Public Facilities and Services

The public facilities and services described herein comprise those which a municipality or county generally provides for its residents. Services include: police and fire protection; water supply, wastewater and solid waste disposal; and education, health care, and social services. The primary study area for this subsection includes all of Mesa County and from Rifle west to the Garfield County line. It is anticipated that this area will be receiving the greatest impact from the CCSOP.

Police and Fire Facilities and Services

Descriptions of law enforcement facilities and services in the study area are provided in Table 3.12-12. Included are Garfield and Mesa county sheriff's offices and the police departments of the incorporated communities of Rifle, Parachute, Grand Junction, Fruita, Palisade, Collbran, and De Beque. Increasing demands are requiring operational changes in some communities. After interviews with local administrators it was determined that jail facilities in both counties are at capacity or have deficiences and that additional jailers are needed (BMML 1982).

According to all law enforcement agencies, reported incidents are increasing (BMML 1982). Incidents usually involve driving under the influence, disorderly conduct, family disturbances, theft from construction sites, and traffic incidents. Although all agencies with the exception of De Beque report and record incidents regularly, the systems are either not uniform, are inconsistent from year to year, or have just been started (e.g., Parachute and Collbran).

Fire protection facilities and services in the study area are summarized in Table 3.12-13. Increasing population has resulted in shortages equipment and facilities in most districts but efforts have been made accomodate growth. This is particularly evident in the volunteer districts such as in the De Beque Fire Department, the Grand Valley Rural Fire Protection District, and the Rifle Rural Fire Department.

Table 3.12-10 HOUSING UNIT VALUES FOR GARFIELD AND MESA COUNTIES, 1970 AND 1980

	Median Owner Occupied[a] Housing Value			Mean Owner Occupied Non-condo Value 1980	Mean Owner Occupied Condo Value 1980
	1970	1980	Percent Change		
Garfield County	$15,100	$76,500	407	$82,300	$78,300
Carbondale	15,288	85,000	456	87,200	---
Glenwood Springs	18,800	84,200	348	88,000	76,300
Parachute (Grand Valley)	9,444	41,700	342	41,900	---
New Castle	7,456	44,600	498	43,800	---
Rifle	12,400	59,300	378	58,000	---
Silt	7,500	47,700	536	46,600	---
Mesa County	13,300	59,000	346	62,400	64,000
Collbran	9,375	35,000	273	38,200	---
De Beque	8,750	29,600	238	33,000	---
Fruita	9,200	45,400	393	46,100	---
Grand Junction	13,300	49,600	273	53,500	54,700
Palisade	9,946	49,800	401	50,200	---
State of Colorado	17,300	64,600	273	70,000	67,000

Source: BMML (1982) from U.S. Bureau of the Census (1971, 1981).

[a] The housing value figures for 1970 to not distinguish between condominium and non-condominium prices as they do for 1980. The figures presented under 1980 are for non-condominiums. The figures still provide a useful comparison, particularly because the prevalence of condominiums was most likely very low on the western slope in 1970.

Table 3.12-11 MEDIAN CONTRACT RENT, RENTER-OCCUPIED HOUSING UNITS FOR GARFIELD AND MESA COUNTIES

	Median Rent 1970	Median Rent 1980	Percent Change
Garfield County	$79	$269	241%
Carbondale	94[a]	355	278
Glenwood Springs	80	247	209
Parachute (Grand Valley)	69[a]	155	125
New Castle	56[a]	197	252
Rifle	69	261	278
Silt	57[a]	233	309
Mesa County	75	227	203
Collbran	55[a]	160	191
De Beque	48[a]	155	223
Fruita	64	217	239
Grand Junction	78	218-294[b]	179
Palisade	61[a]	253	315
State of Colorado	97	225	132

Source: BBML (1982) from U.S. Bureau of the Census (1970, 1980).

[a] These figures from the 1970 census are presented somewhat differently than those for the 1980 census. These 1970 figures are for "monthly contract rent for units with all plumbing facilities". No such restriction applies to the 1980 data.

[b] The census for 1980 presents data on Grand Junction in 2 different groups. However, because the $294 figure represents only 7 units, the $218 figure is used for the calculations made here.

Water, Wastewater, and Solid Waste

Municipalities vary in the adequacy of their water supply treatment facilities. Table 3.12-14 summarizes water system characteristics and demand. In the Grand Valley area, the primary water supplier is the Ute Water Conservancy District; main sources of domestic water for the Grand Valley are reservoirs on Grand Mesa and the Colorado River. The town of Fruita draws from Pinion Mesa. All water suppliers in the Grand Valley area are expanding their systems. The total cost of committed expansion and improvement plans exceeds $20 million. It appears that, given these expansion plans, most entities will be able to provide adequate water supplies. Entities providing water in the De Beque/Collbran area cannot currently support a substantial population increase. Water treatment plants in the area use relatively simple processes. There is limited excess capacity in any system. In the Rifle area, there are three major suppliers of water; the city of Rifle, the town of Parachute, and Battlement Mesa. The main source of water for all three entities is the Colorado River. It appears that the area could absorb significant population increases. All systems are in adequate condition and do not need major improvements. Deficiencies which do exist are mainly in the Rifle system and are being addressed. The Battlement Mesa Water and Sanitation District was recently formed and is being planned to serve up to 20,000 people; a 6.5 mgd-treatment plant is currently under construction.

Table 3.12-12 LAW ENFORCEMENT SERVICE DESCRIPTION

	Service Area	1981[a] Service Population	# Police Stations	Sq ft Office Space	Staff[b]		Equipment			Calls for Service	
					Sworn	Non-Sworn	Patrol Cars	Unmarked	Other	1980	1981
Garfield County											
Garfield County Sheriff's Office	Unincorporated Garfield County	23,910	2[c]	1,956[d]	24	5[e]	10	1	—	NA	1,821
Rifle	Incorporated City Limits and Rifle Mountain Park	3,623	1	3,040[f]	16	10.5[g]	5	1	—	NA	7,329
Parachute	Incorporated City Limits		1	1,800	7	5[h]	2[i]	-	—	NA	NA
Mesa County											
Mesa County Sheriff's Office	Mesa County	87,074	1	11,100	46	24	9	7	12[j]	15,239	15,804
Grand Junction	Incorporated City Limits	29,129	1	7,881	65	32	12	5	12[k]	NA	28,946
Fruita	Incorporated City Limits	2,993	1	1,075	7	5[l]	3	-	1[m]	NA	1,163
Pallisade	Incorporated City Limits	1,773	1	384	4	-	3	-	—	NA	2,448

Table 3.12-12 LAW ENFORCEMENT SERVICE DESCRIPTION (Continued)

	Service Area	1981[a] Service Population	# Police Stations	Sq ft Office Space	Staff[b]		Equipment			Calls for Service	
					Sworn	Non-Sworn	Patrol Cars	Unmarked	Other	1980	1981
Mesa County (cont.)											
Collbran	Collbran Incorporated area, County from I-70 to Vega Reservoir and Mesa Lakes	364	1	100	1	1[n]	2	-	—	NA	NA
De Beque	Incorporated City limits and east end of Mesa County	284	1	480	2	-	2	-	—	NA	NA

Source: BMML (1982)

[a] 1980 Census figures multiplied by average annual growth rate, 1977-1980.
[b] Sworn = Administration, patrol, investigation, etc.
Non sworn = Communications, clerical, reserves, etc.
[c] Stations in Glenwood Springs and Battlement Mesa.
[d] 976 sq ft in Glenwood Springs, 980 sq ft in Battlement Mesa.
[e] Clerical, civil service deputy, dog warden.
[f] Includes 40 sq ft detention cell.
[g] Clerical, dispatchers (1 part-time), meter maid, 4 reserves.
[h] Dispatchers and clerks.
[i] Does not include new car to be purchased this year.
[j] Includes jail members, searched rescue, snow mobiles, boats, and an airplane.
[k] Motorcycles, animal vans, administrative cars and meter wagons.
[l] Reserve officers and part-time clerical.
[m] Animal control.
[n] Reserve officer.

Table 3.12-13 GENERAL INFORMATION — FIRE PROTECTION FACILITIES

	Population Served	Area sq mi	Number of Volunteers	Number of Professional Firefighter/Staff	Pumpers
Grand Valley					
Lower Valley Fire Protection District	10,000-20,000	100	24 total (10 EMT's[a], 1 Paramedic)		1-1,000 gal/400 gpm, 1-750 gal/400 gpm, 1-500 gal/400 gpm
Grand Junction Fire Department	75,000	7/84		60/6 (60 EMT's, 1 chief, 3 battalion chiefs, 2 secretaries)	3-500 gal/1,250 gpm, 1-750 gal/1,250 gpm, 1-300 gal/750 gpm, 1-85 ft platform snorkel
Grand Junction Rural Fire Protection District					1-200 gal/750 gpm, 1-500 gal/750 gpm
Clifton Fire Protection District	17,000-18,000	16	20 total (8 EMT's, 1 Paramedic)		2-500 gal/500 gpm, 1-500 gal/1,000 gpm, 2/55 ft ladder
Palisade Fire Department & Palisade Fire Protection District	NA	NA	25 total (12 EMT's, 1 Paramedic)		1-1,000 gal/300 gpm, 1-1,000 gal/1,250 gpm w/50 ft ladder (April 1982 delivery), 1-250 gal/250 gpm
De Beque Vicinity					
De Beque Fire Department	500	Town + 5 mi radius	12 total (2 EMT's, 1 advanced first aid)		1-700/750 gpm
Plateau Valley Fire Protection District	NA	NA	20 total (10 EMT's, 4 Paramedics available but not district volunteers)		1-400 gal w/pump, 2-400-500 gal w/pump, 1-900 gal w/pump
Rifle Vicinity					
Grand Valley Rural Fire Protection District	NA	360	30 total (8 EMT's, 2 nurses)		2-500 gal/1,000 gpm, 1-750 gal/1,000 gpm (to be provided by Union Oil)
Rifle Rural Fire District	6,000-7,000	294	31 total (10 EMT's)		300 gal/250 gpm, 500 gal/750 gpm, 500 gal/1,000 gpm

Table 3.12-13 GENERAL INFORMATION — FIRE PROTECTION FACILITIES (continued)

	Rescue Squad/ Ambulances	Other	Stations	
			Location	Size
Grand Valley				
Lower Valley Fire Protection District	2 ambulances		Fruita	4,000 sq ft
Grand Junction Fire Department	2 squads	4 cars 1 van 1 foam truck 1 dry chemical foam	330 S. 6th 1135 N. 18th 251 27-1/2 Rd. 582 25-1/2 Rd.	3,900 sq ft 3,500 sq ft 6,000 sq ft 7,200 sq ft
Grand Junction Rural Fire Protection District		1 3,500 gal tanker		
Clifton Fire Protection District	1 squad	1 Hose/Rescue truck	3254 "F" Rd.	5 bays
Palisade Fire Department	1 ambulance		Palisade	2,000 sq ft
Palisade Fire Protection District				3,000 sq ft
De Beque Vicinity				
De Beque Fire Department	1 (plus 1 to be delivered in 2-3 months)	1 200 gal 4WD	Old Town Hall	928 sq ft
Plateau Valley Fire Protection District	2 ambulances		Collbran Mesa	4,000 sq ft 4,000 sq ft
Rifle Vicinity				
Grand Valley Rural Fire Protection District	1 ambulance (plus Battlement Mesa, Inc. has 1 licensed in storage trying to work out who will operate, and how it can be licensed)	11,000 gal truck 1 250 gal truck	Parachute Battlement Mesa (under construction)	2,400 sq ft 5,000 sq ft
Rifle Rural Fire District	2 ambulances	1 300 gal/35 gpm 1 800 gal tanker in cooperation with the Colorado State Forest Service	Rifle	6,500 sq ft

Source: BMML (1982)

[a] EMT — Emergency Medical Technician.

Table 3.12-14 WATER SYSTEM CUSTOMER DEMAND[a]

	No. of Taps/ Population Equivalent	Types of Customers Served	Average Daily Demand	Peak Daily Demand	Water Rights/Source	Facility Capacity
Entities in the Grand Valley Urban Vicinity						
Town of Fruita	3,500 pop.	Residential Commercial Dog Track (Fall '82)	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	8,800 pop., approx. 100 customers outside municipal boundaries	Residential Commercial Industrial	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	2,700 pop. 971 taps	Residential Commercial Agriculture	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	4,500 taps	Residential Commercial City of Grand Junction	3 mgd	8 mgd	Colorado R.: 20 cfs Grand Valley Irrigation District: 2.12 gfs (207 shares Gr. Jct.: 0.5 gpd	1,200 additional taps, total 13,700 tap with 12 mgd treatment capacity. Adequate for 10 years.
Ridges Metro District	1,100 pop. 400 taps	Residential	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	14,560 taps 33,500 pop. (2.3 per HH) +20,000 pop. interim	Residential Commercial Industrial	5 mgd	8 mgd	Colorado R.: 14 cfs (absolute), 1 cfs (conditional); Jerry Ck. Res.: 10,693 ac. ft. (conditional; Ute pipeline: 30 cfs (conditional; Ute pumping station: 50 cfs (conditional); water rights adequate to 1990.	With improvements completed by 1984: approx. 168,000 pop. or year 2000.

Table 3.12-14 WATER SYSTEM CUSTOMER DEMAND[a] (Continued)

	No. of Taps/ Population Equivalent	Types of Customers Served	Average Daily Demand	Peak Daily Demand	Water Rights/Source	Facility Capacity
Entities in the De Beque Vicinity						
Town of De Beque	350 pop.	Residential Commercial	NA	NA	Colorado R.: 0.47 cfs	Approx. 480 additional pop. (200,000 + 240 gpcd).
Town of Collbran	174 taps (500 pop. approx.)	Residential Commercial	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 Company	78 taps	Residential Commercial	26,000 gpd (winter)	52,000 gpd (summer)	Ute Spring: 1 cfs 2 well: 1 cfs & 0.4 cfs	200 taps estimated total capacity
Entities in the Rifle Vicinity						
Battlement Mesa, Inc.	NA	Residential Commercial	NA	NA	Colorado R. cfs	NA
Town of Parachute	1,200 (1982)	Residential Commercial	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	1,190 taps	Residential Commercial	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	NA	NA

Source: BMML (1982).

[a] ac ft = acre feet
cfs = cubic feet/second
gpd = gallons per day
HH = household
mgd = million gallons/day
NA = Not Available

Table 3.12-15 displays the characteristics of the wastewater treatment service systems within the study area. Current wastewater treatment facilities in all communities appear adequate to meet present demand. Larger, more urbanized areas, of course, have more sophisticated systems and are more capable of dealing with increased demand. Facilities serving smaller rural communities and unincorporated areas are for the most part operating at or near maximum capacity and would need to be upgraded if demand were to rise sharply. Wastewater treatment service providers adjacent to Grand Junction have been organized into a 201 region serving 60,000 people. The EPA established 201 planning regions to investigate and analyze site-specific wastewater management needs. The city of Grand Junction is the lead agency. Capital improvements for the 201 region include a regional interceptor system and an $18.98 million treatment plant having a capacity of 12.5 mgd serving 98,500 people. The plant is scheduled for completion in 1984. Systems within the De Beque and Rifle area are adequate to meet existing demand with some possible expansion. Systems in the De Beque area are generally small — either lagoons or ditches. Battlement Mesa's wastewater treatment plant is designed to ultimately accommodate up to 25,500 population, should the need arise. Rifle has just commissioned a new 4.16-mgd plant capable of serving 10,700 people.

Solid waste management in the study area is the responsibility of Mesa and Garfield counties. Solid waste collection varies with each municipality and county. Both counties' landfills are at or over capacity and the counties are in the process of developing solid waste management plans. Garfield County's landfill is located outside Rifle (50 acres, 110 percent used); Mesa County has two functioning landfills (Orchard Mesa Landfill, 140 acres, 100 percent used; and one near Fruita, 40+ acres), and two undeveloped sites adjacent to Orchard Mesa.

Education

Public School Systems. The public school districts in Garfield and Mesa counties described herein include Garfield County School Districts RE16 (Parachute) and RE2 (Rifle, New Castle, and Silt), Mesa County Joint District No. 49 (De Beque), Plateau Valley District No. 50 (Collbran), and Mesa County Valley School District No. 51 (Grand Junction, Fruita, Palisade). School district boundaries are shown in Figure 3.12-1.

Many of the schools in the two-county region have undergone significant changes as a result of energy development activities in the late 1970's and early 1980's. Enrollments have increased (Table 3.12-16) and new services have been demanded. Increased pressure has been placed on the financial resources of most districts.

Garfield County School District No. 16, serving Parachute and Battlement Mesa, has tripled its school enrollment since 1976, with almost all of the growth concentrated in the last 2 years. Garfield County School District RE-2, which serves Rifle, Silt, and New Castle, enrolled approximately one-half of the rural population of Garfield County in the late 1970's. Responding to increased growth from oil shale development, the district has constructed four of its eight schools since 1977. The district currently has excess capacity in its systems.

Mesa County Valley School District No. 51, on the other hand, currently has enrollments in excess of overload figures in several of its elementary and junior high schools. This district serves the majority of the county's population and is essentially an urban school district in size, operation, and services. In 1980, it was the tenth largest school district in the state.

Pupil/teacher ratios for each district have remained fairly constant over the last 5 years (Table 3.12-16). Pupil/teacher ratios for four of the five school districts compare favorably to the 1980 state ratios of 18.5 to 1.

School financing in each of the districts reflects the rapid growth in the region. Two of the districts (No. 16 and RE-2) have received substantial state aid due to increasing enrollment provisions and distribution of Oil Shale Trust and Energy Impact Assistance funds. The Oil Shale Trust Fund was established in 1973 by the State of Colorado from Tract Ca and Cb lease bonus payments to assist energy impacted communities to develop plans and construct new facilities. Energy impact funds are funds earmarked by the state from severance taxes on natural resource development.

Table 3.12-15 WASTEWATER SYSTEM CUSTOMER INFORMATION[a]

	Customers		Flows			
	No. of Taps/ Population Equivalent	Types of Customers Served	Average Daily Flows	Peak Daily Flows	Type of Treatment	Facility Capacity
Entities in the Grand Valley Urban Vicinity						
Centrai Grand Valley Sanitation District	2,500 taps, approx. 6,250 people	NA	378,000 gpd	945,000 gpd (est.)	Contract with Grand Junction	5,000 population capacity now; 42,500 population with expansion
Clifton Sanitation District #1						
Clifton Sanitation District #2	3,100 taps, 14,000 people	Domestic	630,000 gpd	1,050,000 gpd	2 plants in south of district with 2 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	Domestic	NA	NA	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	3,200 taps or 10,560 people	Domestic	520,000 gpd	650,000 bpd	Contracted with City of Grand Junction	700 additional taps or 2,310 people
City of Grand Junction	60,000 taps or 24,953 households (approx.)	Domestic, light industrial	5.35 mgd (1981) average annual	8.7 mgd (Dec. 1981)	Plant at west Grand River Rd., 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	Domestic	NA	NA lagoons	2 non-aerated population;	350 additional equivalent taps have already been sold, thus the system cannot accept additional development

Table 3.12-15 WASTEWATER SYSTEM CUSTOMER INFORMATION[a] (Continued)

	Customers		Flows			
	No. of Taps/ Population Equivalent	Types of Customers Served	Average Daily Flows	Peak Daily Flows	Type of Treatment	Facility Capacity
Orchard Mesa Sanitation District	1,600 taps (1980)	Domestic	NA	NA	Contract with City of Grand Junction (1,200 additional population capacity.)	8,000 total population capacity,
Town of Palisade	614 taps; 1,515 people	Domestic	100,628 gpd	211,888 gpd	Two non-aerated lagoons (6,400 additional population capacity)	2,800 total population capacity,
Ridges Metro District	400 taps; 1,100 people	Domestic	60,000 gpd	150,000 gpd	Contract with City or Grand Junction	2.6 mgd or 10,500 people total capacity
Entities in the De Beque Vicinity						
Town of Collbran	168 taps; 500 people	Domestic	70,000 gpd	190,000 gpd	Activated sludge, oxidation ditch at capacity	Collection and treatment facility are
Town of De Beque	164 taps; approx. 350 people	Domestic	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	Domestic	NA	NA	1 non-aerated lagoon	400 tap capacity (340 additional taps)
Entities in the Rifle Vicinity						
Battlement Mesa, Inc.	NA	Domestic	NA	NA	2 aerated lagoons (interim plant)	25,500 total population
Town of Parachute	330 taps; 1,200 people	Domestic	NA	NA	Uses BMI treatment plant	8,000 population or 3,500 capacity; (additional 3,150 taps)

Table 3.12-15 WASTEWATER SYSTEM CUSTOMER INFORMATION[a] (Continued)

	Customers		Flows			
	No. of Taps/ Population Equivalent	Types of Customers Served	Average Daily Flows	Peak Daily Flows	Type of Treatment	Facility Capacity
City of Rifle	1,694 taps; approx. 5,500 people	Domestic	NA	NA	Lagoons west of town 2 aerated cells; 1 non-aerated	10,700 total population treatment capacity
Rifle Village South Metro District	NA	Domestic	NA	NA	3 cell, aerated lagoons on south side of Colorado River	NA

Source: BMML (1982).

[a] ac. ft = acre feet
cfs = cubic feet/second
gpd = gallons per day
mgd = million gallons/day
HH = Household
NA = Not Available

Schools currently under construction in District No. 16 have been financed with up-front money from the Union and Exxon/Colony oil shale projects. During the past 4 years, District RE-2 has received more than $13 million in Oil Shale Trust Funds. Because of a relatively high assessed value per student, Joint District No. 49 appears to be financially sound at this time. The district has, to date, not been heavily impacted by oil shale development, though between 1975 and 1977 it did receive about $112,000 from the Oil Shale Trust Fund. The De Beque District also received about $80,000 in Energy Impact Assistance funds between 1978 and 1982.

The financial profile of Mesa County District No. 51 reflects a more urban structure than any of the other districts in the area. Enrollments in District No. 51 for 1982 were nearly seven times greater than in the next largest district (Rifle). The district is facing many problems common to large urban school districts. Operating revenues are barely keeping pace with inflation (the Authorized Revenue Base increased by about 7 percent per year between 1980 and 1982), and enrollment increases are straining the district's facilities. In 1980, voters approved a $23.6 million bond issue to finance the first phase of major capital improvements program. This bond issue represented about 57 percent of the district's legal debt capacity in 1982, and left about $18 million of additional capacity. As this bond is retired and assessed values continue to grow, total debt capacity in the district will increase.

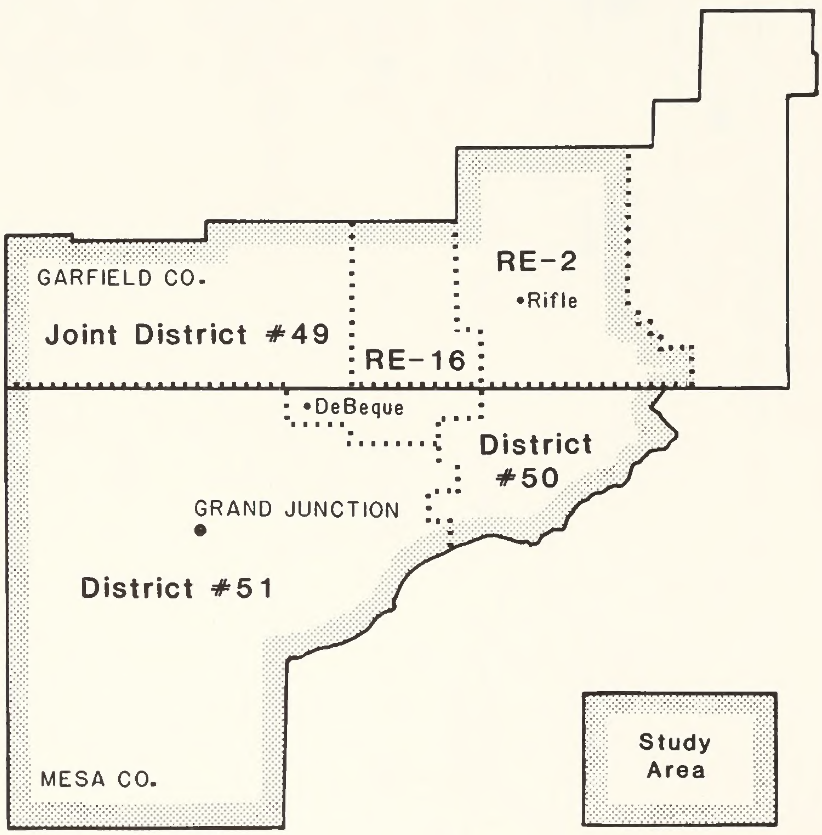


Figure 3.12-1 School Districts in the Garfield and Mesa County Study Area

Table 3.12-16 SCHOOL ENROLLMENTS BY DISTRICT GARFIELD AND MESA COUNTIES

School District	Serving	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	1466	1467	1467	1601	1916	2200	2359	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	De Beque, Roan Creek Valley	145	132	117	119	113	122	165	9.1

Source: BMML (1982).

Higher Education. Garfield County is included in a local tax jurisdiction which provides funding to the Colorado Mountain College (CMC). CMC is a community college providing 1- and 2-year programs for an estimated 20,000 persons in nine Western Slope counties. In Garfield County, CMC has centers in Glenwood Springs, Rifle, and Carbondale. Classes are also offered in New Castle, Silt, and Battlement Mesa. In 1982-83, a National Science Foundation grant will fund a program in "Oil Shale Chemical Technology" leading to an associate science degree.

Mesa College, in Grand Junction, is a state- and tuition-supported 4-year school offering the bachelor's degree. Mesa College's Area Vocational School works closely with oil companies to develop programs which provide appropriate training for industrial employment. Certificates of occupational proficiency or associate degrees are offered for these programs.

Health Care

Within the study area, there are five hospitals and one community clinic/emergency center. Of these, only Clagett Memorial Hospital and the Plateau Valley Clinic (the community clinic/emergency center), are public facilities. The Veterans Administration Hospital in Grand Junction is not included due to specialized services. Table 3.12-17 describes the area's hospitals.

St. Mary's Hospital and Medical Center in Grand Junction provides all medical services found at a metropolitan hospital with the exception of organ transplants and open-heart surgery. Between St. Mary's Hospital and Mesa Memorial Hospital (a division of St. Mary's), there are 264 licensed beds, or 73 percent of the beds in the Grand Valley area. In-patient admissions to St. Mary's increased more than 20 percent between 1975 and 1981; out-patient and emergency room visits increased approximately 50 percent during the same period (BMML 1982).

Table 3.12-17 AREA HOSPITALS

Hospital	Location	# of Licensed Beds	Planned Bed Expan.	# of Phys	Geographic	Service Area Population	Sources of Funding
Grand Valley Urban Area							
Grand Junction Osteopathic Hospital	Grand Junction	78	—	36	Mesa County		Fees for services and donations
St. Mary's Hospital & Medical Center	Grand Junction	222	40	150 +	34,000 sq. mi.	292,000	Patient fees, contribution, and donations
Mesa Memorial Hospital	Grand Junction	42	(division of St. Mary's Hospital and Medical Center)				
Lower Valley Hospital	Fruita	20	—	11	Lower Grand Valley	6,000-10,000	Patient fees and contributions
De Beque Vicinity							
Plateau Valley Clinic (Plateau Valley Hospital District)	Collbran	2	—	1	Plateau Valley	1,800	Patient charges, donations, impact grants
Rifle Vicinity							
Clagett Memorial Hospital (Grand River Hospital District)	Rifle	32	—	4	Garfield County (mainly Rifle, Silt, Parachute)	22,500	

Source: BMML (1982).

Human Services

A common observation about rapid growth, particularly as it relates to the western United States, has been that it disrupts social life and produces increases in delinquency, alcohol and drug abuse, marital instability, and personal disorganization. Social problems are presumed to become more prevalent as relatively stable, homogeneous rural communities are transformed into heterogeneous urban centers. Several previous studies have shown significant problems occurring with such growth (Kassover and McKeown 1981; Davenport and Davenport 1981). Perhaps the most important lesson from these previous studies of communities such as Gillette, Rock Springs, and Craig is that after-the-fact programs to deal with social problems may be too late to be effective. Also, in some cases, programs are much more ineffective than they could have been because the causes of the problems were not mitigated. Social disruption is less likely to occur with advance growth management efforts.

Garfield and Mesa counties, faced with increasing populations, often transient in nature, are attempting to deal with the human service impacts. Both coun ties have established numerous formal and informal support systems to help both longtime residents and newcomers adjust to social change brought about by resource development. Numerous human service agencies, staffed by trained professionals, exist in both counties. Like other rural areas, various informal support groups such as churches and volunteer organizations are also active. For example, a reach-out and newcomer integration program in the Rifle, Parachute, and Battlement Mesa area is provided to integrate both new and old residents and to encourage a sense of community.

Garfield County formed a human services commission and hired a full-time human service planner. A human service plan has been prepared and presented to the county commissioners. This commission was recently disbanded. Interviews with the local human service planner indicate that issues, especially in the western part of the county where energy development has occurred are increases in alcohol and drug abuse, child abuse, isolation, family tensions, and youth problems (BMML 1982).

Mesa County is in the process of forming a human service commission and has signed a contract with the state for funding. Currently, there are nearly 70 human service providers, both individuals and agencies, in the county. The Mesa County Department of Social Services has reduced staff from 82 to 62 in the past 30 months; however, caseloads remain the same or are increasing (BMML 1982).

The human service data collection systems have not been comprehensive in either county. Data are often inconsistent and sketchy. Efforts to correct these problems are underway. In particular, Garfield County's Social Service Department is currently computerizing its record-keeping function and this, in conjunction with a new monitoring system, should allow the county to track data much more effectively.

3.12.7 Local Finances

Local governments, such as Mesa and Garfield counties, and their incorporated cities and towns, vary widely in their fiscal characteristics. Tables 3.12-18 and 3.12-19 summarize the salient characteristics of local finances in a format which facilitates comparisons and provides general indicators of fiscal conditions in the various jurisdictions. Discussions regarding the financial characteristics of the local school districts are included in Section 3.12.6.3.

Revenues

Counties, municipalities, and school districts raise revenues through a variety of sources, including property and sales tax revenues, and federal and state intergovernmental transfers. The major source of revenue for larger entities has traditionally been the property tax. The assessed valuation of a community measures its potential ability to raise additional funds, through property taxes, either by increases in the property tax base or by raising the mill levy (property tax rate).

Until 1982, the major source of revenue in Mesa County was the property tax. With a recent mill levy reduction (the 1982 county mill levy is 22 percent lower than the 1981 levy; 9.5 percent lower than 1980), locally generated revenues from fees and charges and sales tax will probably become more significant. For Garfield County, there has been a rapid increase in assessed valuation, exceeding the rate of inflation, over the past 3 years. Growth in per capita assessed valuation has increased at an estimated average rate of 8 percent per year, a positive sign that financial resources are expanding. The county mill levy total has not decreased despite the growth in its tax base; this is probably appropriate since operating cost requirements increase with inflation. Property tax has contributed approximately the same proportion of general fund revenues over the past several years, and together with revenues derived from other local sources, is one of the main sources of support for the General Fund.

In Grand Junction, the general purpose mill levy has remained consistent for 1981 and 1982, having increased from 8 to 12 mills after 1980. The total property tax rate on municipal residents has averaged 85 mills for the past 10 years, which is not considered excessive compared with other jurisdictions (BMML 1982).

Sales and use taxes are another source of revenue for local jurisdictions. Mesa County has acquired more local revenue generating capability with the recently (January 1982) enacted county-wide 2 percent sales and use tax. The sales tax is levied on the retail sales of tangible personal property, telephone service within the state, prepared food and drink, and lodging accommodations. The use tax is levied on motor vehicles and building materials purchased elsewhere and brought in for use within the county. The use tax will allow for capital projects as well as additional revenues for operating purposes. In terms of the statutory maximum sales tax rate, the imposition of the 2 percent county tax restricts each of the incorporated municipalities to a 2 percent municipal sales tax, since the total rate including the 3 percent state tax may not exceed 7 percent (BMML 1982).

Garfield County instituted a county-wide one-half cent sales tax in January 1981. Food, residential fuel, and machinery are exempt from taxation, which decreases the revenue potential. The county has the ability to impose use tax as a complement to sales tax, but has so far not elected to do so. If Rifle's sales tax rate stays at 2 percent, the county could levy another 1.5 percent (with voter approval). The revenues raised by the county sales tax are currently designated for construction of a new library facility (BMML 1982).

Table 3.12-18 FISCAL CHARACTERISTICS OF COUNTY AND MUNICIPAL GOVERNMENTS — REVENUES — FISCAL 1982 (BUDGETED)

County/ City	1982 Population	Assessed Valuation (Total)	Assessed Valuation (Per Capita)	Taxable Retail Sales	Revenue Sharing Receipts	Property Tax Rates: Total Overlapping Levy	Property Tax Rates: Total This Entity
Garfield County	25,392	$116,347,830	4,548	$135,470,527	$149,144	—	20.74
Rifle	4,083	$12,233,110	2,907	$48,684,211	$ 45,000	89.74	10.49
Parachute	1,200	$684,920	571	$2,326,784	$ 1,996	99.94	14.31
Mesa County	92,995	$340,879,770	3,651	$704,229,760	$528,000	—	17.33
Grand Junction	30,149	$128,649,130	4,259	$350,293,526	$733,705	85.05	12.00
Fruita	3,187	$7,911,440	2,464	$7,755,946	$ 63,580	90.35	15.00
Palisade	2,026	$3,936,740	1,870	$4,136,505	$ 10,000	94.67	24.35
Collbran	385	$692,780	1,799	$1,370,217	$ 3,600	91.19	22.29
De Beque	290	$587,640	2,026	$155,119	$ 2,400	62.89	18.99

Source: BMML (1982).

Table 3.12-19 FISCAL CHARACTERISTICS OF COUNTY AND MUNICIPAL GOVERNMENTS — EXPENDITURES — FISCAL 1982 (BUDGETED)

County/City	General Fund Position: Total Revenues	General Fund Position: Total Expenditures	Per Capita Expenditures	Debts Outstanding	Debt Service General Remaining Obligation Capacity
Garfield County	$4,393,981	$4,239.961	$165.73	N/A	$1,745,217
Rifle	$2,062,204	$1,778,647	$422.68	$765,000 general obligation	$366,993
Parachute	$2,541,149	$2,541,149	$2,118.00	$300,000 (water) general obligation	$68,492
Mesa County	$8,885,367	$8,885,367	$95.17	$1,000,000 (est) general obligation $8,165,000 revenue (sewer)	$5,113,197
Grand Junction	$17,639,860	$19,932,184	$659.85	$360,000 (municipal) general obligation $5,350,000 (water) $385,000 (revenue-golf course)	$12,504,913
Fruita	$2,335,887	$2,335,887	$727.46	$4,000,000 (municipal) $448,000 revenue (sewer)	Unlimited bonding capability
Palisade	$255,613	$255,613	$121.43	$1,300,000 (water) Revenue (sewer) $290,000	$393,674
Collbran	$197,002	$197,002	$511.69	$112,000 (water) Revenue (sewer) $73,000	$69,278
De Beque	$1,494,526	$1,494,526	$5,153.54	$93,000 (water/sewer)	$58,764

Source: BMML (1982).

Intergovernmental revenues from state and federal sources have also historically provided assistance to communities affected by energy development. Federal programs, such as Community Development Block Grants, Farmers Home Administration programs, EPA Wastewater Construction Grants, HUD grants, and payments-in-lieu of taxes (PILT) have been reduced, cut, or are in danger of being discontinued. Other than state revenues shared locally on a formula basis, such as highway users fees or cigarette taxes, state funds are awarded at the discretion of the Legislature. These include grants or loans from programs such as the Energy Impact Assistance Fund, which is funded by appropriations from state severance tax or mineral royalties (BMML 1982).

Expenditures

Per capita expenditures (the amount each jurisdiction spends on providing services to its residents) vary widely among communities. Although there is a tendency for large communities to spend more per capita on services than smaller communities, it is impossible to generalize. In 1982, Grand Junction, for example, expects to spend $659.85 per capita, the town of De Beque, with a 1982 population of approximately 290, expects to spend $5,153 per capita, and Mesa County expects to spend $95.17 per capita (BMML 1982).

Jurisdictions may finance needed capital improvements either out of current revenues or by going into debt. Legal restrictions limit the ability of counties and the larger municipalities to incur debts. Mesa County, for example, currently has no general obligation bonded indebtedness, allowing a bonding capacity of about $5 million. The county's only long-term debt consists of about $1 million in leases and contracts for various purposes which are due to be returned in 1986. Sewer revenue bonds of about $8 million were issued by the county but are supported solely from revenues of the Joint Sewer System. Garfield County has no existing bonded debt. Its current general obligation debt capacity is $1.7 million. Grand Junction, on the other hand, has a small balance of municipal general obligation debt, which allows a margin of about $12.5 million to incur additional general obligation debt (BMML 1982).

Overall Fiscal Condition

Mesa County has recently acquired more local revenue-generating capability with the 2 percent county sales tax. With this additional tax base, as well as the anticipated increase in county assessed valuation, Mesa County should have resources sufficient to support its governmental operations and growth-related needs. Garfield County also has financial resources which are adequate and expanding at a rate which should enable it to meet service demands and cope with inflationary increases. Grand Junction's current financial practices also appear appropriate for a municipality in Colorado which must accommodate growth.

The communities of Rifle and Parachute have recently experienced tremendous growth due to oil shale development. Rifle's total general fund revenues have increased approximately two-thirds over 1980 levels. Sales and use tax revenues together comprise about half the General Fund total. The property tax is a minor source of income. Growth in expenditures has also been exceeding inflation, with 1982 per capita spending 38 percent higher than in 1980. The year-end general fund balance has been consistent over the past 3 years. In Parachute, the recent growth has not yet been evidenced in its tax base. Assessed valuation increased only 29 percent from 1980 to 1982, while population is estimated to have quadrupled. This is due to the 1.5- to 2-year lag time in deriving tax revenues from new development. Parachute's general fund is showing considerable growth in its budgeted revenues and expenditures. In 1982, about $1.9 million in grants from the Oil Shale Trust Fund were expected, amounting to 75 percent of general fund revenues. The funds were earmarked for street projects, recreation, and public safety.

The communities of De Beque, Palisade, Collbran, and Fruita, in Mesa County, vary widely in their current fiscal condition. De Beque and Collbran, for example, have constrained resources. De Beque may have difficulty responding to growth-related needs until growth in its tax rate catches up. In De Beque, taxable retail sales are comparatively low on a per capita basis, and are expected to fall as a result of the exclusion of food and residential fuels from the tax base in April 1982. The town's sales tax rate is at its legal maximum, but no use tax is currently imposed. However, general fund revenues and expenditures have increased since 1980 with the influx of funds from non-local sources, including a $300,000 grant from the Oil Shale Trust Fund and a one-time contribution of $750,000 expected from Mesa County in return for support of the county-wide sales tax. The money was budgeted for capital improvements to De Beque's street system in 1982.

Palisade has recently experienced rapid population growth (about 14.3 percent annually from 1977 to 1980). Growth in assessed valuation has not kept pace with population or inflation and is declining on a per capita basis. Taxable retail sales increased slightly from 1980 to 1981, but were projected to drop in 1982 with the exemption of unprepared food and residential fuels from sales tax. The municipal property tax levy has increased 11 percent since 1980, possibly as a result of the slow growth in assessed valuation. If the tax base does not catch up with the population growth, the town may have to increase its mill levy to offset increased operational costs from inflation and service demand.

Fruita is anticipating significant growth, and has taken steps to expand its systems and financial options. The growth in Fruita's taxable assessed valuation has been adequate to keep up with inflation. In addition, there have been recent significant annexations which more than doubled the city's land area in 1982, and which can be expected to increase Fruita's tax base by an estimated $3 million for 1983 to about $11 million total. Fruita voted to reduce their municipal sales and use tax rate from 3 percent to 2 percent in 1982, due to enactment of the county-wide sales tax.

Fruita's General Fund revenues have historically been derived from the sales tax with property tax the second largest source. The large increase in total revenues budgeted for 1982 results from the influx of $1 million in county funds in compensation for the city's agreement to lower its sales tax rates. These one-time revenues are intended to be used for sewer, water, and other capital projects. The city received another $500,000 from the county to retire its town hall bonds. As a result of these special funds, budgeted expenditures rose and capital outlay exceeded operation and maintenance expenditures for 1982, a trend which is not expected to continue.

3.13 Energy and Transportation

3.13.1 Introduction

The area evaluated for energy includes those portions of western Colorado where energy is produced or transported. The area evaluated for transportation encompasses Garfield and Mesa counties.

3.13.2 Energy

Power generation within the project area consists of hydroelectric and fuel-fired generating plants. Current power generating sources within the region and their respective generating capacities are listed in Table 3.13-1.

Transmission lines in the area include a 69-kv line serving Parachute and Rifle, a 69-kv line connecting the Cameo and Shoshone electric generating plants, and a 230-kv line running through the area south of the Colorado River. Numerous natural gas pipelines run throughout the region. These lines are operated by the Western Slope Gas Company, a subsidiary of Public Service Company of Colorado. Other pipelines for transport of oil and water occur within the region. No major pipelines traverse project sites.

A vast supply of energy resources are present in the project area. These resources include coal, oil shale, oil and gas, uranium, and geothermal.

3.13.3 Transportation

Highways, air and rail transportation, and pipeline facilities exist within the project area. These facilities are shown on Figure 3.13-1 and are described below.

Highways and Roads

Major roadways within the project area are shown on Figure 3.3-1 (Section 3.3). The network consists of roads constructed utilizing federal, state, county, or city funds. Road maintenance is performed by the state, county, or local road departments.

The present inter-city/inter-county road network is adequate for current needs. County roads are deteriorating more rapidly than expected due to increased truck traffic which exceeds the weight capacities of the roads.

TABLE 3.13-1 POWER GENERATING FACILITIES IN PROJECT AREA

Plant	Location	Type of Unit	Generating Capacity[a]
Palisade	Palisade, CO	Hydro	700 kW
Shoshone	Near Glenwood Springs, CO	Hydro	3,000 kW
Fruita	Fruita, CO	Natural Gas/Oil	18,650 kW[b]
Lower Molina	Near Colbran, CO	Hydro	564,000 kW[b]
Upper Molina	Near Colbran, CO	Hydro	9,600 kW[b]
Hayden	Hayden, CO	Coal	Two Units: 180,000 kW 250,000 kW
Nucla Station	Nucla, CO	Steam Turbine	36,000 kW[b]
Bullock Station	Montrose, CO	Steam Turbine	12,000 kW[b]
Morrow Point	Near Montrose, CO	Hydro	120,000 kW[b]
Crystal	Near Montrose, CO	Hydro	28,000 kW[b]
Craig	Craig, CO	Coal	800,000 kw[b]
Bonanza	Near Bonanza, UT	Coal	Under construction

Source: EWD (1982); Wendling (1982).

[a] kW = kilowatts (1,000 watts)
[b] These units are either peaking or intermediate units

Interstate 70 is the major transportation link between Denver and the Colorado/Utah border. It is a four-lane roadway through most of the project area, except through De Beque Canyon and Parachute, where it is currently two-lane. Construction in the Parachute vicinity is scheduled to be completed in 1983. The De Beque Canyon segment of approximately 7 miles should be completed between 1988 and 1990.

Highway use and capacity for selected road segments are shown in Table 3.13-2. The average daily traffic (ADT) is the average number of vehicles using the given highway section in one day. Peak hour traffic is the 30th highest amount of traffic than can be expected in an hour for the year. It approximates above average rush hour traffic. The peak hour traffic/capacity ratio indicates the approximate traffic conditions on the road during high use. If this ratio approaches 0.85, occasional traffic slowdowns will occur. If the ratio is at or over 1.0, the traffic speed, and hence level of service, will be reduced. The capacities of road segments A to E are adequate through 2010. The other road segments indicate some potential congestion problems which may require corrective actions.

Accident rates on the affected road segments during 1981 ranged from 60 to 198. Fatalities ranged from one to four. A breakdown, by road segment, is shown in Table 3.13-3

Other major highways in the area are U.S. Highways 6, 24 and 50. State road 139 runs from I-70 north through Douglas Pass to Rangely. In 1978, ADT for SH 139 was 1,250 vehicles. State Highway 13 follows Government Creek north to Rio Blanco and Meeker. These are shown on Figure 3.13-1.

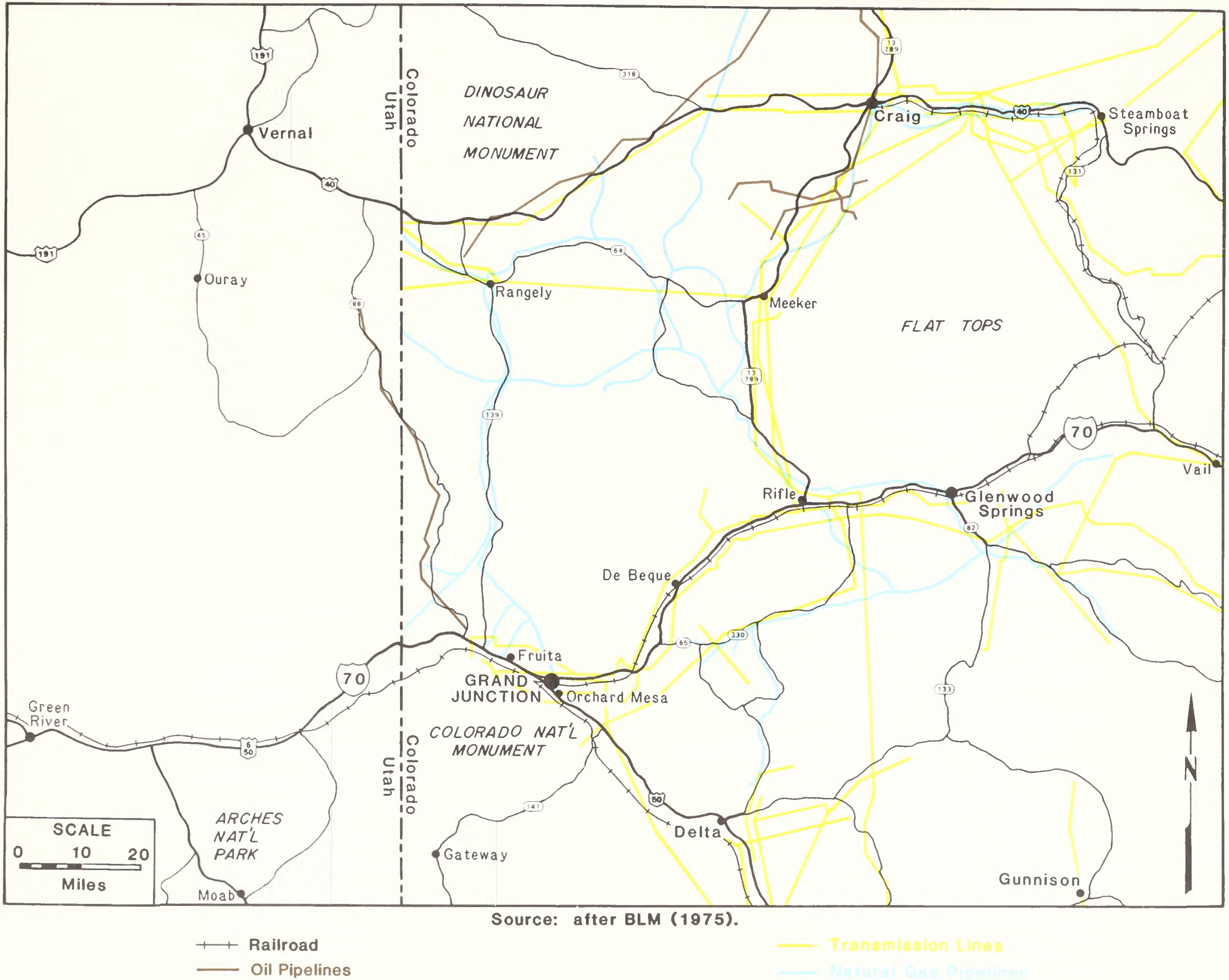


Figure 3.13-1 Project Area Transportation Network

County road mileage accounts for approximately 2,529 miles in Garfield and Mesa counties. Garfield County's system consists of 929 miles, 409 miles of which are considered primary thoroughfares. Mesa County has approximately 1,600 miles of county-maintained roads, of which approximately 500 miles are paved. Communities within the area have varying mileages of streets and roadways. Grand Junction leads the urbanized areas, having approximately 150 miles of streets within the city limits.

The Roan Creek Road provides access to the Clear Creek site from De Beque (Figure 3.3-1). Approximately one-half of the distance is paved, ranging between 18 and 30 feet in width. The remainder is graded dirt road which narrows from 22 feet in width to 10-14 feet at the northernmost extreme. Daily traffic for this road ranges from 50 to 150 vehicles.

Table 3.13-2 TRAFFIC VOLUMES ON AFFECTED HIGHWAY SEGMENTS

Year	Road[a] Segment	Segment Length	ADT[b]	PHT[c]	CAP[d]	PHT/Capacity Ratio
1980	A	29.6	3600	400	3400	.12
	B	19.4	5200	660	3500	.19
	C	17.0	5450	750	3450	.22
	D	8.9	5400	750	3450	.22
	E	42.4	6100	850	3500	.24
	F[e]	15.1	3750	500	950	.53
	G[e]	4.3	21150	2350	2000	1.18
	H[e]	8.4	4800	600	1400	.43
1995	A	29.6	5750	650	3400	.19
	B	19.4	7600	950	3500	.27
	C	17.0	8300	1150	3450	.33
	D	8.9	8250	1150	3450	.33
	E	42.4	9300	1300	3500	.37
	F[e]	15.1	5750	750	950	.79
	G[e]	4.3	27350	3050	2000	1.53
	H[e]	8.4	6900	850	1400	.61
2010	A	29.6	7900	900	3400	.26
	B	19.4	9950	1250	3500	.36
	C	17.0	11150	1550	3450	.45
	D	8.9	11050	1550	3450	.45
	E	42.4	12500	1750	3500	.50
	F[e]	15.1	7700	1000	950	1.05
	G[e]	4.3	33500	3700	2000	1.85
	H[e]	8.4	9000	1100	1400	.79
2070	A	29.6	16550	1900	3400	.56
	B	19.4	19500	2500	3500	.71
	C	17.0	22550	3150	3450	.91
	D	8.9	22400	3150	3450	.91
	E	42.4	25250	3550	3500	1.01
	F[e]	15.1	15650	2050	950	2.16
	G[e]	4.3	58250	6460	2000	3.23
	H[e]	8.4	17400	2100	1400	1.50

Source: Colorado Department of Highways (1981)

[a] See Figure 3.3-1 for locations of road segments.
[b] ADT — Average Daily Traffic. Projections include anticipated increases in population without project.
[c] PHT = Peak Hourly Traffic
[d] CAP = Capacity of highways and roads at level of service "C". This is typical level of service for rural areas.
[e] Segments F to H are State Highway 6.

Airports

Walker Field airport, located in Grand Junction and run by a public airport authority, serves western Colorado and eastern Utah. It is the only airport capable of handling commercial jet-traffic in northwest Colorado. Expansion of the passenger terminal and the air field has been recently completed to accommodate expected increases. Total operations in 1981 increased 14.5 percent over 1980; general aviation operations increased 13.7 percent; air carrier and air taxi increased 18.5 percent. The completion of improvements is intended to keep pace with the anticipated increases in traffic.

The Garfield County airport in Rifle provides service to private operations and also offers commercial service between Rifle, Aspen, and Denver.

Railroads

The Grand Valley urban vicinity is served by the Denver and Rio Grande Western Railroad Company. Freight routes connect Grand Junction with Pueblo, Montrose, Salt Lake City, and Denver. The only passenger route is between Denver and Salt Lake City, with stops in Glenwood Springs and Grand Junction. Daily traffic is approximately 25 freight trains per day with a capacity of 48 trains per day.

Pipelines

There presently are no shale oil pipelines within the project area. There are existing oil pipelines near Craig, Colorado and north of Highway 40 in Moffat County. In addition, there is an existing oil pipeline west of the project site that runs into Utah. The capacities of these pipelines are adequate to transport existing volumes of oil. Shale oil pipelines are planned (e.g., SOPS, La Sal) but have not been built. Natural gas pipelines exist throughout the project area, the closest being approximately 8 miles east of the proposed mine site.

Table 3.13-3 ACCIDENT RATES ON AFFECTED HIGHWAY SEGMENTS (1981)

		Accident Rates			
Road[a] Segment	Segment Length	PDO[b]	INJ[c]	FAT[d]	Total
A	29.6	32	25	3	60
B	19.4	44	15	3	62
C	17.0	56	11	1	68
D	8.9	40	22	0	62
E	42.4	130	64	4	198
F	15.1	39	22	1	62
G	4.3	375	88	1	464
H	8.4	37	16	0	53

Source: Colorado Department of Highways (1981)

[a] See Figure 3.3-1 for locations of road segments.
[b] PDO = Property damage accidents only
[c] INJ = Injury producing accidents
[d] FAT = Fatality producing accidents

4.0

Environmental Consequences

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

4.1.1 Approach Used in this Chapter

Environmental impacts of the Proposed Action and the various project siting, production rate, and transportation alternatives are presented in this chapter for each environmental discipline. These discussions are presented in the same order as in Chapter 3.0, Affected Environment

Each section in Chapter 4.0 presents analyses of project impacts according to the subsections described below for each discipline. Note that not all subsections are pertinent for all disciplines.

General Impacts

The first subsection for each discipline discusses those impacts which are characteristic of any oil shale development in western Colorado of the magnitude of the CCSOP. These impacts generally apply to the CCSOP and its alternatives.

Clear Creek Mesa and Associated Siting Activities

Impacts specific to development of oil shale facilities on Clear Creek mesa for the Proposed Action and Clear Creek project configurations are presented in this subsection. The discussions address corridors and ancillary facilities associated with the alternatives (see Section 2.3 for descriptions of the alternatives). Discussions of impacts for the 100,000-bpd (designated PA-100 for the Proposed Action and CC-100 for the Clear Creek alternative) and 50,000-bpd (PA-50 and CC-50) production rates are included here.

Grand Valley and Associated Siting Activities

In this section, impacts in the Grand Valley area specific to the development of the Fruita I and Fruita II project configurations are discussed. Corridors and ancillary facilities associated with the Grand Valley alternatives are also discussed. Impacts of 100,000-bpd (FI-100) and 50,000-bpd (FI-50 and FII-50) production rates are discussed.

Alternative Siting Activities

Other alternative project sites (e.g., corridors, reservoirs) are discussed in this subsection as applicable to major project configurations. Alternative sites included are those deemed necessary by the BLM for detailed consideration in the EIS. Alternatives eliminated from detailed study by the BLM are not addressed in this subsection, but are described in Section 2.2. The rationale for elimination of alternatives from detailed analysis is also presented in Section 2.2. Further details concerning the eliminated alternatives and the rationale for elimination are provided in Appendix A.

Transportation

The impacts of various transportation alternatives for materials, supplies, and workers are presented in this subsection.

Solid and Hazardous Waste Disposal

This subsection presents discussions of impacts due to solid and hazardous waste disposal, exclusive of spent shale disposal. Spent shale disposal is discussed under the Clear Creek mesa and Grand Valley subsections.

Secondary Impacts

Secondary impacts, mostly related to population growth associated with the project, are briefly discussed at the end of each discipline-specific analysis.

4.1.2 Impact Assessment Methodologies

Methodologies used to assess the impacts of alternatives are documented in the *Final Impact Analysis Guide, Chevron Clear Creek Shale Oil EIS* (BLM 1982a), prepared by the third-party EIS contractor, Camp Dresser & McKee Inc. (CDM), for the BLM. This document is on file in BLM's Grand Junction office. Impact comparisons for major project configurations and various project components were provided in Section 2.4. These were compiled from the more detailed discipline-specific impact comparisons discussed in the following sections of Chapter 4.0.

4.1.3 Study Areas for Impact Evaluation

The specific area evaluated for each discipline varied according to the nature of the analysis. In subsections of Chapter 3.0, the study area for each discipline is described and impact discussions generally follow those study areas.

4.2 Air Quality and Meteorology

4.2.1 General Impacts

Air quality will be generally impacted by the addition of dust or total suspended particulates (TSP), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and hydrocarbons (HC) from construction activities, plant operations, and the increased population anticipated from development of the CCSOP.

The ambient concentrations of various pollutants which would result from the proposed facilities would depend upon a variety of factors, including wind speed and direction, temperature lapse rates, local topography, precipitation, emission rates, emission source design characteristics, temperature and discharge velocity of emissions, and other complex factors which tend to vary substantially during even brief periods of time. Computer models were used to simulate environmental conditions and predict ambient concentrations. Descriptions of the models and the assumptions used in defining air quality impacts of the project are presented in Appendix B-2.

Air quality impact studies using three U.S. Environmental Protection Agency (EPA) approved methods have been completed by the Operator's contractor and are presented in the PSD applications for mining and retorting (Chevron 1982d) and upgrading (Chevron 1982f) facilities. These models are COMPLEX I (EPA 1980a), PTPLU (EPA 1980b), and ISC (EPA 1979b). It should be noted that data and analyses provided in the Operator's PSD applications and additional submitted information forms the basis of the following analyses. Air quality modeling techniques are still being developed. The above three EPA models apply relatively simple Gaussian concepts involving homogeneous and constant flow. The accuracy of the results of these Gaussian techniques is generally within a factor of two.

Modeling studies have attempted to predict the impacts of plant operations upon the air quality above the Clear Creek mesa, in Clear Creek canyon, and in the Grand Valley in the vicinity of the proposed facilities. Because of the varied production rate of emissions produced by construction activities, the studies were confined to concentrations which may be produced by operation of permanent installations. The syncrude product pipeline and powerline corridor were also excluded since they are not expected to be sources of significant air emissions during operations. Construction impacts for the pipeline and powerline corridors are expected to be short-term, localized, and minor.

Data concerning the effects of mining and retorting on Clear Creek mesa indicate that these facilities would be in compliance with federal and state standards and would partially consume PSD increments. Data concerning the upgrading facility in Grand Valley indicate that this facility would be in compliance with all federal and state standards, and only partially consume the PSD increments. Impacts from construction activities have been considered, but, due to their temporary and limited emissions, have not been modeled.

4.2.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action (PA-100) and Clear Creek Alternative (CC-100)

This section considers air quality impacts due to the Proposed Action with the mine, retorting facility, and upgrading facility located on Clear Creek mesa.

Emissions. The air quality impact analysis of the proposed CCSOP considers stack and fugitive releases of SO_2, TSP, NO_x, CO, and HC.

Dust emissions sources anticipated from mining and shale handling activities on Clear Creek mesa would include a wide variety of source types. The exact location of sources may move across wide areas in a day-to-day progression. These sources include the pit operation, reclamation activities and wind erosion of stockpiles and other bare areas. Other sources, such as haul roads or uncovered conveyors, emit almost continuously along well defined routes. A summary of total NO_x, SO_2, and CO emissions from 1988 through 2007 associated with mining activity combustion sources is presented in Table 4.2-1. The detailed emissions inventory used in the analysis can be found in Appendix A of the PSD application for the mine and retort facilities (Chevron 1982d).

Three different years, each with different mine configurations and fugitive dust emissions were modeled. Year 2005 was chosen because it is the year with maximum potential fugitive dust emissions. Year 2001 was modeled because of maximum near-surface emissions and year 2007 was modeled because it is the first year of maximum production.

Table 4.2-1 TOTAL ANNUAL SURFACE AND UNDERGROUND MINING EMISSIONS AND TOTAL GASEOUS EMISSIONS (tons/yr)

Year	TSP	SO_x	NO_x	CO
Total Emissions 1988-2007	15,454	1,673	23,023	206,028
1988	13			
1989	220			
1990	325			
1991	310			
1992	344			
1993	539			
1994	618			
1995	736			
1996	945			
1997	886			
1998	1,023			
1999	1,027			
2000	1,029			
2001	1,097			
2002	963			
2003	1,003			
2004	1,053			
2005	1,133			
2006	1,102			
2007	1,088			

Source: Chevron (1982d).

The emissions and stack height information associated with the retorting facilities are presented in Table 4.2-2. Sources with identical stack parameters in the same vicinity were grouped to form composite sources with the combined emissions of the individual stacks. These composite sources were assigned geographical coordinates corresponding to the geometric mid-point of the individual sources in each source group. Constant year-round emissions corresponding to retorting for a 100,000-bpd oil shale facility were assumed for the base case modeling analyses. Emissions calculations for the point sources associated with the retorting facility can be found in Appendix A of the PSD application (Chevron 1982d).

Table 4.2-2 CLEAR CREEK MESA RETORTING EMISSIONS AND STACK DATA DURING NORMAL OPERATIONS[a]

Facility	Stack[b] Height	SO_2 (g/sec)	SO_2 (ton/yr)	TSP (g/sec)	TSP (ton/yr)	NO_x (g/sec)	NO_x (ton/yr)	CO (g/sec)	CO (ton/yr)
Coal Grinding	Low	0.55	19.1	1.10	38.2	1.8	61.2	0.55	19.1
Steam Superheaters	Mid	6.71	233.3	1.65	57.4	21.7	753.3	6.7	233.3
Retort Combustor	Upper	93.50	3,250.2	118.58	4,122.1	1,007.6	35,026.1	2,043.8	71,046.4
TEG Concentrator	Mid	0.02	0.7	0.04	1.4	0.05	1.7	0.02	0.7
TOTAL EMISSIONS		100.78	3,503.3	121.37	4,219.1	1,031.1	35,842.3	2,051.1	71,299.5

Source: Chevron (1982d).

[a] Minor and start-up sources not included in air quality impact analysis
[b] Low = "lower-level emissions" (0-25 m)
Mid = "mid-level emissons" (25-45 m)
Upper = "upper-level emissions" (45-100 m)

The emission and stack exhaust information for the upgrading facility is presented in Table 4.2-3. Detailed emissions calculations for the upgrading point sources can be found in Appendix 1 of the upgrading PSD application (Chevron 1982f). Table 4.2-4 presents the fugitive dust sources associated with coal, limestone, and ash handling for the steam generators. These sources would amount to less than 1 percent of the total TSP emissions associated with the upgrading, and therefore were not modeled in the air quality impact analysis. Detailed fugitive dust emission calculations are contained in Appendix 2 of the upgrading PSD application (Chevron 1982f).

The emission source configuration used in the modeling was derived from the plot plans of the planned upgrading facility (Chevron 1982f). For modeling, emissions from a single-stack type by-process operation are assumed to be collocated at the mean coordinate for that stack type.

Air Quality. This section describes the results of the ISC modeling of the operational phase of the mining and ore handling as well as the COMPLEX I results from the preliminary screening modeling of retorting and upgrading emissions on the mesa. Explicit determination of accumulated mesa concentrations from retorting, upgrading, and mining emissions in the present engineering configuration has not been performed. Nevertheless, the preliminary retorting and upgrading modeling results can be used to make a conservative estimate of mesa-top retorting and upgrading concentrations because the retort combustor stacks were modeled at 15 percent reduction in stack height. Table 4.2-5 lists the predicted air quality impacts of the plateau-top retorting and upgrading facilities for the Proposed Action. Listed for each appropriate pollutant and averaging time are the predicted maximum concentrations off of the property boundary in the PSD Class II areas and concentrations in the Class I Flat Tops Wilderness Area. The date and time (hour of the day) of impact, the PSD increment and federal standard for each pollutant are also provided.

Table 4.2-3 CLEAR CREEK MESA UPGRADING EMISSION AND STACK DATA[a]

		Emissions Per Stack							
		SO_2		PM		NO_x		CO	
Facility	Stack Height[b]	(g/sec)	(tons/yr)	(g/sec)	(tons/yr)	(g/sec)	(tons/yr)	(g/sec)	(tons/yr)
Reactor Feed	Mid	0.13	4.4	0.03	1.1	0.41	14.1	0.13	4.4
Reactor Charge	Mid	0.13	4.4	0.03	1.1	0.41	14.1	0.13	4.4
Fract Tower Reboiler	Mid	0.63	21.9	0.16	5.5	2.04	70.3	0.63	21.9
Reformer Furnaces	Mid	1.41	50.3	1.34	46.5	8.71	300.3	1.41	49.1
Naphtha Vaporizers	Mid	0.13	4.4	0.03	1.1	0.41	14.1	0.13	4.4
Feed Gas Preheat	Mid	0.10	3.5	0.025	0.9	0.33	11.4	0.10	3.5
BSRU Tail Gas	Mid	0.35	12.3	—	—	—	—	0.35	12.3
Steam Generator	Upper	6.49	225.9	1.03	35.7	23.90	832.0	1.44	50.0
TOTAL EMISSIONS		44.16	1,544.8	16.18	566.8	174.8	6,339.2	23.96	1,028.0

Source: Chevron (1982d)

[a] Based on: 4 upgrading modules producing a nominal total of 100,000 bpd (emission rates are per stack basis)
[b] Mid = "mid-level emissions" (25-45 m)
Upper = "upper-level emissions" (45-100 m)

Table 4.2-4 SUMMARY OF FUGITIVE DUST ASSOCIATED WITH COAL, LIMESTONE AND ASH HANDLING AT THE UPGRADE FACILITY

	Emissions	
Source	(g/sec)	(ton/yr)
Coal Handling	0.0039	0.13
Limestone Handling	0.00020	0.01
Ash Handling	0.00053	0.02
Total	0.0046	0.16

Source: Chevron (1982d).

Table 4.2-5 CLEAR CREEK MESA RETORTING AND UPGRADING AIR QUALITY CLASS II AND CLASS I IMPACTS SUMMARY

		Predicted Impacts										
Pollutant	Average Time	Conc. Class II (μg/cu m)	Date	Time Hour	Conc. Class I (μg/cu m)	Date	Time Hour	Background Conc. (μg/cu m)	Class II PSD Increment (μg/cu m)	Class I PSD Increment (μg/cu m)	Total Conc. Class II (μg/cu m)	NAQQS (μg/cu m)
SO_2	Annual	20	—	—	0.1	—	—	1	20	2	21	80
	24-Hour	110	12/8	24	2.4	8/15	24	14	91	5	124	365
	3-Hour	324	8/25	3	10.9	3/29	6	17	512	25	341	1,300
TSP	Annual	12	—	—	0.2	—	—	15	19	5	27	60
	24-Hour	61	11/10	24	2.4	8/15	10	89	37	10	150	150
NO_2[a]	Annual	113	—	—	—	—	—	4	—	—	117	100
CO	8-Hour	971	12/23	8	—	—	—	2,500	—	—	3,471	10,000
	1-Hour	4,075	1/6	22	—	—	—	3,000	—	—	7,075	40,000

Source: Chevron (1982v).

[a] Modeled as total NO_x

For the Proposed Action, PSD Class II increments for the annual and 24-hour SO_2 and the 24-hour TSP impacts may be consumed and/or exceeded. Annual NO_2 also is predicted to exceed the federal annual ambient standard. The short-term SO_2 concentrations in the Flat Tops Wilderness Area were found to be most constraining for Class I areas, each consuming up to 50 percent of the respective Class I increments. Additionally, when the retorting and upgrading impacts were added to the background concentrations, only 24-hour particulate and annual NO_2 values were predicted to equal or exceed the federal annual ambient air quality standard.

As with the emissions from the retort facility, fugitive dust emissions from the mining and ore handling operations were modeled to quantify potential impacts on ambient air quality. Since fugitive dust emissions associated with mining occur primarily near the ground, ambient TSP concentrations decrease rapidly with distance as dispersion and deposition processes dilute and physically remove plume mass. The highest 24-hour particulate concentration due to mining and ore handling is 31 micrograms per cubic meter (μg/cu m), occurring on the southern property boundary at receptor N84 (see Figure 3.2-1). The highest concentrations are predicted for the month of January (Chevron 1982d). Table 4.2-6 summarizes the results of the ISC modeling for each of the three years modeled. The highest and predicted annual arithmetic means ranged from 2.6 to 4.2 μg/cu m and also occur at the southern property boundary. The maximum predicted 24-hour TSP concentration from mining consumes 84 percent of the PSD Class II increment; the maximum annual arithmetic mean of 4.2 μg/cu m consumes 22 percent of the PSD annual geometric mean increment.

Predicted maximum mining impacts would occur at different receptor locations than those for the retorting and upgrading facilities. Hence, the maximum predicted values for all three areas (mining, retorting, and upgrading)

Table 4.2-6 MAXIMUM 24-HOUR AND ANNUAL PARTICULATE MATTER CONCENTRATIONS DUE TO MINING AND ORE HANDLING ON CLEAR CREEK MESA

		24-Hour Concentration (μg/cu m)		
Day	Receptor	2001	2005	2007
13	N84	18.2	21.3	31.1
13	N86	18.2	20.3	22.9
13	N89	11.2	12.8	10.9
20	N84	14.2	16.2	21.6
20	N86	11.6	13.1	14.0
20	N89	6.4	7.4	6.4

	Annual Arithmetic Mean (μg/cu m)		
Receptor	2001	2005	2007
N84	2.6	2.7	4.2
N86	2.7	3.1	3.8
N89	2.6	3.2	3.1

Source: Chevron (1982d).

are not additive. However, the overall predicted maxima for particulates should be represented by the values for retorting and upgrading. Therefore, these receptor locations, which are much further from the mining locations, whould experience the highest levels of project-related particulate concentrations.

Visibility. As a first step, a Level-1 visibility screening analysis (Ireson 1980) was performed to determine whether any significant impacts would occur at the nearby Flat Tops Wilderness Class I area. The Level-1 visibility screening analysis is a simple, straightforward calculation designed to identify those emission sources that have little potential of adversely affecting visibility. If a source passes this screening test, it would not be likely to cause adverse visibility impairment, and further analysis of potential visibility impairment would not be necessary (Iresen 1980). This analysis indicated that significant impacts cannot be ruled out at 82 kilometers (the distance to the Class I area); and, moreover, that the Level-1 analysis would not be passed until a distance of 149 kilometers when considering the retort and upgrade emissions on the mesa. Thus, a more detailed visibility analysis was required to predict potential impacts on visibility. The PLUVUE visibility model was applied to some representative worst-case meteorological scenarios.

The worst-case meteorology was based on methods presented in Ireson (1980). The lines of sight of concern were determined in conjunction with the National Forest Service, and were found to be the views of Shingle Peak as observed from Big Marvine Peak and Blair Lake. The plume trajectories from the source to either of the lines of sight were calculated.

After all trajectories were calculated using hourly meteorological data collected at the mesa, the data were sorted by considering the persistence of the required meteorological conditions, the time of day of plume arrival (after sunrise and before sunset), and the time of year in terms of likely visitor use of the Class I area. Four cases were identified after this trajectory calculation.

The visibility impacts predicted by the modeled plume were found to be significant for both lines of sight under two cases. Although no explicit guidelines are presently available regarding the significance thresholds of these visibility indices, the values suggested in Ireson (1980) may be used to interpret the results. These values indicate significant impacts in contrast/discoloration for the plume perceptibility from the Blair Lake line of sight and the Big Marvine line of sight.

Atmospheric Deposition. Acid deposition is considered as an Air Quality Related Value (AQRV) for federally designated Class I areas which are within close proximity of a facility. Acid rain is a regional phenomenon generally associated with emissions generated by large cities and major industrial sources. Even so, acid rain has been documented in a high-altitude Rocky Mountain setting where no direct connection can be made with major emissions sources (Lewis and Grant 1980). Additional studies and analyses have been done by Grant of CSU, Turk of U.S. Geologic Survey, and Fox of the U.S. Forest Service. Most of these studies of western acid deposition indicate minimal contribution from an individual source.

Potential deposition of sulfur and nitrogen in the Flat Tops Wilderness was modeled using the deposition velocity approach presented in the air quality technical report for the supplemental EIS for the Prototype Oil Shale Leasing Program (Dietrich et al. 1982). Deposition in the Flat Tops Wilderness Area from the retorting and upgrading facilities located on Clear Creek mesa was estimated from the predicted maximum 24-hour SO_2 and NO_2 concentrations. This analysis assumes the following.

- The estimated worst-case single concentration is representative of deposition to the entire wilderness area.

- All sulfur compounds were assumed to be SO_2 and nitrogen compounds were assumed to be NO_2.

- Dry deposition velocity of NO_2 and SO_2 was assumed to be 1 centimeter per second (cm/sec).

- Annual average deposition rates for nitrogen are estimated assuming a ratio of 5:1 from the 24-hour scaled estimate.

The 24-hour and annual dry sulfur deposition rates are estimated to be 10.3 gram/hectare/day and 0.2 kilogram/hectare/year respectively. The 24-hour and annual nitrogen dry deposition rates are estimated to be 7.8 gram/hectare/day and 0.6 kilogram/hectare/year.

Wet deposition rates were estimated from precipitation statistics for the Flat Tops Wilderness Area. Assuming an annual average mixing depth of 2,600 meters (Holzworth 1972) and the complete removal during the 1-hour precipitation event on each of the event days (Department of Commerce 1968), the effective annual-average wet deposition velocity of 0.8 cm/sec can be calculated. Applying these values to the concentrations of SO_2 and NO_x in the wilderness area results in conservative wet deposition rates of 80 percent of the dry deposition rates.

In the Flat Tops Wilderness Area, sulfur and nitrogen deposition is conservatively estimated to be as high as 0.3 and 1 kilogram/hectare/year, respectively. These values are well below the anticipated background levels. Turk and Adams (1982) have measured the buffering capacity of a number of lakes, and have identified three, Oyster, Upper Island, and Ned Wilson, with alkalinities of 200, 100, and 70 microequivelents per liter (μe/l). The estimated deposition rates are not expected to lower the levels of these lakes below a value of 6.0 μe/l. It is not currently known what effect, if any, these shifts would have on biota. These calculations assume complete mixing in the lakes of snowmelt or runoff with ground water.

Production Rate Alternatives (PA-50, CC-50)

Preliminary information suggests that reducing production by 50 percent would reduce all applicable air quality impacts by a proportional amount. However, specific changes in facility configuration may vary this relationship. Fugitive dust impacts from mining and ore handling activities would be further reduced because a 50,000-bpd facility would have all underground mining. Locations of maxium concentrations for all facilities could also be different than those for a 100,000-bpd facility. An EPA Level I visibility analysis was undertaken to determine potential visibility impacts for a 50,000-bpd facility on Dinosaur and Colorado National Monuments. EPA's VALLEY model was run for these two areas to predict the SO_2 and TSP impacts (Chevron 1982y). TSP and SO_2 impacts are predicted to be negligible at Colorado National Monument and less than 30 percent of EPA's PSD Class I increments at Dinosaur National Monument. Although only very small SO_2 or TSP impacts are predicted, potential visibility effects cannot be ruled out for this configuration. Regional haze should not be a problem, but "Level I results indicate that plume blight might merit further study, if one of these (50,000 bpd) alternatives were pursued" (Chevron 1982y).

4.2.3 Grand Valley and Associated Siting Activities

Fruita I Alternative (FI-100)

This section considers the combined air quality impacts of the retorting and mining facilities on Clear Creek mesa and the upgrading facility in Grand Valley.

Emissions. Basic emission assumptions other than location of sources are the same as described in Section 4.2.2. Emissions rates for the mining and ore handling activity, retort facility, upgrade facility, and coal, limestone and ash handling are presented in Tables 4.2-1 through 4.2-4.

Air Quality. This section describes the results of the COMPLEX I modeling of the operational phase of the upgrading facility in Grand Valley, the updated modeling of the current engineering configuration of the retorting facility, and the ISC modeling of the mining and ore handling facility. Table 4.2-7 lists the predicted air quality impacts in the immediate vicinity of the proposed upgrading facility using meteorological data for 1977 through 1981. All of the predicted maximum annual average short-term impacts are in compliance with the PSD Class II increments. Short-term impacts of SO_2 and TSP were found to be the most constraining, each consuming more than 80 percent of the respective Class II increments. These impacts occurred during low wind speed, stable plume transport to high terrain areas adjacent to the upgrading site. A detailed listing of the meteorological conditions associated with the worst-case short-term impacts can be found in Chevron (1982f).

Table 4.2-7 GRAND VALLEY UPGRADING AIR QUALITY IMPACTS SUMMARY 1977 - 1981

Pollutant	Average Time	Conc. (μg/cu m)	Predicted Impacts Receptor	Year	Date	Time	Background Conc. (μg/cu m)	Class II PSD Increments (μg/cu m)	Class I PSD Increments (μg/cu m)	Total Conc. (μg/cu m)	NAAQS (μg/cum)
SO_2	Annual	5	59	1980	—	—	3	20	2	8	80
	24-Hour	79	51	1979	12/5	1-24	24	91	5	103	365
	3-Hour	420	51	1978	11/24	22-24	39	512	25	459	1,300
TSP	Annual	2	59	1980	—	—	33	19	5	35	60
	24-Hour	31	51	1979	12/5	1-24	121	37	10	152	150
$NO_2$2[a]	Annual	21	59	1980	—	—	2	—	—	23	100
CO	8-Hour	242	51	1978	3/4	1-8	1,040	—	—	1,282	10,000
	1-Hour	389	51	1980	12/16	23	2,680	—	—	3,609	40,000

Source: Chevron (1982f).

[a] Modeled as total NO_x

When the upgrading impacts were added to representative background pollutant concentrations, predicted impacts were well below all applicable NAAQS standards, except for the predicted 24-hour TSP which slightly exceed these applicable standards.

Particulate concentration levels in the Mesa County TSP nonattainment area were predicted to be below the EPA significance levels, as shown in Table 4.2-8. Maximum annual average impacts at the nonattainment area were less than 1 μg/cu m. Maximum 24-hour impacts were 60 percent of the significance level. Therefore, no significant impact on the particulate non-attainment areas is anticipated.

Table 4.2-8 UPGRADING IN GRAND VALLEY IMPACTS AT MESA COUNTY TSP NONATTAINMENT AREA[a]

	Annual Average TSP		24-Hour Average TSP			
Year	Conc. (μg/cu m)	Receptor	Conc. (μg/cu m)	Receptor	Date	Time
1981	< 0.1	174	1	174	29	1-24
1980	< 0.1	174	1	174	264	1-24
1979	0.1	174	3	175	37	1-24
1978	0.1	174	2	174	177	1-24
1977	< 0.1	174	1	174	274	1-24

Source: Chevron (1982f).

[a] EPA significance levels for TSP - 1 μg/cu m annual average
5 μg/cu m 24-hour average

Impacts from the upgrading facility predicted to occur at Arches National Park (Table 4.2-9) are well below the Class I PSD increments. Annual average impacts were not specifically modeled but will be less than the maximum 24-hour average.

Table 4.2-9 GRAND VALLEY UPGRADING IMPACTS AT ARCHES NATIONAL PARK

		Predicted Impact	Class I PSD Increment
Pollutant	Time Averaging	(μg/cu m)	
SO_2	Annual	1	2
	24-hour	1	5
	3-hour	2	25
TSP	Annual	1	5
	24-hour	1	10

Source: Chevron (1982f)

Impacts at other Class I PSD areas such as West Elk Wilderness and Black Canyon of the Gunnison Wilderness were estimated using COMPLEX I and worst-case meteorological conditions. Table 4.2-10 presents modeling results with all concentrations less than or equal to 1 μg/cu m for SO_2 and TSP. No significant impact is expected to occur in the Flat Tops Wilderness due its distance and the improbable meteorological conditions required for pollutant transport to impact the wilderness.

Table 4.2-10 UPGRADING IN GRAND VALLEY IMPACTS AT CLASS I PSD AREAS

			Black Canyon		West Elk	
Pollutant	Averaging Time	Class I PSD Increment (μg/cu m)	Predicted Impact (μg/cu m)	Meteorological Scenario	Predicted Impact (μg/cu m)	Meteorological Scenario
SO_2	Annual	2	< 1	—	< 1	—
	24-hour	5	< 1	Stable	< 1	Neutral
	3-hour	25	1	Stable	< 1	Neutral
TSP	Annual	5	< 1	—	< 1	—
	24-hour	10	< 1	Stable	< 1	Neutral

Source: Chevron (1982d).

Specific air quality impact analyses for Colorado National Monument, a Colorado Category I area, have been completed. Table 4.2-11 presents the COMPLEX I modeling results for SO_2 impacts. All state increments are met, with the 3-hour average consuming most of the SO_2 increments during the majority of the 5 years. It is expected that TSP values would be less or equal to the Mesa County non-attainment area values in Table 4.2-8, as the Colorado National Monument is at a greater distance. Dinosaur National Monument, which is also a Category I area, is over 70 miles from the Fruita facility and should not be affected.

An analysis of the ozone impacts from the FI-100 upgrade facility has also been conducted and is discussed in the PSD application (Chevron 1982f). The projected ozone impacts were calculated using EPA's (1980c) Empirical Kinetics Modeling Approach (EPA/EKMA) and ERT/EKMA (Chevron 1982f). Results of the ozone impact analysis indicate that emissions of hydrocarbons and oxides of nitrogen from oil shale upgrade facilities will have a minimal impact on ambient maximum ozone concentrations, with a range in background ozone concentrations for all the scenarios from 0.022 to 0.043 ppm and from 0.019 to 0.055 ppm for the ERT/EKMA and EPA/EKMA simulations, respectively.

Impacts from the Clear Creek mesa retorting facility, presented in Table 4.2-12, show no predicted exceedences of federal ambient air quality standards or PSD Class II increments. The most adverse impacts would be 24-hour average TSP, which consumes 75 percent of the PSD Class II increment and the annual average NO_2 concentration, which is predicted to be 46 percent of the federal ambient air quality standard. A full discussion of the modeling results can be found in Chevron (1982d). Impacts from the mesa retorting facility in the Flat Tops Wilderness Area are shown in Table 4.2-13. Short-term SO_2 concentrations consume 30 percent of the Class I PSD increment and 24-hour TSP concentrations consume 20 percent of the PSD increment.

Table 4.2-11 GRAND VALLEY UPGRADING SO_2 IMPACTS AT COLORADO NATIONAL MONUMENT[a]

Year	Averaging Time	Highest Concentration (μg/cu m)	Highest Second-Highest Concentration (μg/cu m)
1977	Annual	<1	-
	24-hour	2	2
	3-hour	16	9
1978	Annual	<1	-
	24-hour	6	4
	3-hour	24	23
1979	Annual	<1	-
	24-hour	2	2
	3-hour	11	11
1980	Annual	<1	-
	24-hour	3	2
	3-hour	21	11
1981	Annual	<1	-
	24-hour	3	2
	3-hour	24	15

Source: (Chevron 1982f).

[a] Colorado Category I Incremental Standard for SO_2 —
2 μg/cu m annual average
5 μg/cu m 24-hr average
25 μg/cu m 3-hr average

Table 4.2-14 presents the predicted maximum cumulative particulate impacts from both the mining and retorting facilities on the mesa. The maximum 24-hour cumulative impact is 32 μg/cu m, predicted along the northern property boundary. Retorting emissions contributed 89 percent of the anticipated impact at this location. The second predicted maximum TSP concentration of 31 μg/cu m occurs at the same location on a different day. The mining and ore handling activities account for 99 percent of this impact. The maximum predicted annual average cumulative impact is 7 μg/cu m or about 37 percent of the annual average PSD Class II increment.

When the nocturnal drainage pattern is strong and well developed, plumes originating on the mesa can be entrained into the canyon. A box model approach was used in the PSD application (Chevron 1982d) to simulate SO_2 and TSP concentration in the canyon. The worst-case, 24-hour predicted average particulate and SO_2 concentrations are 24 and 7 μg/cu m, respectively, which are 65 and 3 percent of the Class II PSD increments. These concentrations are predicted 8 kilometers down the canyon at the closest point off the CCSOP property.

Visibility. A Level-1 visibility screening analysis at Arches National Park was conducted for the FI-100 upgrade facility in Grand Valley. Three parameters were calculated: plume contrast against the sky, sky-terrain contrast reduction, and the change in sky-terrain contrast caused by primary and secondary aerosals. If the absolute value of any of these parameters exceeds 0.10, then the source fails the Level-1 screening test and analysis should proceed to Level-2 (Ireson 1980). The results of the Level-1 calculations, which are discussed in the PSD application (Chevron 1982f), show the absolute values of all three parameters to be less than 0.10. Consequently, the proposed upgrading facility is not likely to cause any visibility impairment at Arches National Park.

Table 4.2-12 MAXIMUM PREDICTED CONCENTRATIONS FROM A 275,000 TON/DAY RETORT FACILITY ON CLEAR CREEK MESA — RETORTS ONLY

	Retort Impacts (μg/cu m)	PSD Class II Increment (μg/cu m)	Background Concentration (μg/cu m)	Maximum Concentration (μg/cu m)	NAAQS (μg/cu m)	Day-End	Distance from Facility (Kilometers)	Bearing From Facility
SO_2								
Annual	6.2	20	1	7	80	—	4	North-northeast
24-Hour	28	91	14	42	365	11/10	4	North-northeast
3-Hour	99	512	17	116	1,300	8/16	7	North-northwest
Particulate Matter								
Annual	5.5	19	15	21	60	—	6	North-northeast
24-Hour	28	37	89	117	150	2/27	6	North-northeast
NO_2								
Annual	46	—	4	50	100	—	6	North-northeast
CO								
8-Hour	971	—	2,500	3,471	10,000	12/23	16	West-southwest
1-Hour	4,075	—	3,000	7,075	40,000	1/6	11	Northwest

Source: Chevron (1982d).

Table 4.2-13 MAXIMUM PREDICTED CONCENTRATIONS IN FLAT TOPS WILDERNESS AREA FROM A 275,000 TON/DAY RETORT FACILITY ON CLEAR CREEK MESA

Pollutant	Concentration (μg/cu m)	Class I Increment (μg/cu m)	Day
SO_2			
Annual	0.1	2	—
24-Hour	1.7	5	8/15
3-Hour	7.6	25	3/29
Particulate Matter			
Annual	0.2	5	—
24-Hour	2.1	10	8/15

Source: Chevron (1982d).

A detailed discussion of visibility impacts in the Flat Tops Wilderness Class I area is presented in Appendix 7 of Chevron (1982d). Both Level-1 and refined analyses are discussed. The Level-1 analysis indicates that contrast reduction in the Flat Tops due to haze would be insignificant but that plume blight from project emissions is a possibility. Based on these results, a more refined analysis was conducted to predict the plume blight impact more precisely.

The refined analysis for Flat Tops indicates two worst-case meteorological scenarios in which significant visibility impacts could occur. For the view of Shingle Peak from Blair Lake, the project plume was predicted to be perceptible on two days during the visitor season. For the view of Shingle Peak from Marvine Peak, the plume was estimated to be perceptible one day. In both cases, some contrast reduction and discoloration were predicted.

Because of the conservative assumptions concerning plume transport to Flat Tops, the intervening rough terrain, and the rarity of predicted impacts, it is unlikely that vistas within Flat Tops will actually be impaired due to emissions from the proposed project.

In the immediate vicinity of the project, mining operations will result in localized dust plumes. These plumes should not result in any regional visibility degradation because most of the particles drop out rapidly. The gaseous emissions from the project should not have any significant effect on visibility in the Clear Creek vicinity.

Atmospheric Deposition. Emissions from the upgrading facility in the Grand Valley will be well below Class I PSD increments and thus will not aggravate the acid rain problem in Arches National Park to a significant extent. Because the Flat Tops Wilderness is located more than 56 miles from the upgrading plant, and because occurrence of meteorological conditions necessary to transport pollutants to the wilderness area would be rare, adverse impacts due to acid deposition are not likely. A study of the acid deposition flux was performed for the FI-100 configuration using ERT's Source Depletion Model (Chevron 1982e). Six sources were considered:

- CCOSP - 100 bpd retorting at Clear Creek
- Rio Blanco - Lurgi Demonstration Project
- Cathedral Bluffs - 5,000bpd MIS facility at Tract C-b
- Colony and Union - 46,000 bpd and 10,000-bpd, respectively
- CCOSP - 100,000 bpd upgrading in Grand Valley
- Uinta Basin - Moonlake Power Plant (800 MW), TOSCO (46,000 bpd), White River (106,000 bpd), and Paraho-Ute (42,000 bpd)

Table 4.2-14 MAXIMUM CUMULATIVE PARTICULATE MATTER (TSP) IMPACTS FROM MINING AND RETORTING ON CLEAR CREEK MESA[a]

			24-Hour Concentration (μg/cu m)		
Year	Day	Receptor	Retorts	Fugitives	Total
2001	54	147	28.4	3.6	32.0
2005			28.4	3.3	31.7
2007			28.4	2.9	31.3
2001	13	N84	0.2	18.2	18.4
2005			0.2	21.3	21.5
2007			0.2	31.1	31.3

		Annual Arithmetic Mean (μg/cu m)		
Year	Receptor	Retorts	Fugitives	Total
2001	N125	4.9	2.0	6.9
2005		4.9	2.0	6.9
2007		4.9	1.9	6.8
2001	147	5.5	1.4	6.9
2005		5.5	1.3	6.8
2007		5.5	1.2	6.7
2001	N84	0.3	2.6	2.9
2005		0.3	2.7	3.0
2007		0.3	4.2	4.5
2001	N86	0.5	2.7	3.2
2005		0.5	3.1	3.6
2007		0.5	3.8	4.3

Source: Chevron (1982d).

[a] PSD Class II Incremental Standard for TSP — 19 μg/cu m for annual average
37 μg/cu m for 24-hr average

Impacts from the deposition were evaluated for Ned Wilson Lake on the Flat Tops. This lake was identified as having little buffering potential (Turk and Adams 1982) and, hence, is particularly susceptible to damage from acid rain. The predicted pH change is −0.16 (Chevron 1982y). This value would yield a new pH in the lake of 6.60. Impacts from minor shifts in pH such as these deposition rates are not anticipated to cause significant impacts.

Table 4.2-15 shows estimated 24-hour and annual dry and wet deposition rates resulting from upgrading in the Grand Valley on Arches National Park, Colorado National Monument, Black Canyon of the Gunnison Wilderness, and the West Elk Wilderness. Table 4.2-15 also shows estimated atmospheric deposition from retorting on the mesa on the Flat Tops Wilderness.

A comparative study (SAI 1982) indicates that cumulative maximum deposition in Colorado National Monument will be less than 0.1 grams per square meter per year each for sulfur and nitrogen. These values indicate a minimum lake pH of 6.0 for a poorly buffered lake of 70 μ /l.

Table 4.2-15 ATMOSPHERIC DEPOSITION RATES IN PSD CLASS I AREAS AND COLORADO CATEGORY I AREAS FROM UPGRADING FACILITY IN GRAND VALLEY AND RETORTING ON MESA

	Arches National Park[a]				Black Canyon of Gunnison Wilderness[b]				Flat Tops Wilderness[b]				West Elk Wilderness[b]				Colorado National Monument[a]			
	24-hr (g/ha/d)		Annual (kg/ha/yr)		24-hr (g/ha/d)		Annual (kg/ha/yr)		24-hr (g/ha/d)		Annual (kg/ha/yr)		24-hr (g/ha/d)		Annual (kg/ha/yr)		24-hr (g/ha/d)		Annual (kg/ha/yr)	
Constituent	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Upgrade NO_2	<5.6	<5.6	<0.4	<0.4	<5.6	<4.5	<0.4	<0.3	N[c]	N	N	N	<5.6	<4.5	<0.4	<0.3	33.5	33.5	2.3	2.3
Upgrade SO_2	<4.3	<4.3	<0.3	<0.3	<4.3	<3.4	<0.3	<0.2	N	N	N	N	<4.3	<3.4	<0.3	<0.2	25.8	25.8	1.8	1.8
Retort NO_2	N	N	N	N	N	N	N	N	10.1	8.1	0.7	0.6	N	N	N	N	N	N	N	N
Retort SO_2	N	N	N	N	N	N	N	N	7.3	5.8	0.5	0.4	N	N	N	N	N	N	N	N

[a] Wet deposition velocity at Arches National Park and Colorado National Monument was calculated to be 1.0 cm/sec.
[b] Wet deposition velcoity at Black Canyon, Flat Tops, and West Elk was calculated to be 0.8 cm/sec.
[c] N = Negligible due to distance and meterological conditions.

Alternative Production Rates (FI-50)

Available data suggest that reducing the production rate by 50 percent would reduce all applicable air quality impacts by a proportional amount. However, specific changes in facility configuration may vary this relationship. Fugitive dust impacts from mining activities would be further reduced due to the use of an all underground mine. Maximum SO_2 impacts at Colorado National Monument are estimated to be 10.5 μg/cu m for a 3-hour averaging period and 2.6 μg/cu m for a 24-hour average. These compare to Colorado and PSD Class I standards for SO_2 of 25 μg/cu m for 3 hours and 5 μg/cu m for a 24-hour average, or 40-55 percent of the increment. Predicted 24-hour TSP values of 1.0 μg/cu m are 10 percent of the PSD Class I increment. Values predicted for Dinosaur National Monument are approximately 25 percent less for SO_2 and about equal for TSP to those estimated for Colorado National Monument.

Fruita II Alternative (FII-50)

This section presents the air quality impacts from retorting and upgrading facilities in the Grand Valley at a production rate of 50,000 bpd.

Emissions. Emission and stack data on a per stack basis for a facility upgrading of 74,000 bpd and retorting of 62,000 bpd are presented in Table 4.2-16. Because of methods used in the cracking process at the upgrading facility, the final output can be as much as 12,000 barrels more per 100,000 barrels of syncrude processed (Chevron 1982o).

Fugitive dust emissions due to mining and ore handling activities have been discussed in previous sections.

Air Quality. This section presents the results of the COMPLEX I and ISC modeling of the operational phase of the FII-50 upgrading and retorting facility in Grand Valley. Impacts for the underground mine should be less than the mining scenario described earlier. All annual average concentrations listed in this section represent the maximum concentrations reported for each calendar year. This allows direct comparison of the predicted concentrations to air quality standards. Table 4.2-17 presents the impacts.

All of the predicted maximum annual average and short-term impacts for SO_2 are in compliance with PSD Class II increments. However, the 24-hour TSP concentration slightly exceeds the PSD increment. When added to the background concentration, the 24-hour TSP impacts slightly exceed the NAAQ standards.

Particulate concentration levels in the Mesa County TSP nonattainment area were predicted to be at the level of significance for 24-hour averages. These values are presented in Table 4.2-18.

Information concerning impacts on Class I areas from this alternative and comparative PSD Class I and Colorado Category I increments are compiled in Table 4.2-19. These data were scaled linearly from available data presented in the preceding sections. Much of the earlier data were presented as less than 1 μg/cu m.

Visibility. Visibility impacts at the Colorado National Monument for FII-50 are estimated by EPA Level I screening analysis to be the most adverse of any 50,000-bpd scenario. Dinosaur National Monument passes the EPA Level I screening analysis.

Atmospheric Deposition. Potential deposition of sulfur and nitrogen resulting from estimated concentrations in the Class I and Category I areas from the retorting and upgrading facility located in Grand Valley are presented in Table 4.2-20. These values were scaled from data supplied for the mine and retorts on Clear Creek mesa and the upgrade facility near Fruita. Major shifts in pH values in these areas are not expected. It is not currently known what effect, if any, these shifts would have on biota.

Table 4.2-16 EMISSIONS AND STACK DATA FOR RETORTING AND UPGRADING IN THE GRAND VALLEY[a]

Facility	Stack Height[b]	Emissions per Stack (g/sec)			
		SO_2	TSP	NO_x	CO
Coal Grinding	Low	0.06	0.10	0.18	0.06
Steam Superheaters	Mid	0.68	0.17	2.21	0.68
Retort Combustor	Upper	9.52	12.07	102.60	208.20
TEG Concentrator	Mid	0.003	0.009	0.01	0.003
Reactor Feed	Mid	0.16	0.03	0.50	0.15
Reactor Charge	Mid	0.16	0.03	0.50	0.15
Fract Tower Reboiler	Mid	0.77	0.20	2.52	0.77
Reformer Furnaces	Mid	1.74	1.65	10.76	1.73
Naptha Vaporizers	Mid	0.16	0.03	0.50	0.16
Feed Gas Preheat	Mid	0.12	0.03	0.40	0.12
BSRU Tail Gas	Mid	0.44	—	—	0.44
Steam Generator	Upper	8.02	1.28	29.50	1.78
Misc TSP[c]	Low	—	2.25	—	—
Total Emissions		57.406	49.088	425.87	640.886

Source: Chevron (1982d, 1982f, 1982p).

[a] Based on: 2 Upgrading Modules Producing 74,000 bpd
3 Retort Modules Producing 62,000 bpd

[b] Low = "low-level emissions" (10-25 m)
Mid = "mid-level emissions" (25-45 m)
Upper = "upper-level emissions" (45-100 m)

[c] Stack parameters arbitrarily set to generate negligible plume rise

4.2.4 Alternative Siting Impacts

Alternative reservoir and corridor siting should not have an air quality impact.

Based on the PSD applications for mining and retorting on the Clear Creek mesa (Chevron 1982d), the spent shale storage piles represent a very small amount (1-5 percent) of the total contribution to total suspended particulates at the locations of overall maximum impact. The concentrations fall off rapidly and are below the PSD Class II increments within 3.5 kilometers of the source. The site location will not affect the air quality impact, which has been determined as a minor negative impact.

4.2.5 Transportation Impacts

Using trains to transport coal for all of the alternative packages would require one train a day running about 26 miles and would result in a very low adverse impact. Using trucks to transport coal would require about 450 trucks a day over the same route and would obviously increase the air quality impact.

Table 4.2-17 GRAND VALLEY MAXIMUM ANNUAL SHORT-TERM CONCENTRATIONS PREDICTED WITH COMPLEX I — FROM PRIMARY EMISSION SOURCES[a]

Pollutant	Averaging Time	Concentration (μg/cu m)	Receptor	Date	Time	Background Conc. (μg/cu m)	Total Conc. (μg/cu m)	PSD Incr. (μg/cu m)	NAAQS (μg/cu m)
SO_2	Annual	3.1	95	—	—	3	6.1	20	80
	24-hr	31	59	12/5	1-24	24	55	91	365
	3-hr	216	59	12/6	4-6	39	255	512	1,300
TSP	Annual	3.2	F29	—	—	33	35.2	19	60
	24-hr	38[b]	F43	12/4	1-24	121	169	37	150
NO_2[c]	Annual	20.7	95	—	—	2	22.7	—	100
CO	8-hr	842	54	12/5	17-24	1,040	1,882	—	10,000
	1-hr	3,413	31	8/13	2	2,680	6,093	—	40,000

Source: Chevron (1982p).

[a] Retorting and upgrading combined
Sources: 3 retort modules at 62,000 bpd
2 Upgrade modules at 74,000 bpd
Including misc. TSP
[b] Predicted exceedance of PSD increments or NAAQS
[c] Modeled as total NO_x

Table 4.2-18 MAXIMUM ANNUAL AND MAXIMUM SECOND-HIGHEST SHORT-TERM TSP CONCENTRATIONS PREDICTED IN GRAND VALLEY WITH COMPLEX I AT THE MESA COUNTY TSP NON-ATTAINMENT AREA

Averaging Time	Concentration (μg/cu m)	Receptor	Date	Time
Annual	0.2	177	—	—
24-hr	5.0	178	1/20	1-24

Source: Chevron (1982p).

[a] Retorting and upgrading combined
Sources: 3 retort modules at 62,000 bpd
2 Upgrade modules at 74,000 bpd
Including misc. TSP

4.2.6 Solid and Hazardous Waste

Available data indicate that insignificant air quality impacts would result from either solid or hazardous wastes.

Table 4.2-19 MAXIMUM CONCENTRATIONS FROM UPGRADING AND RETORTING EMISSIONS IN GRAND VALLEY AND MINING EMISSIONS ON THE MESA IN CLASS I AND COLORADO CATEGORY I AREAS

Pollutant	Averaging Time	Class I PSD[a] Increment (μg/cu m)	Arches National Park (μg/cu m)	Black Canyon of Gunnison Wilderness (μg/cu m)	Flat Tops Wilderness (μg/cu m)	West Elk Wilderness (μg/cu m)	Colorado National Monument (μg/cu m)	Dinosaur National Monument (μg/cu m)[b]
SO_2	Annual	2	< 0.6	< 0.6	0	< 0.6	< 0.6	—
	24-Hour	5	< 0.4	< 0.4	0	< 0.4	< 2.4	0.7
	3-Hour	25	1.0	0.5	0	< 0.5	12	2.9
TSP	Annual	5	< 1.6	< 1.6	0	< 1.6	—	—
	24-Hour	10	< 1.2	< 1.2	0	< 1.2	—	0.9

[a] Colorado Category I Increments for SO_2 are the same. No TSP Category I Increment.
[b] Source: Chevron (1983b).

Table 4.2-20 ATMOSPHERIC DEPOSITION IN PSD CLASS I AREAS AND COLORADO CATEGORY I AREAS FROM THE UPGRADING AND RETORTING FACILITY IN GRAND VALLEY

	Arches National Park				Black Canyon of Gunnison Wilderness				Flat Tops Wilderness			
	24-hr (g/ha da)		Annual (kg/ha yr)		24-hr (g/ha da)		Annual (kg/ha yr)		24-hr (g/ha da)		Annual (kg/ha yr)	
Constituent	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
NO_2	8.5	8.5	0.5	0.85	8.5	7.0	0.5	0.5	0	0	0	0
SO_2	1.7	1.7	0.1	0.1	1.7	1.4	0.1	0.1	0	0	0	0

	West Elk Wilderness				Colorado National Monument			
	24-hr (g/ha da)		Annual (kg/ha yr)		24-hr (g/ha da)		Annual (kg/ha yr)	
Constituent	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
NO_2	8.5	7.0	0.5	0.5	51.5	51.5	3.5	3.5
SO_2	1.7	1.4	0.1	0.1	10.3	10.3	0.7	0.7

Source: Chevron (1982d).

4.2.7 Secondary Impacts

Retorting and Mining on Clear Creek Mesa

This section presents the estimated air quality impacts from secondary growth emission sources associated with the construction and operation of the mine and retorting facility on Clear Creek mesa. The secondary growth sources included in the analysis are increased space heating requirements and increased motor vehicle traffic in the De Beque area.

The emission estimates from increased space heating and transportation requirements are presented in Tables 4.2-21 and 4.2-22. Space heating emissions were calculated by assuming each new household was a consumer of natural gas and used 115,000 standard cubic feet of gas per customer year (COEC 1982). Emission factors for natural gas combustion were derived from EPA's compilation of emission factors (AP-42; EPA 1977). Vehicle exhaust emissions were calculated from national average emission factors presented in AP-42. It was assumed that each household operated an average of two vehicles and each vehicle averaged 12,000 miles traveled per year. As the tables show, the highest emissions are expected in 1992. The air quality impacts of the 1992 projected emissions were estimated with the highly conservative screening technique outlined below.

A worst-case trapping episode was considered to estimate the highest short-term concentrations possible in De Beque from the projected 1992 secondary emissions. The scenario assumes all motor vehicle emissions from 3 pm one day until 9 am the next morning are trapped over the De Beque area. In addition, continuous space heating emissions are added to the vehicle emissions. The meteorological conditions assumed are a regional high pressure

Table 4.2-21 EMISSION ESTIMATES FROM SPACE HEATING FOR DE BEQUE (TONS/YR)

Year	No. of Houses	NO_x	SO_2	CO	HC	TSP
1982	70	0.32	0.002	0.08	0.03	0.02
1983	500	2.30	0.02	0.58	0.23	0.14
1984	1,150	5.29	0.04	1.32	0.53	0.33
1985	1,700	7.82	0.06	1.96	0.78	0.49
1986	1,700	7.82	0.06	1.96	0.78	0.49
1987	1,700	7.82	0.06	1.96	0.78	0.49
1988	1,150	5.29	0.04	1.32	0.53	0.33
1989	1,400	6.40	0.05	1.60	0.64	0.40
1990	5,400	24.84	0.19	6.21	2.48	1.55
1991	6,000	27.60	0.21	6.90	2.76	1.73
1992	6,200	28.52	0.21	7.13	2.85	1.78
1993	5,600	25.76	0.19	6.44	2.58	1.61
1994	4,700	21.62	0.16	5.41	2.16	1.35
1995	3,200	14.72	0.11	3.68	1.47	0.92
1996	3,200	14.72	0.11	3.68	1.47	0.92

Table 4.2-22 EMISSION ESTIMATES FROM SECONDARY TRANSPORTATION FOR DE BEQUE (TONS/YR)

Year	No. of Automobiles	NO_x	SO_2	CO	HC	TSP
1982	140	14.81	0.43	55.19	8.70	1.11
1983	1,000	105.82	3.04	394.12	62.17	7.94
1984	2,300	243.39	7.00	906.61	142.99	18.25
1985	3,400	359.79	10.34	1,340.21	211.38	26.98
1986	3,400	359.79	10.34	1,340.21	211.38	26.98
1987	3,400	359.79	10.34	1,340.21	211.38	26.98
1988	2,300	243.39	7.00	906.61	142.99	18.25
1989	2,800	296.30	8.52	1,103.70	174.07	22.22
1990	10,800	1,142.86	32.86	4,257.14	671.43	85.71
1991	12,000	1,269.84	36.51	4,730.16	746.03	95.24
1992	12,400	1,312.17	37.72	4,887.83	770.90	98.41
1993	11,200	1,185.19	34.07	4,414.82	696.30	88.89
1994	9,400	994.71	28.60	3,507.29	584.39	74.60
1995	6,400	677.25	19.47	2,522.75	347.88	50.79
1996	6,400	677.25	19.47	2,522.75	397.88	50.79

stagnation episode, with zero ventilation. Thus, pollutants emitted during the 18-hour period are assumed to accumulate over the town, and then be fumigated down to the ground and fill a well mixed box surrounding De Beque. A 32-square-mile area surrounding De Beque was assumed for the well mixed region. To add to the conservatism, the vertical extent of the mixed region was taken as only 200 meters (650 feet). The worst-case short-term concentrations were then calculated as the total amount of pollutant mass released during the period divided by the volume of the well mixed box as for the Grand Valley upgrading secondary growth estimates.

The uniform concentration estimates calculated using the above worst-case dispersion episode are 95, 3, 345, 55, and 7 μg/cu m for NO_x, SO_2, CO, HC, and TSP, respectively. Except for NO_x, these concentrations are at the level of natural background concentrations, and are insignificant. Extrapolating the NO_x concentration to an annual average using a factor of 0.06 (the ratio of the annual to 3-hour average SO_2 standard) results in a concentration of 6 μg/cu m, or only 6 percent of the annual NO_2 NAAQS. Thus, the NO_2 impacts are also expected to be insignificant.

Upgrading in Grand Valley

Data for addressing secondary impacts associated with the upgrading facility in Grand Valley and those associated with the mine and retorting facilities on Clear Creek mesa are discussed in the PSD application (Chevron 1982d,f) and are briefly summarized below. Table 4.2-23 presents secondary emissions related to project growth.

Construction and operation of the CCSOP in Grand Valley would result in a general area-wide population expansion and generate an increase in the emissions of air pollutants in the region, particularly in urban areas. For the purpose of the secondary air quality impacts associated with this facility, population forecast figures have been drawn from the upgrading PSD application (Chevron 1982f). The expected population increase is a function of the increased work force associated with the facility. The work force projection fluctuates throughout the life of the project, but peaks in 1993 at 2,000 additional jobs. Population increases can be estimated by assuming an average of one family unit per worker, or a total of 2,000 family units. It was assumed in the PSD application that 80 percent of these families will take up residence in the greater Grand Junction area, and 20 percent will live in Fruita and other smaller communities.

Table 4.2-23 SECONDARY EMISSIONS IN GRAND JUNCTION AND FRUITA FROM SECONDARY PROJECT-RELATED GROWTH (1993)

	(Tons/Year)				
	PM	SO_2	CO	VOC	NO_x
Grand Junction					
Space Heating	1	<1	2	1	9
Vehicle Exhaust	26	10	645	66	61
TOTAL	27	10	647	67	70
Fruita					
Space Heating	<1	<1	1	<1	2
Vehicle Exhaust	6	2	161	16	15
TOTAL	6	2	162	16	17

Two major emission sources will result from the projected population increase: (1) space heating and (2) vehicular exhaust. Space heating emissions were calculated by assuming each of the new 2,000 family units will be a residential user of natural gas and the average natural gas consumption will be 130,000 cubic feet per customer year (U.S. Department of Commerce 1979; EPA 1977b). Vehicle exhaust emissions were calculated using high altitude vehicle emission factors for NO_x, CO, and volatile organic compounds (VOC) (EPA 1978a) and EPA's compilation of air pollutant emission factors (1977b) for SO_2 and particulate matter. National average vehicle age mixes and mileage accumulation rates projected for the year 1993 were used (EPA 1978a). It was assumed that the 2,000 families operated two vehicles each, and that 75 percent of the vehicles were gasoline-powered automobiles, and 25 percent of the vehicles were light-duty gasoline-powered trucks (less than 6,000 lbs). Table 4.2-24 summarizes the 1993 projected emissions increase in Grand Junction and Fruita from secondary growth.

Air quality impacts from these emissions were calculated using box modeling techniques. Appendix B-2 of this EIS presents additional discussion on this methodology. Table 4.2-24 summarizes the results of the box model calculations. Impacts of PM, SO_2, and CO emissions for both Grand Junction and Fruita were estimated to be well below the EPA significance levels. Impacts of NO_x and VOC were also calculated to be very small, less than 1 μg/cu m. These results lead to the conclusion that secondary growth-related emissions associated with the proposed upgrading project should have minimal impacts on regional air quality, particularly in Grand Junction and Fruita. Some localized CO or TSP problems may occur, although none were predicted by the box model approach because the model approach was not significant enough to resolve these properly.

Table 4.2-24 AIR QUALITY IMPACTS FROM SECONDARY GROWTH-RELATED EMISSIONS IN GRAND JUNCTION AND FRUITA (1993) DUE TO UPGRADING FACILITY IN GRAND VALLEY

City	Pollutant	Averaging Time	Growth-Related Impact (μg/cu m)
Grand Junction	SO_2	3-hr	0.1
		24-hr	0.1
	PM	24-hr	0.1
	NO_2	1-hr	0.5
	CO	8-hr	3.3
		1-hr	4.4
	VOC	3-hr	0.5
Fruita	SO_2	3-hr	0.1
		24-hr	0.1
	PM	24-hr	0.1
	NO_2	1-hr	0.5
	CO	8-hr	3.3
		1-hr	4.4
	VOC	3-hr	0.5

Source: Chevron (1982f).

4.3 NOISE

4.3.1 General Impacts

A noise analysis has been performed based on estimated sound levels emitted from selected sources. Traffic noise estimates were based on peak hourly traffic levels per road segment. The road segments are the same as presented in Sections 3.3 and 3.13 for Noise and Transportation, respectively. Railroad noise calculations were based on estimated number of trains per day per railroad section. Calculations assume a sound exposure level of 90 dBA (decibels) at 50 feet for a passing train (BLM undated). The railroad sections are presented in Table 4.3-1 and illustrated in Figure 4.3-1. Noise levels for process equipment are estimated based on proposed activities and mining equipment noise levels quoted in other oil shale literature (Bechtel 1981).

The assessment area for noise impact analyses includes the project area and areas along road and railroad corridors associated with project alternatives. The area impacted for each corridor was calculated as the acreage enclosed by a 50 dB contour resulting from noise generated along the corridor.

It is assumed that three basic types of noise sources would be representative of each alternative. These sources are traffic, railroads, and process equipment. Only major sources are considered in this assessment as lesser sources would be masked by major sources and not contribute significantly to the overall noise level.

Construction noise is not treated as a source for analysis in this assessment. Noise generated during the construction phase is difficult to estimate and highly dependent on equipment used, work schedule, and duration. Major noise sources and corresponding untreated equipment noise levels during construction are shown in Table 4.3-2. All construction operations are assumed to be in compliance with the federal Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) regulations of occupational exposure. For this reason, and also because of the short duration relative to the project lifetime and the remote nature of the project, construction noise is anticipated not to have a significant environmental impact away from the disturbed area.

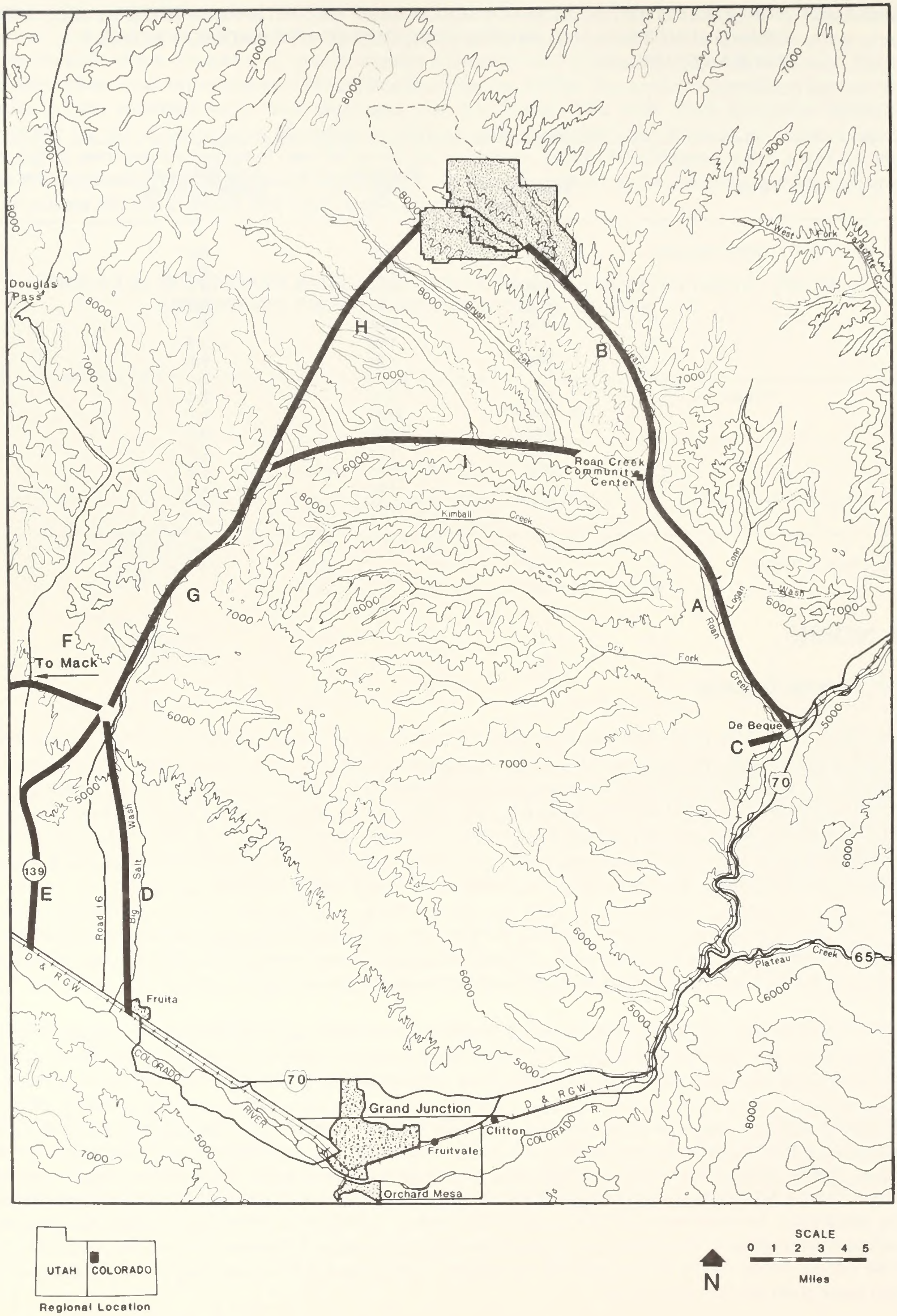


Figure 4.3-1 Railroad Segments Used for Noise Impact Analysis

Table 4.3-1 RAILROAD ANALYSIS SEGMENT DESCRIPTIONS

Railroad Segment	Location/Description	Length (miles)
A	From D&RGW RR[a] west of De Beque to confluence of Roan Creek and Clear Creek	13
B	From confluence of Clear Creek to Clear Creek mesa	12.5
C	Spur on D&RGW RR, 2.5 miles southwest of De Beque	0.6
D	From D&RGW RR at Fruita to Fruita plant site	11.6
E	From D&RGW RR at Loma to Fruita plant site	10.7
F	From D&RGW RR at Mack to Fruita plant site	12.5
G	From Fruita plant site to Roan Creek tunnel	11.6
H	From west end of Roan Creek tunnel to Clear Creek mesa	14.1
I	From Roan Creek Tunnel to confluence of Clear Creek	14.8

[a] D&RGW = Denver and Rio Grande Western Railroad

Table 4.3-2 CONSTRUCTION NOISE LEVELS FROM TYPICAL EQUIPMENT WITHOUT NOISE CONTROLS

Equipment	At Operator Position	At 50 Feet
Earth-Moving Equipment	80-105 dBA	75-95 dBA
Drilling	95-112 dBA	80-97 dBA
Blasting	90-140 dB[a]	135 dB

Source: Bechtel (1981).

[a] Peak sound pressure levels.

Project equipment is also not treated on an individual alternative basis. Specific locations of the process equipment is not critical from a noise standpoint. Based on the large area required for the plant and the remote site locations, process equipment noise impact would be approximately equivalent for all CCSOP alternatives. Noise would be generated by mining and processing equipment during facility operations. Typical noise levels associated with both types of uncontrolled equipment are presented in Tables 4.3-3 and 4.3-4. OSHA and MSHA regulations would be complied with during all operations.

The CCSOP has been designed using good engineering noise control practices (e.g., partitions and/or insulation) where required and wherever practical. The major operational noise sources would be the shale crushers and screens; these would be enclosed for noise shielding. The untreated sound levels presented in Table 4.3-2 greatly overestimate the anticipated levels. This approach was utilized as actual sound levels are not available for

Table 4.3-3 MINING NOISE LEVELS FROM TYPICAL EQUIPMENT WITHOUT NOISE CONTROLS

Equipment	At Operator Position (dBA)
Drills	80-104
Scalers	85-103
Roof Bolters	85-106
Loaders	85-108
Blasting	(90-140 dB peak)
Trucks	85-98
Crushers	105-115
Vibrating Screens	95-110
Ventilation Fans	70-95[a]

Source: Bechtel (1981).

[a] No operators, noise level at 50 feet.

Table 4.3-4 PROCESSING NOISE LEVELS FROM TYPICAL EQUIPMENT WITHOUT NOISE CONTROLS

Equipment	At 3 feet (dBA)
Atmospheric Relief and Vent Valves	100-140
Control Valves and Piping Systems	80-100
Cooling Towers and Forced-Draft Coolers	85-95
Blowers and Fans	85-110
Compressors	95-110
Pumps	80-105
Motors	80-105
Gears	80-100
Solids Conveyance Equipment	75-115
Rock Crushers	100-110
Vibrating Screens	100-110
Trucks	90-110
Steam Turbine	85-95
Flares	110-130

Source: Bechtel (1981).

analysis. Based on the untreated noise levels, calculations of point noise source spreading indicate operational noise would not have a significant impact away from the project site.

Noise from blasting operations is expected to carry off-site and contribute to noise impacts. There is insufficient information to quantify such a component, since charge placement and size would greatly affect the noise generated. Blasting would take place at the end of a shift for the underground and open pit mines. Blasting would occur three times per day for the underground mine; one time per day for the open pit mine. Sequential detonation would be utilized to enhance fragmentation and reduce air concussions, noise level, and ground vibrations (Chevron 1982c). Qualitatively, blasting noise would rate as a low adverse impact.

Increases in noise levels would affect individuals living or working within approximately 500 feet of the railroad lines or affected road segments. Additional adverse effects would be observed by these persons seeking recreational activities (hunting, hiking, etc.) near the CCSOP facilities. Potential impacts associated with noise include possible minor physiological reactions, behavioral interferences with work, sleep, or hearing, as well as subjective effects including irritation and annoyance. Increased noise levels could also affect animals living on or near proposed facilities and transporation corridors (BLM 1980g). Effects on animals may be short-term duration due to the potential for adaption.

Discussion of noise impacts presented below contain traffic and railroad-generated noise by alternatives.

4.3.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action (PA-100)

Traffic noise levels estimated for the Proposed Action are presented in Table 4.3-5. Traffic densities used in these calculations are as projected in the transportation impact analyses (see Tables 3.13-2 and 4.13-3 to 4.13-11). Table 4.3-6 presents the increased noise levels above background. Noise levels for road segments A through H and 16 Road would not be significantly different from background levels (3 dBA change is considered significant). Roan Creek road is affected for both of the sub-alternatives presented.

Table 4.3-7 presents a comparison of the two options for Roan Creek road as distance to the 50 dBA contour line, area impacted, sensitive receptors, and noise levels at these receptors. Sensitive receptors were identified from recent 1:50,000 scale USGS topographical maps. For perspective, typical household noise levels are in the range of 45 to 65 dBA (EPA 1978b). The average individual would probably not be able to detect the increase in noise indoors, based on the equivalent sound level. In reality, noise variations due to traffic from the CCSOP would be perceptible but should not be obtrusive.

Table 4.3-5 TRAFFIC NOISE LEVELS (L_{eq})[a] FOR PROPOSED ACTION

Road Segment	Decibel Level (dBA) at 50 feet, by year								
	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	74	75	76	76	77	77	78	79	81
B	76	77	78	79	79	79	79	80	83
C	76	77	79	79	79	79	80	80	83
D	76	77	79	79	80	80	80	80	83
E	76	77	78	79	79	79	80	80	83
F	72	73	73	74	75	75	75	76	79
G	82	83	83	83	84	84	85	85	87
H	76	77	78	79	79	79	79	79	83
RCRa[b]	46	69	72	73	72	72	72	72	72
RCRb[c]	74	76	78	78	78	78	78	78	78
16 Road	46	47	47	47	47	47	48	48	49

[a] L_{eq}: Equivalent Sound Level

[b] RCRa: Roan Creek Road from De Beque to Clear Creek mesa, subalternative with commuter traffic.

[c] RCRb: Roan Creek Road from De Beque to Clear Creek mesa, subalternative with commuter traffic plus trucks hauling supplies to plant.

Table 4.3-6 INCREASE IN TRAFFIC NOISE (dBA)[a] DUE TO PROPOSED ACTION

Road Segment	Increase in Traffic Noise (dBA) at 50 feet, By Year								
	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	0	0	0	0	0	0	0	0	0
B	0	0	1	1	0	0	0	0	0
C	0	0	2	1	0	0	1	0	0
D	0	0	2	0	1	1	0	0	0
E	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0
RCRa[b]	0	23	25	26	25	25	24	24	23
RCRb[c]	28	30	31	31	31	31	30	30	29
16 Road	0	0	0	0	0	0	0	0	0

[a] dBA: Decibels
[b] RCRa: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic.
[c] RCRb: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic plus trucks hauling supplies to plant.

Table 4.3-7 TRAFFIC NOISE IMPACT FOR THE PROPOSED ACTION

Road Segment	Distance to 50 dBA Contour (feet)	Area of Impact (acres)	Sensitive Receptors	Noise Level (dBA) at Receptor	
				Outdoor	Indoor[a]
RCRa[b]	1,050	6,600	7 houses and Roan Creek Comm. Center	60-65	45-50
			3 houses	55-60	40-45
			3 houses	50-55	35-40
RCRb[c]	2,450	15,450	7 houses and Roan Creek Comm. Center	65-70	50-55
			6 houses	60-65	45-50
			11 houses	50-55	35-40

[a] Assuming 15 dBA alternation from outdoors to indoors. Range of typical attenuation is 12 to 27 dBA (EPA 1978).
[b] RCRa: Roan Creek from De Beque to Clear Creek plant site, subalternative with commuter traffic.
[c] RCRb: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic plus trucks hauling supplies to plant.

Railroad segments A, B, and C (see Table 4.3-1) are the sections analyzed for the Proposed Action. Table 4.3-8 presents the predicted impacts for the Proposed Action. Segments A and B are combined as an alternative to transport supplies to the Clear Creek plant site. Section C represents a spur to be used with the alternative of using trucks to transport the supplies from the railhead to the plant. Due to the low frequency, penetrating rumble of the trains, the higher noise levels shown in Table 4.3-8 may be objectionable to some individuals.

The noise levels associated with the Proposed Action rate as a low adverse impact. It must be noted, however, that noise impact is highly specific to individuals. Many people living in remote areas of western Colorado are there primarily because it is remote, and may very likely view any increase in noise as medium-to-high adverse impact.

Clear Creek Alternative (CC-100)

The noise impact is identical to the Proposed Action at this level of analysis.

Table 4.3-8 RAILROAD NOISE IMPACT FOR PROPOSED ACTION

Railroad Segment	Trains per day	Distance to 50 dBA Contour (ft)	Area of Impact (acres)	Sensitive Receptors	Noise Level (dBA) at Receptor	
					Outdoor	Indoor
A + B	3	3,700	23,750	1 house	70-75	55-60
				7 houses	65-70	50-55
				6 houses and Roan Creek Comm. Center	60-65	45-50
				8 houses	55-60	40-45
				3 houses	50-55	35-40
C	3	1,850	500	None identified within 50 dBA contour		

Production Rate Alternatives (PA-50, CC-50)

Noise impacts associated with a 50,000 bpd facility located on the mesa should be slightly less than for a 100,000 bpd facility. With the elimination of the surface mine, construction and operational noise would decrease. Traffic projections indicate that increased noise levels on segments RCR_a and RCR_b should be somewhat reduced. However, as noted in Section 4.3.2.1, these values indicate a low adverse impact even at 100,000 bpd.

4.3.3 Grand Valley and Associated Siting Activities

Fruita I Alternative (FI-100, FI-50)

Tables 4.3-9, 4.3-10 and 4.3-11 present traffic noise levels, noise increases and impacts, respectively, for the FI-100 Alternative. Traffic densities, as for the Proposed Action, are as presented in the Energy and Transportation impact analyses (see Tables 4.13-7, 4.13-8, and 4.13-9).

Table 4.3-9 TRAFFIC NOISE LEVELS (L_{eq}) FOR FRUITA I ALTERNATIVE

Road Segment	Decibel Level (dBA) at 50 feet, By Year								
	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	74	76	76	77	77	78	79	79	81
B	76	77	78	79	79	79	80	80	83
C	76	77	78	79	79	79	80	80	83
D	76	77	78	79	79	79	80	80	83
E	76	77	78	79	79	79	80	80	83
F	72	73	73	74	75	75	75	76	79
G	82	83	83	83	84	84	85	85	87
H	76	77	78	79	79	79	79	79	83
RCRa[a]	46	66	68	71	69	69	69	69	69
RCRb[b]	46	75	76	77	76	76	76	76	76
Road 16	46	66	69	71	71	71	71	71	71

[a] RCRa: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic only.
[b] RCRb: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic plus trucks hauling supplies to plant.

Railroad noise impact is presented in Table 4.3-12 for segments A & B and for D, E, and F. Segments D, E and F represent alternatives for shipping materials to and from the Fruita plant site. It is anticipated that only one of the three routes would be implemented.

Noise levels associated with the FI-50 Alternative rate as a low adverse impact. Traffic noise at sensitive receptors would be barely preceptible to most individuals indoors, with railroad noise slightly more noticeable.

Fruita II Alternative (FII-50)

Ultimate traffic noise impacts are assumed to be nearly equal to those presented for the FI-50 alternative.

Table 4.3-13 presents railroad noise impacts for this alternative. Railroad segments A + B represent material transportation to the mine site while segments D, E and F represent alternatives for transport of materials to the Fruita plant site. Segments G + H and G + I + B represent alternatives for transport of oil shale to the Fruita plant site and spent shale back to the Clear Creek mesa plant site.

Noise levels from segments A + B and D, E or F would present very slight adverse impacts. However, segments G + H and G + I + B represent higher disturbances, giving the Fruita II alternative a moderately adverse noise impact rating.

4.3.4 Alternative Siting Activities

Noise impacts for alternative corridors are addressed above.

Table 4.3-10 INCREASE IN TRAFFIC NOISE DUE TO FRUITA I ALTERNATIVE

Road Segment	Increase in Traffic Noise (dBA) at 50 feet, By Year								
	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	0	1	0	1	0	1	1	0	0
B	0	0	1	1	0	0	1	0	0
C	0	0	1	1	0	0	1	0	0
D	0	0	1	0	0	0	0	0	0
E	0	0	1	1	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0
RCRa[a]	0	20	21	24	22	22	21	21	20
RCRb[b]	0	29	29	30	29	29	28	28	27
16 Road	0	19	22	24	24	24	23	23	22

[a] RCRa: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic.
[b] RCRb: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic plus trucks hauling supplies to plant.

Table 4.3-11 TRAFFIC NOISE IMPACT FOR FRUITA I ALTERNATIVE

Road Segment	Distance to 50 dBA Contour (ft)	Area of Impact (acres)	Sensitive Receptors	Noise Level (dBA) at Receptor	
				Outdoor	Indoor
RCRa[a]	700	4,350	10 houses and Roan Creek Comm. Center	55-60	40-45
			3 houses	50-55	35-40
RCRb[b]	1,850	11,650	7 houses and Roan Creek Comm. Center	65-70	50-55
			6 houses	60-65	45-50
			9 houses	50-55	35-40
Road 16	900	2,650	18 houses	60-65	45-50
			3 houses	55-60	40-45
			2 houses	50-55	35-40

[a] RCRa: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic.
[b] RCRb: Roan Creek Road from De Beque to Clear Creek plant site, subalternative with commuter traffic plus trucks hauling supplies to plant.

Table 4.3-12 RAILROAD NOISE IMPACT FOR FRUITA I ALTERNATIVE

Railroad Segment	Trains per day	Distance to 50 dBA Contour (ft)	Area of Impact (acres)	Sensitive Receptors	Noise Level (dBA) at Receptor	
					Outside	Inside
A + B	2	2,850	18,350	7 houses and Roan Creek Comm. Center	70-75	55-60
				3 houses	65-70	50-55
				3 houses	60-65	45-50
				7 houses	55-60	40-45
				4 houses	50-55	35-40
D[a]	2	2,850	8,700	1 house	70-75	55-60
				4 houses	65-70	50-55
				7 houses	60-65	45-50
				22 houses	55-60	40-45
				30 houses	50-55	35-40
E[b]	2	2,850	8,050	17 houses	70-75	55-60
				2 houses	65-70	50-55
				8 houses	55-60	40-45
				22 houses	50-55	35-40
F[c]	2	2,850	9,300	1 house	60-65	45-50
				3 houses	55-60	40-45
				9 houses	50-55	35-40

[a] Approximately 230 other houses in Fruita, at least 1 church, and 1 school are within the 50 dBA contour, but noise due to Fruita I Alternative is masked by DRGW railroad noise.
[b] 31 other houses, 1 church, and 1 school are within the 50 dBA contour, but noise due to Fruita I Alternative is masked by DRGW railroad noise.
[c] 3 other houses are within the 50 dBA contour, but noise due to Fruita I Alternative is masked by DRGW railroad noise.

With regards to spent shale disposal, noise levels and time intervals are not dependent on location. Therefore noise impacts would be the same as the Mesa Valley Fill spent shale disposal, which is very low adverse impact.

4.3.5 Transportation Alternatives

Using trains to transport coal for the alternatives would call for one train a day running approximately 26 miles. This has been assessed as low adverse impact. Use of trucks would require 540 trucks a day, increasing the noise to a moderate adverse impact.

4.3.6 Hazardous Waste Disposal

On-site disposal of hazardous waste would not create additional noise impacts.

4.3.7 Secondary Impacts

Secondary noise impacts related to increased population in the region is not quantifiable, but some general statements can be made. Noise impacts related to traffic increases (the major secondary noise source) should be diffuse and of low adverse impact. Additional railroad and construction noises would occur in the region to accompany the increased populations. Most of these impacts should be of short duration and temporary, although major project construction (e.g. a shopping center) or frequent train traffic could cause local adverse impacts of some importance.

Table 4.3-13 RAILROAD NOISE IMPACT FOR FRUITA II ALTERNATIVE

Railroad Segment	Trains per day	Distance to 50 dBA Contour (ft)	Area of Impact (acres)	Sensitive Receptors	Noise Level (dBA) at Receptor	
					Outdoor	Indoor
A + B	1	1,900	11,950	1 house	65-70	50-55
				7 houses	60-65	45-50
				6 houses and Roan Creek Comm. Center	55-60	40-55
				8 houses	50-55	35-40
D	2	See Fruita I Alternative Table 4.3-12				
E	2	See Fruita I Alternative Table 4.3-12				
F	2	See Fruita I Alternative Table 4.3-12				
G + H	8	6,590	40,300	1 house	80-85	65-70
				1 house	75-80	60-65
				1 house	70-75	55-60
				2 houses	65-76	50-55
				4 houses	60-65	45-50
				2 houses	55-60	40-45
				3 houses	50-55	35-40
G + I + B	8	6,590	63,000	2 houses and Roan Creek Comm. Center	80-85	65-70
				6 houses	75-80	60-65
				6 houses	70-75	55-60
				4 houses	65-70	50-55
				2 houses	60-65	45-50
				3 houses	55-60	40-45
				6 houses	50-55	35-40

4.4 Water Resources

4.4.1 Surface Water

4.4.1.1 General Impacts

Major surface water impacts due to development of the CCSOP relate primarily to water quantity, water quality, and changes in the physical configurations of drainage channels. Water withdrawals from surface streams could deplete stream flow of the Colorado River and increase salinity, especially during low flow periods. Water storage reservoirs may pose potential hazards to downstream communities if dam failure occurs. Surface mining may alter stream channels and mine through springs and seeps. Specific CCSOP impacts on surface water may include increases in total suspended solids, total dissolved solids, sedimentation, and peak flows of storm runoff events.

Spent shale disposal may pose potential water quality impacts to Clear Creek and Big Salt Wash due to leachates and surface runoff from the spent shale pile. Runoff storage reservoirs could reduce stream flows and cause stream channel disruption due to water releases from runoff events larger than the design runoff events.

Withdrawals of ground water from alluvial aquifers could deplete stream flows of Roan Creek. Construction of various pipelines and corridors could cause stream flow disruption at the stream crossing and increase the potential of soil erosion and sedimentation.

Accidental spills and leakage from syncrude pipelines may pollute streams crossed by the pipeline. Finally, facility construction (e.g., pipeline, access road, site development) could disturb numerous acres of watershed, causing potential increases in soil erosion and flood flows.

The above general impacts are discussed below as they relate specifically to Clear Creek mesa and Grand Valley activities.

4.4.1.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action (PA-100)

Surface Mine. Surface mine development (including overburden disposal) would disturb a total of 8,400 acres of land for approximately 90 years (Moore 1982c). The drainages that would be disturbed include Mud Springs Creek, Cottonwood Creek, No Name Creek, Willow Creek, East Willow Creek, and West Willow Creek. A total of 16 springs and seeps which contribute to the stream flow of these drainages would be mined through and eliminated (Figure 4.4-1; Table 4.4-1). Each spring or seep contributes an estimated flow of less than 0.1 cubic feet per second (cfs) to the stream channels. The impacts of disturbance of springs and seeps on stream flows could be significant during low flow periods. In addition, the stream channels of Mud Spring Creek, Cottonwood Creek, No Name Creek, and Willow Creek would be completely altered as a result of surface mining. Segments of East Willow Creek and West Willow Creek within the Clear Creek property would also be mined through. These drainages contribute about 8.7 percent of Clear Creek flows at station CJ-23 according to 1981 water year stream flow data (Chevron 1982h).

The surface runoff management plan for the surface mine is designed to (1) collect all water passing through mined and disturbed areas in sedimentation reservoirs (Figure 4.4-2), (2) retain and divert surface runoff upstream of the mine site to avoid interruptions of mining activities, and (3) collect all off-site drainage and route it around the mining areas. This management plan should minimize any flood hazard to the mining operation.

It is estimated that soil erosion prior to reclamation activities would be 64 acre-feet per year (Moore 1982c). Revegetation to cover the area of disturbed land and waste piles should start as early as possible. The sedimentation reservoir, which would be constructed in Clear Creek canyon below the confluence of Willow Creek, has a design dead storage capacity of 90 acre-feet for annual sediment storage (Chevron 1982i). The sedimentation reservoir is designed as a zero discharge system and the stored water would be used for dust control. Sediment stored in the reservoir would be removed on a regular basis to increase its storage capacity and to decrease the likelihood of uncontrolled releases of sediment-laden water during major runoff events.

It is difficult to predict the quality of the surface runoff from the mine site and disturbed areas. However, water in contact with the mine area would likely be high in total suspended solids. Mine water from the south side of the open pit backfill would be routed to the plant water treatment system. The remaining runoff water would be diverted to the sedimentation reservoir to settle out suspended solids. The potential impact on water quality in lower Clear Creek would be minimal except during high runoff events. The release of reservoir water during overflow may contribute to the suspended solids of stream flows.

Underground Mine. The underground mine would cover an area of 3,600 acres at an average depth of 600 feet below ground level. Surface disturbance would be limited to 15 acres. The impacts on the drainage basin, water quality, and water quantity would be minimal provided that an appropriate runoff diversion scheme around the disturbed area is planned.

Plant Site. Plant site development would require excavation, fill, and embankment placement for the feed stock preparation facilities, retort units, upgrading facilities, and other support facilities. The total disturbed area

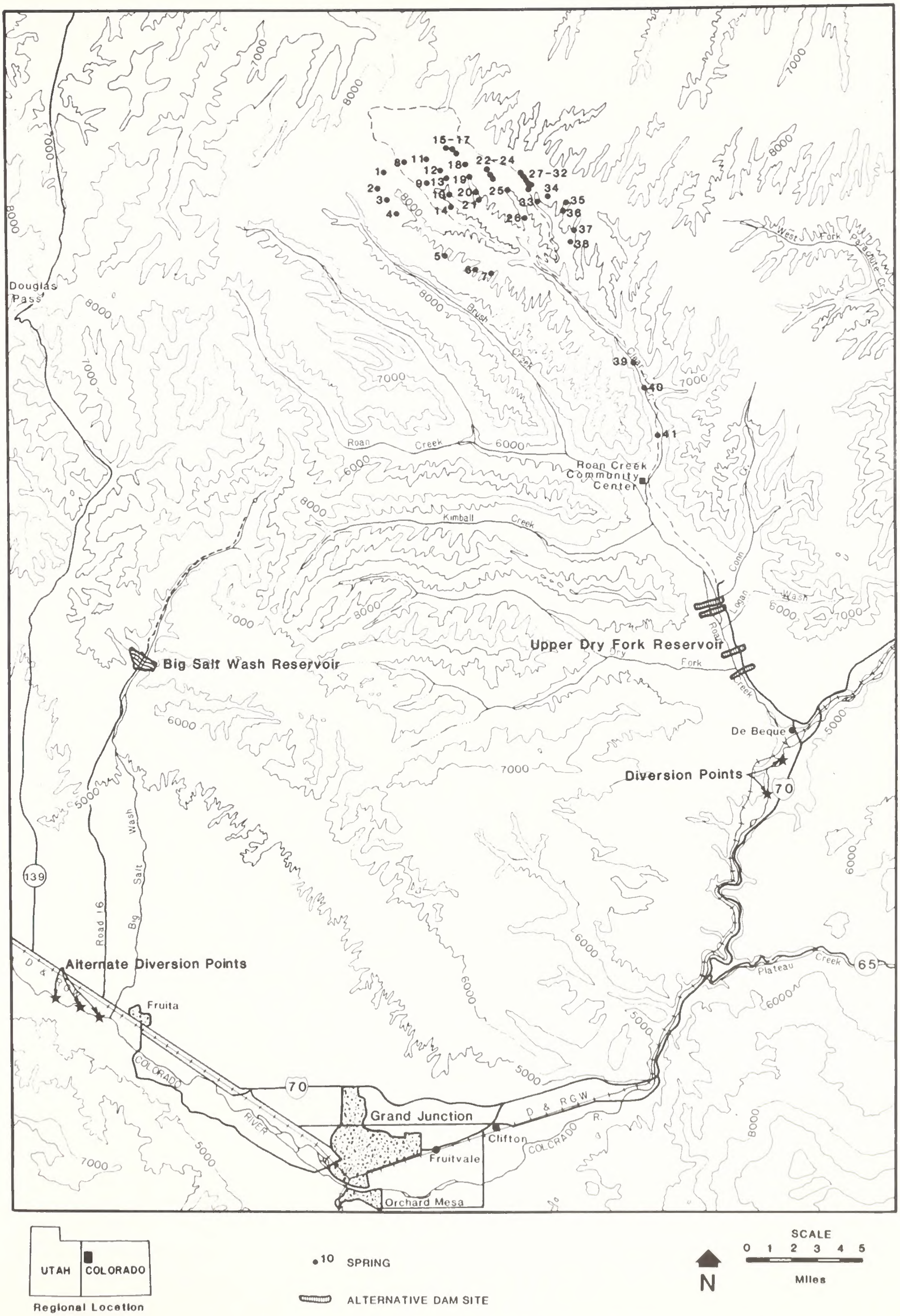


Figure 4.4-1 Location of Springs, Alternative Diversion Points, and Dam Sites

Table 4.4-1 IDENTIFIED SPRINGS AND SEEPS WITHIN THE CLEAR CREEK PROPERTY BOUNDARY THAT WILL BE AFFECTED BY MINING[a]

Identification	Elevation (ft)	Approximate Flow (cfs)	Comments
CS-14	8,120	0.1	Seep
CS-19	7,990	0.1	Seep emerging from rate shelf
CS-20	7,940	0.1	Undeveloped spring
CS-21	7,940	0.1	Undeveloped spring
CS-22	8,110	0.1	Seep
CS-23	8,120	0.1	Developed spring
CS-24	8,100	0.1	Developed spring
CS-25	7,990	0.1	Seep
CS-26	7,760	0.1	Seep
CS-29	8,020	0.1	Large, well defined seep
CS-30	8,020	0.1	Concentrated seep
CS-31	8,020	0.1	Multiple springs
CS-32	8,030	0.1	Seeps
CS-33	7,960	0.1	Small spring
CS-34	8,030	0.1	Two small seeps
CS-38	7,740	0.1	Multiple seeps

Source: Chevron (1982h)

[a] Majority of visible springs and seeps were identified during helicopter flights and ocular estimates of flow contribution were made during 1981.

around the plant site would encompass 850 acres. Soil erosion due to runoff event' vould be a main concern during the construction and operation stages. The quality of runoff water from the plant site can be best estimated by the known quality of runoff water from a Chevron refinery, as shown in Table 4.4-2 (Moore 1982f). Concentrations of calcium, bicarbonate, and sulfate are relatively high when compared with other parameters.

In addition, wastewater generated from the process plant and ancillary facilities would include effluent from the oil separation unit, cooling tower and boiler blowdown, clarifier sludge, filtration backwash, demineralizer waste, wash waters from boiler feedwater treatment, sour water from retort and upgrading facilities, and sanitary wastewater. All collected waters would be sent through the water treatment system before being released into the sediment reservoir on Clear Creek. Water quality impacts on streams would be minimal. The only possible impact might be due to a spill of water containing oil from the process area drainage pond and API surge basin. This impact can be minimized by appropriate spill prevention and mitigation measures as required by the EPA.

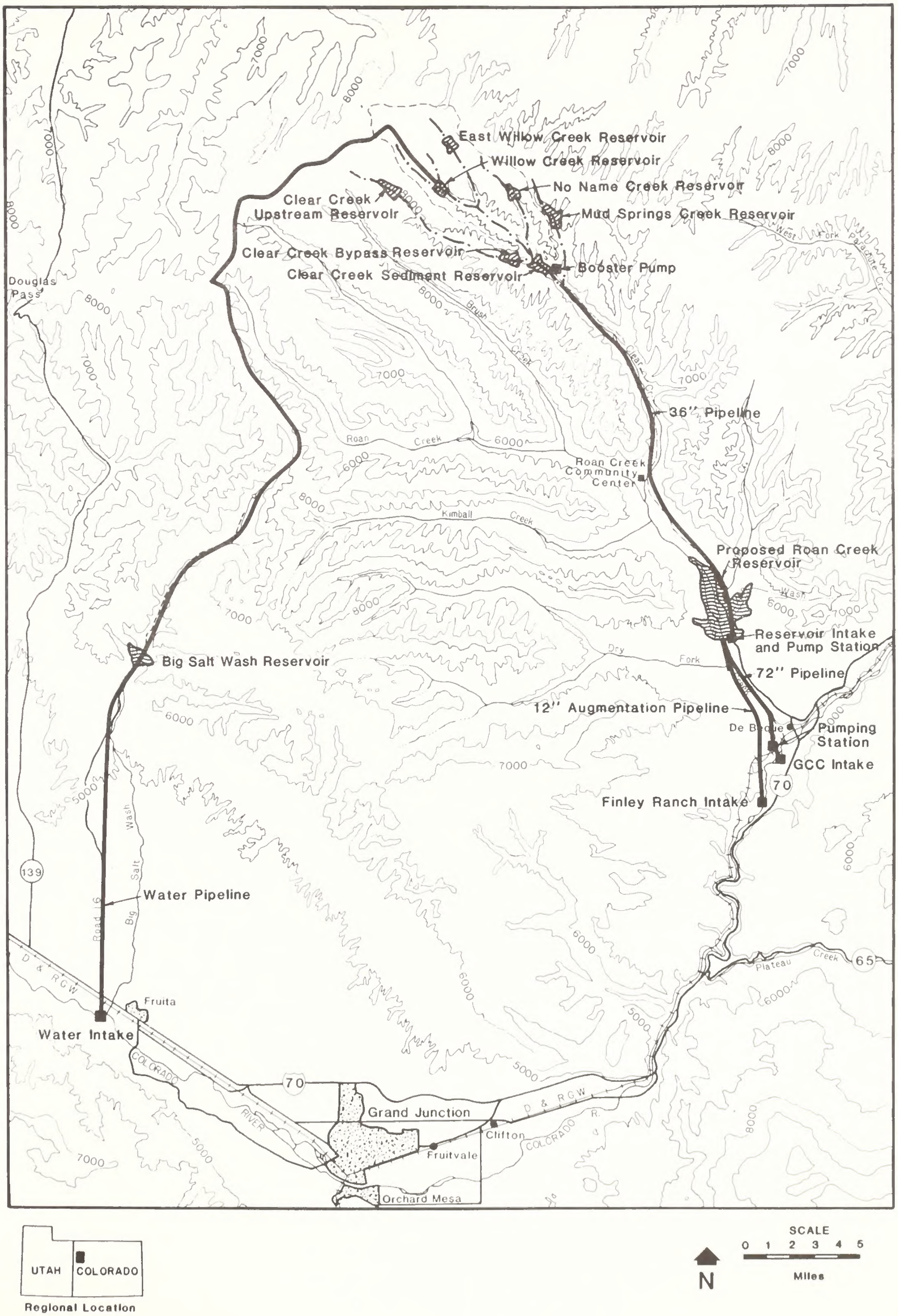


Figure 4.4-2 Location of Proposed CCSOP Water Facilities

Table 4.4-2 SURFACE RUNOFF WATER QUALITY FROM A CHEVRON REFINERY

Parameters	Concentration Range (ppm)
Sodium	5 - 70
Calcium	17 - 135
Magnesium	5 - 26
Potassium	3 - 69
Carbonate	240
Bicarbonate	88 - 451
Nitrate	1 - 4
Sulfate	8 - 375
Chloride	5 - 40
Sodium Adsorption Ratio	0.2 - 0.8

Source: Moore (1982f).

Corridors. Impacts on water resources due to construction of all corridors may be significant during the short term. Soil erosion/sedimentation and stream flow disruption are expected, especially at the intersections of corridor crossings and stream drainageways. These corridors would cross numerous washes, creeks, and streams. Table 4.4-3 lists the names and types of the drainages that would be affected by the various corridors. The Roan Creek, Big Salt Wash, and Parachute Creek corridors would disturb two perennial (Colorado River and Roan Creek), seven intermittent, and two ephemeral streams.

An accidental spill is a possible impact of the syncrude pipeline on the environment. The spill volume, frequency, and rate of discharge depend on the pipeline length and operation year of the pipeline. The national average annual accident rate is about 0.001 accidents per mile of pipeline (BLM 1981c). Based on the La Sal syncrude pipeline length of approximately 27-28 miles, the average leak frequency would be on the order of one leakage every 35 years (or 0.028 accidents per year) for the system. Using the projected throughflow of 36.5 million barrels per year at 100,000 bpd, the predicted total spills in a given year would be approximately 130 barrels, based on the formula developed by Beyer and Painter (BLM 1981c). The average spill size would be about four barrels based on the spill frequency of 0.028 spills per year. The spilled oil may damage vegetation, contaminate soils, or pollute stream water. Such an event could occur as a result of accidental damage during excavation near the alignment, improper operation, stream washouts, geological hazards, or sabotage. The watersheds that could be affected due to leakage include West Fork Parachute Creek, Clear Creek, Willow Creek, Wolf Creek, and Wiesse Creek.

Upper Dry Fork Reservoir. As explained in Section 2.3, a full scale GCC joint venture facility would be required to meet Phase II commercial shale oil production. The Roan Creek reservoir (Upper Dry Fork site) would be constructed to provide the necessary storage capacity for the GCC water supplies. The reservoir would be built under a plan of staged construction. The first stage storage capacity of this reservoir would most likely be in the range of 30,000-70,000 acre-feet. However, the ultimate storage capacity could be as much as 175,000 acre-feet, depending on future needs.

Table 4.4-3 LOCATION AND STREAM TYPE OF DRAINAGES AFFECTED BY CCSOP CORRIDORS

Corridors	Affected Stream	Stream Type
Roan Creek - De Beque to Clear Creek Mesa	Colorado River	Perennial
	Roan Creek	Perennial
	Clear Creek	Intermittent
	Cottonwood Creek	Intermittent
Big Salt Wash - Fruita to Clear Creek Mesa	Colorado River	Perennial
	Big Salt Wash	Intermittent
	Grand Valley Canal	Irrigation Canal
	East Branch Reed Wash	Ephemeral
	Coyote Wash	Ephemeral
La Sal - Clear Creek Mesa to Davis Point	West Fork of Parachute Creek	Intermittent
	Wolf Creek	Intermittent
	West Willow Creek	Intermittent
	East Willow Creek	Intermittent
Rangley A Corridor	Soldier Creek	Perennial
	Lake Creek	Perennial
	Cathedral Creek	Intermittent
	East Douglas Creek	Perennial
	White River	Perennial
	Douglas Creek	Perennial
Rangely B Corridor	Douglas Creek	Perennial
	White River	Perennial
SOPS Syncrude Pipeline Lisbon Connection	Clear Creek	Intermittent
	Buck Gulch	Ephemeral
	Wiesse Creek	Intermittent
	Sheep Gulch	Ephemeral
Douglas Pass Road Multi-Purpose Corridor	Coyote Wash	Ephemeral
	Reed Wash	Ephemeral
	Grand Valley Canal	Irrigation Ditch
	Mack Wash	Ephemeral
Dorchester Railroad Alternative	East Salt Creek	Intermittent
	Mack Wash	Ephemeral
	Coyote Wash	Ephemeral
Big Salt Wash to SOPS Syncrude Pipeline	East Salt Creek	Intermittent
	Mack Wash	Ephemeral
	Coyote Wash	Ephemeral
	Dry Canyon Wash	Ephemeral
Roan Creek Railroad Corridor	Roan Creek	Perennial

To estimate the possible effects of diverting stream flow from the Colorado River, a worst-case flow analysis was performed for the Colorado River near De Beque. The mean annual flow of the Colorado River near De Beque is 2,612,000 acre-feet (Table 3.4-1). Based on an estimated maximum annual water withdrawal (72,000 acre-feet/year) for the GCC joint venture, plus the water required to fill the ultimate reservoir storage (175,000 acre-feet), approximately 10 percent of the mean annual flow could be diverted. During low flow, water may not be available for diversion from the Colorado River to the storage reservoir on Roan Creek due to the relatively junior status of GCC's direct diversion appropriations. Senior water users downstream of the proposed diversion would have a decreed prior right to water use.

Salinity is currently a problem within the Colorado River Basin. The operation of the proposed water supply reservoir may increase salinity in the Colorado River. As a result of the diversion and consumptive use of stream flow, the salt load would be concentrated in a smaller volume of water. Based on the rate of diversion withdrawal and stream discharge the concentration of dissolved solids would vary.

The potential impact of stream diversions on salinity concentrations in the Colorado River is presented in Figure 4.4-3. The formula used in calculating the salinity changes was obtained from the U.S. Bureau of Reclamation (USDI 1982). Assuming the worst-case condition of 250,000 acre-feet/year water withdrawal (sum of Roan Creek reservoir storage of 175,000 acre-feet and GCC annual withdrawal of 72,000 acre-feet), salinity of the Colorado River at the Imperial Dam in the year 2010 would have increased by approximately 17.23 milligrams/liter (mg/l). Based on the projected water uses of 24,000 acre-feet/year (66 acre-feet/day) for the CCSOP and 72,000 acre-feet/year for the GCC joint venture, salinity would increase by 1.6 mg/l and 4.8 mg/l, respectively.

The operation of a water storage reservoir on Roan Creek may have positive impacts on the water quality of Roan Creek downstream of the reservoir site. Changes in water quality may include decreased concentrations of bacteria, dissolved solids, and suspended sediment (Hannan 1979). These changes would be dependent upon the size and depth of the reservoir and the quality of the influent stream flow. Also, minor stream channel configuration changes may occur upstream and downstream of the reservoir site. Upstream of the reservoir, sediment could be deposited along the channel, while the channel below the dam site could be degraded due to the increased erosivity of the stream flow (EPA 1975; Simons 1979).

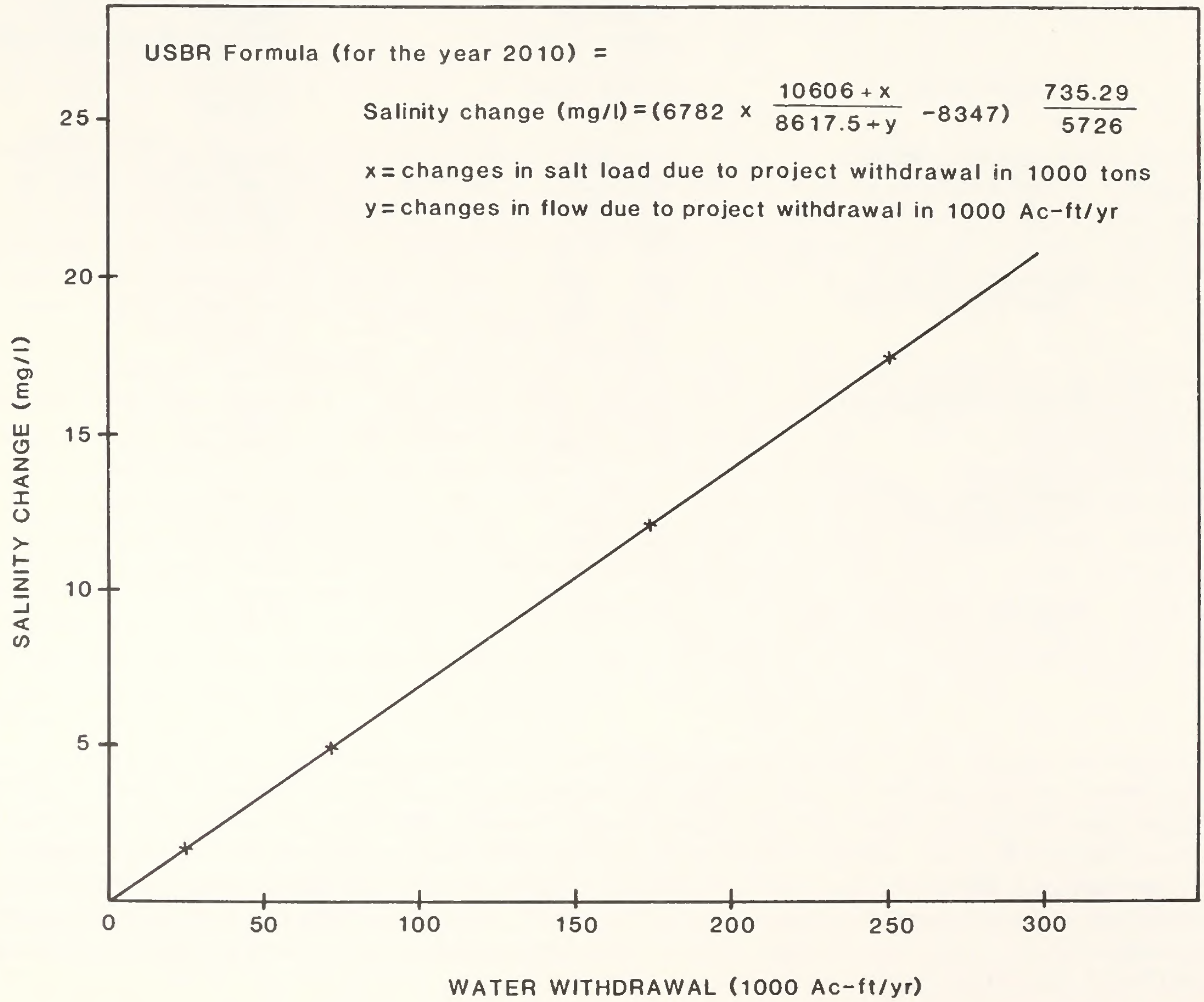


Figure 4.4-3 Discharge vs. Salinity for the Colorado River During the Period 1973-1980

In addition to the potential hydrologic impacts of the proposed storage reservoir, the actual operation of the reservoir may pose a safety concern for the downstream inhabitants of De Beque. The proposed dam would be constructed as zoned earth-fill with underseepage control, an emergency spillway, and a gated outlet-works.

The probability of the storage reservoir dam being breached due to structural failure is small. The probability of failure of a specific dam is difficult to assess precisely; it is dependent on the conditions of dam design, construction, maintenance, operation, and foundation materials. The historical records support an average annual probability of about 10^{-4} failures per dam year for major projects in the United States (Baecher et al. 1980).

To simulate the failure of the proposed dam at the Upper Dry Fork site, a storage volume of 175,000 acre-feet and dam height of 205 feet were assumed. It is estimated that the peak discharge under the totally breached condition would be 1.32×10^6 cfs. The mean velocity of the flow was estimated to be 15.1 feet/second with a travel time for the peak discharge, from the dam site to De Beque, of approximately 23 minutes.

The peak discharge was routed through four cross sections downstream of the dam to determine flood stage. At peak discharge the width of the flood zone would range from 1,700 to 6,700 feet and cover a significant portion of the lowland valley. Flow depths within the floodplain would range from 26 to 33 feet. At De Beque (4 miles downstream of the dam site), the mean depth of flow through the town would range from 25 to 35 feet with a mean flow velocity of approximately 4.3 feet/second.

Big Salt Wash Reservoir. The Big Salt Wash storage reservoir would be located on Big Salt Wash downstream of the Garvey Canyon confluence, approximately 15 miles north of Fruita. The proposed dam would have a maximum height of 165 feet and a length of 1,700 feet. The total capacity of the reservoir at the spillway crest would be 12,000 acre-feet, with an active capacity of 10,000 acre-feet.

Water stored in the reservoir would be diverted from the Colorado River at a point near the town of Loma. No historical discharge records exist for the Colorado River near Loma or Fruita. Based on the stream flow records for the Colorado River near the Colorado-Utah state line, the mean annual flow from 1951 to 1980 was about 4,193,000 acre-feet (USGS 1981). The stream flow and salinity impacts on the Colorado River would be minimal due to the small reservoir size and the diversion system.

It is estimated that the peak discharge due to dam failure would be about 7.25×10^4 cfs for the Big Salt Wash reservoir. Compared to the calculated peak flood discharge for the proposed Roan Creek reservoir (1.32×10^6 cfs), the peak flood discharge for Big Salt Wash would be orders of magnitude less due to smaller reservoir size. Also, the Big Salt Wash reservoir would be located approximately 15 miles upstream from the nearest major population center (Fruita). The valley of Big Salt Wash gently slopes from the base of the damsite to the Colorado River. The width of the valley ranges from 600 feet near the base of the damsite to greater than 2 miles near its confluence with the Colorado River. Both the travel time of flood flow and the volume of the flow would be attenuated by the length of the valley and the gentle channel slope. Flooding due to dam failure could damage the pipeline, irrigation ditches, agricultural land, and houses in the Fruita area.

Clear Creek Mesa Water Diversion and Storage Reservoirs. The surface runoff management plan for Clear Creek mesa includes several water diversion dams (Figure 4.4-2). Specifications for these dams and reservoirs are listed in Table 4.4-4. Water stored in these reservoirs would be used for mining, retorting, upgrading, spent shale conditioning, dust control, and domestic uses. Impacts due to the on-site runoff storage reservoirs would include reduction of stream flows in lower Clear Creek and hydrologic disruption of drainages on top of Clear Creek mesa. The Clear Creek sedimentation reservoir would be used as the downstream water runoff control of all the mining activities on top of the mesa. Surface runoff and seepage flowing through the mine area would be routed through the reservoir to allow for settlement. With a dam height of 81 feet, the reservoir is designed to store 100-year, 24-hour storm events. For any higher recurrence interval flood events, the release of reservoir water would also release sediment into Clear Creek. A portion of the sediment would be deposited along the creek channel bottom but the rest would be carried downstream, causing water quality degradation of Clear Creek and Roan Creek.

Table 4.4-4 SPECIFICATIONS OF ON-SITE RUNOFF STORAGE RESERVOIRS

Reservoir Name	Location	Storage (acre-ft)	Dam Height × Length (ft)		(ft)	Pipeline Diversion Claimed (cfs)	Crest Elevation (ft)	Source
Clear Creek Upstream Reservoir	SW¼, SW¼ Sec. 3 T5S, R99W	100	30	×	300	15	7,825	Clear Creek
Clear Creek By-Pass Reservoir	NW¼, NW¼ Sec. 17 T5S, R98W	1,430	115	×	650	15	6,665	Clear Creek & West Willow Creek
Clear Creek Sedimentation Reservoir	NW¼, NE¼ Sec. 17 T5S, R98W	1,000	81	×	680	30	6,541	Clear Creek & Willow Creek
Willow Creek Reservoir	NE¼, NW¼ Sec. 1 T5S, R99W	450	60	×	380	10	7,783	Willow Creek & East Willow Creek
East Willow Creek Reservoir	SW¼, NE¼ Sec. 26	40	20	×	200	5	8,023	East Willow Creek
No Name Creek Reservoir	SW¼, NW¼ Sec. 5 T5S, R98W	110	55	×	200	5	7,707	No Name Creek
Mud Springs Creek Reservoir	SW¼, NE¼ Sec. 9	50	30	×	300	5	7,600	Mud Springs Creek
Big Salt Wash Reservoir	SW¼, NE¼ Sec. 12 T8S, R102W	12,000	165	×	1700	125	5,505	Big Salt Wash & Colorado River
Roan Creek GCC Reservoir (Upper Dry Fork)	S½, S½ Sec. 6 T8S, R97W	175,000	225	×	3700	442.25	5,320	Colorado River & Roan Creek

Source: CDNR (1981a).

The Clear Creek by-pass reservoir, located upstream of the sedimentation reservoir, would collect all the upstream runoff diverted from upper Clear Creek and West Willow Creek, plus that water routed through the underground mine panels. The dam is designed for 100-year, 24-hour storm runoff events with a dam height of 115 feet and storage capacity of 1,430 acre-feet.

Runoff stored in the Clear Creek by-pass reservoir would be used as part of the project water supply. Potential water quality and stream flow impacts associated with this reservoir operation were discussed under spent shale disposal. Because of the proximity of the by-pass reservoir and sedimentation reservoir, cumulative impacts of reservoir releases on flood peak and stream channel disruption of Clear Creek would be significant for any runoff events larger than the 100-year, 24-hour events.

Well Field System. The well field system would include approximately 33 wells: 21 along the Clear Creek valley, 4 in Roan Creek valley, and 8 on top of Clear Creek mesa. Wells on top of the mesa would be deep, ranging from 370 to 790 feet. Water would be withdrawn at an approximate rate of up to 200 acre-feet/year from the aquifer waters of the Mahogany Zone, Parachute Creek Member, and Green River Formation. Impacts on surface stream flows would be negligible. The four wells along Roan Creek would withdraw water from the alluvial aquifer underlying Roan Creek at a maximum rate of 2,000 gallons per minute (gpm; 4.46 cfs) from each well. This well system would be used to augment the yield of Clear Creek mesa and the alluvial well system and to protect senior downstream appropriators. The alluvial aquifer appears to be in communication with the stream

(Chevron 1982h). Wells located along Clear Creek canyon would withdraw up to 6,700 acre-feet annually from the alluvial aquifer underlying the stream channel bed. It is expected that the ground water withdrawal would deplete the alluvial aquifer storage and Roan Creek stream flow. The percentage of stream flow depletion would depend on recharge conditions, total pumpage, and Clear Creek stream flows.

Spent Shale Disposal. Spent shale from underground workings and the initial open pit mine would be deposited within upper Clear Creek canyon, above the water fall, to an approximate elevation of 8,100 feet, or about the elevation of the existing ridgetop. The volume of spent shale to be deposited within Clear Creek canyon is 604 million cubic yards, which would cover a total area of approximately 1,682 acres. Spent shale from the remaining open pit mine would be backfilled into the pit as the mine workings progress. The design of the spent shale pile includes plans to control erosion, surface runoff, and slope stability. Revegetation would begin in 1987 and continue throughout the life of the project. Potential impacts on watershed drainages prior to revegetation include soil erosion and degradation of water quality. Long-term surface water impacts would include stream channel disruption, water quality degradation, and sediment deposition along the drainageway if a failure of the spent shale pile occurs.

Spent shale leachates are a potential environmental concern which may have a long-term impact on surface water quality. Percolating water from rainfall and snowmelt, or groundwater intrusion into the waste pile could migrate through the spent shale disposal site and dissolve a portion of the spent shale matrix. This organic and mineral-laden water could migrate to underground aquifers and eventually drain to surface water sources. Surface water quality changes due to spent shale leachates are difficult to estimate due to the complexity of geochemical process in the leaching system. However, it is expected that concentrations of TDS, TOC, fluoride and sodium could increase slightly (U.S. Army Corps of Engineers 1982).

The surface runoff control plan includes diverting stream flow from West Willow Creek and upper Clear Creek, routing the water through the abandoned underground workings, and then returning it to the natural water course below the Clear Creek waterfall. Potential impacts associated with this diversion scheme are twofold. First, stream flow routed through the underground workings may be contaminated by contact with raw shale and other residue such as oil and grease, dust, and ammonium nitrate from explosives. Second, the stream channel segment of Clear Creek, flowing through the spent shale disposal and underground mine area, is composed of thick alluvial deposits. More than 217 acre-feet of the annual mean stream flow between gaging stations CI-13 and CI-14 are retained as alluvial channel storage during low flow periods. Diverting the runoff through the underground mine would reduce the alluvial channel storage.

Clear Creek Alternative (CC-100)

This alternative eliminates the Big Salt Wash reservoir and the water pipeline corridor from the Colorado River near Loma to Clear Creek mesa as presented in the Proposed Action. Therefore, there would be no surface water impacts on the Grand Valley area or any potential impacts on the Colorado River due to the Big Salt Wash reservoir. Other surface water impacts would be the same as discussed for the Proposed Action.

Production Rate Alternatives (PA-50, CC-50)

The 50,000-bpd alternatives for Clear Creek mesa would lack the Willow Creek, No Name Creek, and Mud Springs Creek surface runoff control reservoirs, along with the surface mine. Surface water impacts would be same as for the PA-100 Alternative except for the three streams identified above. Potential stream sedimentation impacts due to soil erosion in the surface mine area would be less for a 50,000-bpd alternative. In addition, those springs located in the area of the surface mine would not be impacted.

4.4.1.3 Grand Valley and Associated Siting Activities

Fruita I Alternative (FI-100)

Impacts on surface water from the project components on top of the Clear Creek mesa and the associated corridors and reservoir would be the same as those of the Proposed Action. The Grand Valley upgrading site would include not only the upgrading facilities but also additional support facilities such as a natural gas pipeline, transmission line, access road, syncrude pipeline, railroad corridor, and an intertie pipeline. These facilities would cause some impacts on the Big Salt Wash drainage system.

The upgrading facilities would occupy about 400 acres in the Grand Valley area (Chevron 1982c). Water courses located within the proposed off-site upgrade location include Big Salt Wash, Mack Wash, and Coyote Wash. Since the channel gradient is low with wide meanders, significant water loss presently occurs from evaporation and infiltration into the valley alluvium. Short reaches of surface flow are separated by reaches of saturated streambed with no surface flow. Therefore, impacts of the upgrading facilities on the watershed or stream flows would be very minimal. The only potential impact would come from accidental leakage which may cause a water pollution problem on irrigated land. Appropriate design of an on-site drainage collection system and spill prevention plan should alleviate the potential impacts.

Impacts due to the corridors along Big Salt Wash would include soil erosion, sedimentation, and stream flow disruption during construction. An accidental spill from a syncrude pipeline connecting upgrading facilities to the Clear Creek mesa is a possible impact. Water resources which may be affected by an accidental spill include Big Salt Wash, Echo Lake, Ruby Lee Reservoir, numerous springs, and stock ponds.

Fruita II Alternative (FII-50)

The feed preparation, retorting, and upgrading activities would disturb approximately 800 acres of watershed in the Grand Valley area. Since Big Salt Wash and its tributaries in the vicinity of the plant site are either intermittent or ephemeral, impact of these facilities on average stream flows would be insignificant. However, flood flows would increase due to the surface disturbance, which reduces the vegetation cover and runoff retention potential. Soil erosion would also increase during runoff events. Runoff water would have high concentrations of suspended solids, dissolved solids, oil, and grease from the plants and equipment.

Surface water impacts of the ore-haulage railroad (Straight Line Tunnel Route) during construction would include soil erosion, sedimentation, stream flow disruption, and increased total suspended solids. A backwater effect on Carr Creek and Brush Creek might occur during flood flow events due to the bridges across the creek. An accidental oil spill from the syncrude pipeline could contaminate stream water. Since the pipeline length is approximately equal to the La Sal pipeline route, the spill volume, frequency, and size would also be approximately the same as described in Section 4.4.1.2.

Potential impacts on surface water for other project components would be the same as those for the Proposed Action. Minor impacts would be expected for Carr Creek, Brush Creek, and Clear Creek from the construction of a power transmission line from Big Salt Wash to the mine site.

Production Rate Alternatives (FI-50)

Surface water impacts on Clear Creek mesa due to a 50,000-bpd alternative would be the same as discussed in Section 4.4.1.2. Surface water impacts at the Fruita plant site would be the same as discussed above.

4.4.1.4 Alternative Siting Activities

Corridors

Impacts on water resources due to construction of alternative corridors would include soil erosion, sedimentation, stream flow disruption, and increased suspended solids in those streams that the corridors parallel or intersect. An accidental oil spill from the syncrude pipelines would pose water pollution problems to the drainages.

In addition, peak discharges of flood flow events would increase as a result of disturbance of vegetation cover and reduced runoff retention. Backwater effects, causing upstream flooding, would be possible due to railroad and access road corridors crossing streams. Those streams that would be affected by alternative corridors are presented in Table 4.4-3.

Reservoirs

Potential surface water impacts on Roan Creek for the alternative reservoir sites on Roan Creek (Lower Dry Fork, Upper Conn Creek, and Lower Conn Creek; Figure 4.4-1) would be similar to the proposed reservoir site described in Section 4.4.1.2. However, the alternative reservoir sites of Upper and Lower Conn Creek and Upper Dry Fork would inundate parts of Conn Creek and Dry Fork, respectively. Also, the upstream reservoir sites would flood a longer stream segment of Roan Creek and potentially cause less damage to De Beque should a dam failure occur.

Spent Shale Disposal

The Garvey and Stove/Buniger canyons alternative disposal sites in the Grand Valley are close to the proposed Big Salt Wash reservoir and within the Big Salt Wash drainage. Potential surface runoff and soil erosion from the spent shale pile may pollute the reservoir water and stream flows. The Dry Gulch site would have minimal surface water impacts due to the distance from the site to Big Salt Wash. The Munger Canyon disposal site, located in the Munger Creek drainage, may interrupt stream flow and degrade water quality in Munger Creek. In addition, water requirements for spent shale moistening would be higher in the Grand Valley because of a higher evaporation rate (resulting from higher air temperature) than at the Clear Creek mesa disposal site.

4.4.1.5 Transportation Alternatives

The coal transportation alternatives may increase suspended sediment in streams from coal dust.

4.4.1.6 Solid and Hazardous Waste Disposal

Alternatives for waste disposal include on-site disposal and off-site disposal by a licensed contractor. There would be no project-site surface water impact due to off-site disposal. Impacts due to on-site disposal would include water quality impacts due to potential leaching and accidental spillage of hazardous wastewater from the disposal site. Surface runoff from the disposal site may also contain hazardous constituents.

Nonhazardous solid waste would be disposed in the spent shale disposal area. There would be no additional surface water impacts other than those described for spent shale disposal.

4.4.1.7 Secondary Impacts

Secondary impacts to surface water would result from increased population in the region. Secondary impacts would include increased water consumption, potential water contamination from wastewater and sanitary landfill, and increased suspended solids in streams due to increased activities adjacent to the streams.

4.4.2 Ground Water

4.4.2.1 General Impacts

The disruption of ground water movement and changes in ground water quantity and quality as a result of the CCSOP could result from (1) removal of portions of aquifers, (2) dewatering around the mined areas, (3) modification of ground water movement resulting from the backfilling of mining spoils or from abandoned underground workings, and (4) potential subsidence and fracturing of overlying rocks in the underground mine area.

Other local impacts ranging from minor to significant may also occur as a result of ancillary operations on or near the site, including spent shale disposal, water supply withdrawals, and other activities.

Development of the proposed facilities on Clear Creek mesa, the alternative facility site in Grand Valley, the proposed syncrude pipeline to Davis Point, and the alternate route to Rangely would have no significant regional impact on the ground water system.

Local impacts would occur in the vicinity of No Name, Willow, and Clear creeks due to mining activities. Impacts would likely occur as a result of disruption of ground water movement, quantity, or availability, and changes to ground water quality.

Impacts discussed in the following sections are believed to be significant for the Proposed Action and alternatives to the Proposed Action.

4.4.2.2 Clear Creek Mesa and Associated Siting Activities

Mining Activities (PA-100, CC-100)

Aquifer Disruption. Underground mining would be limited to removal of the kerogen-rich Mahogany bed. Exploration adits driven into the wall of Clear Creek canyon to obtain bulk shale oil samples from the Mahogany bed did not experience significant inflows (approximately 1 gpm; Chevron 1982g, 1982w). Based on these data, underground mining operations themselves would not interfere significantly with the existing physical integrity of the A-Groove or B-Groove aquifers. However, underground mining would remove portions of the rock unit which separates these aquifers, thereby increasing the potential for inflows to the underground workings via interconnecting fractures. It is also possible that potential inflows to the underground workings would be greater in areas beneath or adjacent to saturated alluvial deposits in the valley bottoms (e.g., East Clear Creek), particularly where hydraulic communication between the alluvial aquifer and underground workings is facilitated by substantial fracture interconnections.

Surface mining would destroy the A-Groove and B-Groove bedrock aquifers by removal of these water-bearing strata within the mined area. The surface extent of removal would be approximately 8,400 acres over a period of 90 years. Table 4.4-5 summarizes the relationship of the affected area to the total area of the Clear Creek watershed and to the anticipated cumulative removal of all aquifers by the proposed shale oil mining operations.

In addition to disruption of the A- and B-Groove aquifers, surface mining would effectively remove the less extensive ground water bearing alluvial deposits in portions of West Willow, East Willow, No Name, and Mud Springs creeks. Based on the Operator's current plans, direct disturbance of the alluvial aquifer in the upper portions of Clear Creek would not occur.

Aquifer disruption would be a locally significant impact. Aquifers like the A-Groove and B-Groove, which typically have very low horizontal hydraulic conductivities, would probably exhibit areally limited drawdowns as a result of mine dewatering. As such, the aquifers would be impacted in the vicinity of the open pit mine, but the net effects should not extend away from the mine since water contained in storage is unable to move quickly through the aquifer to the seepage faces in the mine.

Those portions of the shale oil-bearing rocks and interlayered aquifers that are removed by surface mining would eventually be replaced by a single aquifer comprised of broken waste rock and backfilled spoil material. Underdrains consisting of local materials, probably Uinta Sandstone, would be placed below the overburden backfill to allow ground water to flow beneath the backfill after reclamation (Chevron 1982g). Unless compacted, the backfilled spoil materials should also be moderately permeable and the resulting porosity would likely be higher in the backfill materials than in the original aquifers.

The backfill placement of spoils would presumably be accomplished by a combination of truck and shovel, and conveyor belt techniques. Spoils placement utilizing these methods should allow for only moderate sorting due to

Table 4.4-5 MINE AREA/WATERSHED DISTURBANCE RELATIONSHIPS

		Acreage of Disturbance by Year					
Activity	Location	1983	1986	1991	1996	2008	2036
Aquifer disruption	Underground mine	0	0	0	0	0	0
Aquifer disruption	Surface mine	0	195	325	455	2080	2250
Cumulative area of aquifer removal	Underground and surface mine	0	195	520	975	3055	6305
Watershed area disturbance	Underground mine	15[a]	2800[b]	0	0	0	0
Watershed area disturbance	Surface mine	0	595[c]	325	455	2080	3250
Cumulative area disturbed due to mining	Underground and surface mine	15	3310	3630	4085	6165	9410

		Percentage of Removal by Year					
Activity	Location	1983	1986	1991	1996	2008	2036
Mine area[d]	Underground and surface mine	0.12	25.46	29.92	31.42	47.42	72.38
Clear Creek[e] watershed	Underground and surface mine	0.02	4.38	4.81	5.41	8.16	12.46

[a] Initial mine site.
[b] Clear Creek spent shale disposal area.
[c] Include Mesa facilities (400 acre) and a mine rate of 65 acre/year.
[d] 13,000 acres (includes all facilities).
[e] 75,520 acres of Clear Creek watershed.

gravity and undergo no appreciable compaction due to rubber-tired traffic. However, studies to specifically evaluate the resulting permeabilities of spoils placed by these methods are unknown. The anticipated backfill placement methods should yield permeabilities many times greater than that of the undisturbed aquifer and have at least as much capacity to store and transmit ground water as the original aquifers.

Unlike the waste rock spoils, spent shale and retorted materials placed in the mine pit would be isolated from the ground water system. As depicted in Figure 4.4-4, isolation of spent shale would be achieved by encapsulation within a highly compacted blanket of low permeability material near the top of the backfilled surface mine. Under current plans, it is assumed that the encapsulated zones of spent shale would be situated above the post-mining ground water potentiometric surface. Infiltration of precipitation and snowmelt would be reduced through the construction of a capillary barrier below subsoil and topsoil layers.

Dewatering and Ground Water Flow. Mine water inflow pumped from both the surface and underground operations would create a local cone of drawdown (depression) in the ground water flow system around the mine. Dewatering at the mine would intersect ground water which is moving down gradient through the mined

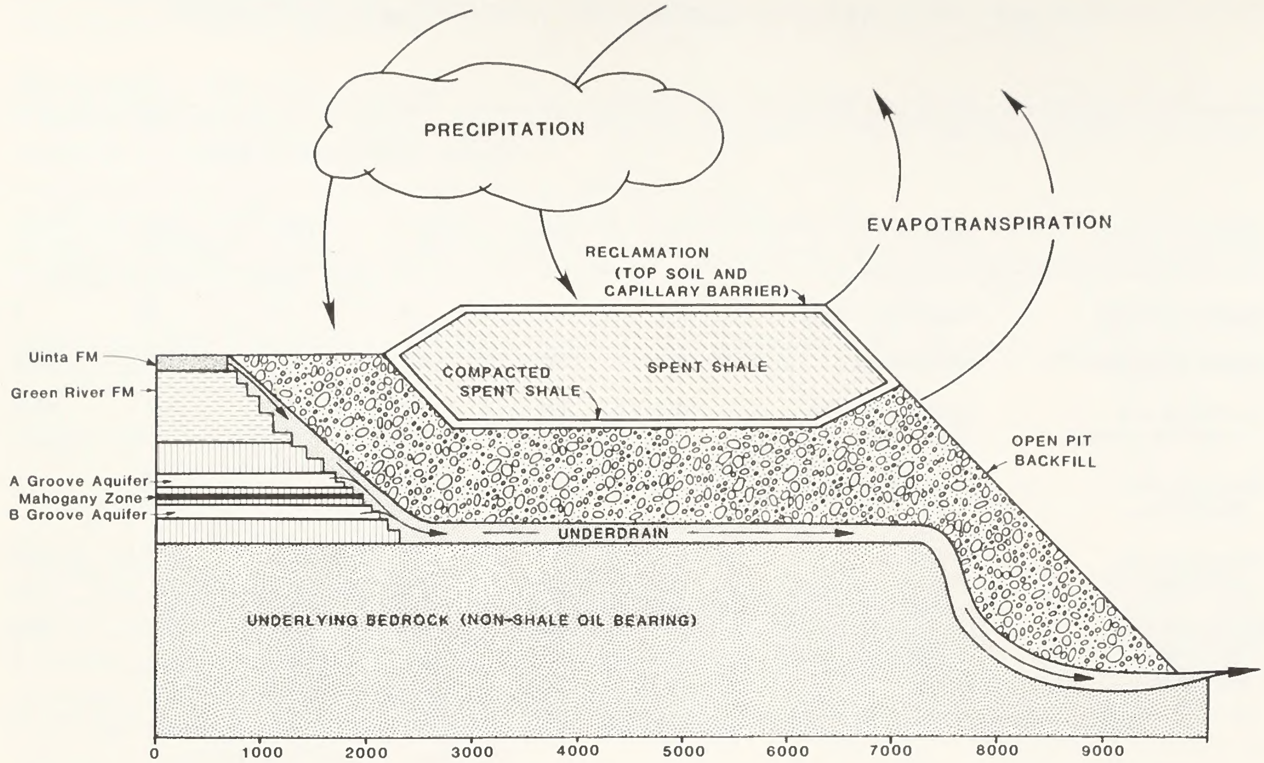


Figure 4.4-4 Conceptual Cross-Section Through Pit After Reclamation

areas towards natural discharge points. Pre-mining ground water discharge points are located where the water-bearing units (the A- and B-Groove aquifers) are exposed in the adjacent canyon walls. It is likely that dewatering would lower ground water levels in the A- and B-Groove aquifers around the mines. Drawdown influence due to open pit operations to the east and south would probably be reduced considerably because the mined section and aquifers are exposed in the canyon walls in these directions.

The actual magnitude of water level decline would be dependent on aquifer properties and discharge characteristics. The ground water inflow to the surface mine is estimated to be approximately 140 gpm (maximum) and should decrease to 50 gpm after 1 year (Chevron 1982g). Inflows to the surface mine would be higher initially as the hydrostatic pressure of the larger, regional fractures are drained. Mine inflows should then decrease more slowly as the pressure heads in the local joint system around the pit are reduced due to the dewatering effects. Water level declines in these aquifers would probably not be noticeable beyond a 1-mile radius of the active mine cut.

Three stock watering wells are present in the upland areas within a 2-mile radius of CCSOP property (Figure 3.4-6). Two of these wells (9 and 10) are completed in the Uinta Formation to depths of 83 feet and are located well beyond the future mine area to the northeast. The shallow completion depths for these two wells suggest that they would not be affected by mine dewatering and any declines in hydrostatic head in the deeper aquifers. One well (Well 8 on Figure 3.4-6) is located within the property boundary and is completed in the proposed mining zone. This well could experience water level declines because of its position within the mine's radius of influence.

Underground mining would have a limited impact on the local ground water system. Unlike surface mining, the underground mine should not, through removal of the Mahogany zone, severely disrupt the A-Groove and B-Groove aquifers.

Bedrock aquifer characteristics vary significantly on Clear Creek mesa due to the fracture-controlled nature of the permeability characteristics. As a result, it is estimated that inflows associated with underground mining would range from 100 to over 1,500 gpm based on assumed transmissivities, storage coefficients, and the mining method employed. Mine inflows encountered under stream canyon beds could, however, be greater than predicted if there is substantial hydraulic connection between the alluvial and bedrock ground water systems (Chevron 1982g). The dewatering associated with the proposed underground mining would have less effect on ground water levels in the A- and/or B-Groove aquifers than the proposed surface mining activities.

Modification of Ground Water Movements. Relatively impermeable shales of the Green River Formation interfinger with the overlying permeable sands of the Uinta Formation in the project area. This results in perched ground water conditions, which cause springs to emanate at the surface at selected locations. These conditions exist at the headwaters of Willow and No Name creeks, where springs discharge from the incised Uinta sandstone along the exposed contact between the Uinta and the Green River formations. Removal of these perched conditions would not occur as a result of the proposed mining activities. However, as the working face of the surface mine advances, these spring discharge locations would progressively shift to the north a maximum of 0.5 to 0.75 miles. The magnitude of these spring discharges should not be affected unless the areal extent and saturated thickness of these perched zones is naturally restricted.

At the completion of surface mining activities, underdrain materials would be placed against the Uinta/Green River contact within the mined area. These backfill materials would be highly permeable and have a high recharge capacity. Once the underdrain system is in place, the aforementioned springs would be covered with backfill materials and would discharge underground to the surface mine underdrain system. Due to a lack of information on the Uinta Formation ground water system at the site, it is not known whether this subsurface drainage would cause depletion of the perched ground water zones.

Impacts resulting from modification of flow by the replaced spoil materials on the shallow, perched ground water system as well as the deeper, bedrock ground water system should be local. The effects would be minor during the active surface mining period and would become locally significant only after completion of mining and reclamation. These impacts would continue over the long term as the underdrain becomes saturated and new springs occur either along the contact between the bedrock and spoils backfill, or somewhere on the face of the backfill, where permeability is high enough to direct flow laterally to the fill face. Changes in ground water flow resulting from underground mining activity would not represent a material impact on the local or the regional scale.

Effects of Subsidence From Underground Mining. Long-term subsidence effects following completion of underground mining may cause stresses in the overlying rocks, eventually resulting in fracturing and possibly collapse of overlying bedrock. Fractures that intersect the overlying A-Groove aquifer may allow ground water inflows to the underground workings of an unknown quantity and duration. The potential effects on the B-Groove aquifer may be an increase in recharge of mine waters to this underlying aquifer.

Water Quality Impacts. Two potential ground water quality impacts have been identified for the Clear Creek mining activities:

- Impacts due to ground water interaction with underdrain materials in the open pit mine
- Impacts due to ground water interaction with mine backfill (spoil) materials

The Operator has proposed construction of a subsurface drainage system at the base of the backfill material in the open pit mine (Chevron 1981a). This drain would be constructed with Uinta Formation geologic materials and is designed to collect inflows into the backfill material and transmit the ground water to surface diversions in the Willow Creek drainage. The chemical and physical nature of the Uinta Formation material is such that major water quality changes would not be likely. The presence of good quality ground water in saturated areas of the Uinta Formation (Murray 1974) is supportive of this contention. Some potential increases in total dissolved solids, calcium, and bicarbonate concentrations may result from the interaction of local ground water and the Uinta Formation drain materials.

Over very long periods of time, limited recharge may occur through the backfilled mine spoil materials via the infiltration and percolation of snowmelt, precipitation, and/or surface runoff. This recharging ground water may pick up additional ions in solution via the geochemical interaction with the spoil materials, resulting in higher TDS (total dissolved solids) concentrations. Depending on the amount of recharge moving through the backfill materials, some higher TDS ground water may reach the underdrain and (eventually) be discharged from the reclaimed mine area along with ground water flow transmitted from the A- and B-Groove aquifers.

Impact on Downstream Surface and Ground Water Interaction. In addition to those impacts directly attributable to mine dewatering, minor impacts to the interaction between surface and ground water could occur downstream along Clear Creek. Changes in this interaction could where (1) stream flow recharges the alluvial aquifer of Clear Creek canyon, and (2) where alluvial springs discharge, thereby contributing directly to stream flow. Recharge to both stream flow and the alluvial aquifer could be altered and perhaps decreased, but is not expected to substantially reduce surface or subsurface flow.

Impacts on Shallow Aquifers. Numerous seeps and springs have been documented as discharging small quantities of water from Clear Creek mesa (Chevron 1982g). These sources contribute to stream flow on the mesa, which in turn flows through waterfalls to Clear Creek. The springs originate near the contact between the Uinta Formation and the Parachute Creek Member of the Green River Formation. Additional springs have also been identified as discharging from alluvial deposits in the lower reaches of Clear Creek (Chevron 1982g).

Dewatering impacts directly associated with the mine should be negligible for the alluvial springs of lower Clear Creek. Significant impacts are likely for springs emanating from the mesa top area. Approximately eight of these upland springs are situated within the proposed surface mining area and, thus, their pre-mining points of discharge would be eliminated. Other springs adjacent to the mine site may cease to flow as a result of the dewatering of their source strata. As previously described, the cone of depression and resultant dewatering of shallow aquifers may remove the perched conditions occurring at or near the base of the Uinta Formation.

Plant Site and Ancillary Facilities

Surface runoff derived from the plant site and ancillary facilities would be collected in surface holding ponds. Infiltration of these waters into the subsurface is unlikely (Chevron 1982g), but unexpected infiltration could result in the contamination of ground water. Table 4.4-3 presents estimates of surface runoff water quality for major constituents. Comparing these values to ground water quality beneath the plant site (site CC-A, Table 3.4-5) shows that calcium, potassium, and chloride concentrations are greater in the runoff water. Concentrations of chemical and oil and grease contamination were not estimated. It is assumed that any spills would be contained to the immediate source area and undergo immediate cleanup efforts.

Ground Water Withdrawals for Facility Water Supply

The Clear Creek alluvium well field system (Figure 4.4-5) would provide a portion of the water to the project from the start through the commercial first phase (roughly 5 years) and beyond if necessary (Chevron 1981a). Project requirements for ground water may taper off as water stored behind reservoirs (constructed during this early period) is used. The well field could then be used as a supplemental water supply after completion of the reservoirs.

The proposed pumpage from the Clear Creek alluvial aquifer would adversely impact the alluvial aquifer system. The major impact would be a decrease of the saturated thickness of the aquifer (decrease in aquifer storage) due to drawdown associated with pumpage. The types of impacts that may be expected are listed in Table 4.4-6. Drawdown within a 200-foot radius of each production well after 5 years of consecutive pumpage was calculated using the Thies (1935) non-equilibrium equation to simulate aquifer response. Known transmissivity, storage coefficient, and pumpage values (Chevron 1981a, 1982w) were used in the calculation of drawdown. Calculated drawdown estimates range from 5.2 to 7.3 feet (Table 4.4-6) at a radius of 200 feet from these production wells.

Table 4.4-6 ESTIMATED DRAWDOWN, 200 FEET AWAY FROM SELECTED PRODUCTION WELLS AFTER 5 YEARS OF CONTINUOUS PUMPING

Well Number	Transmissivity[a] (gpd/ft)	Storage Coefficient[a] (dimensionless)	Pumpage[b] (gpm)	Estimated[c] Drawdown at Radius = 200 ft (ft)	Location
CC-ALL-17	98,000	0.02	400	5.2	Mouth of Cottonwood Creek
CC-ALL-6	307,000	0.10	1,000	4.0	Between Deer Park and Scott Gulch
CC-ALL-19	264,000	0.05	1,500	7.3	Between Deer Park and Scott Gulch

[a] Source: Chevron (1982w).
[b] Source: Chevron (1982g).
[c] Calculated using Theis (1935) non-equilibrium formula

The decrease in alluvial water level due to pumpage from the well field would be dependent on the quantities of ground water removed and the spatial distribution of production wells in the field. Detailed studies of the Clear Creek alluvial aquifer (Chevron 1982w) indicate that a maximum sustained yield of 6,780 acre-feet (approximately 3,000 gpm) could be drawn from the well field without decreasing water levels below the production zone of each well. The field would be comprised of 21 production wells from the confluence of Willow and Clear creeks to the confluence of Roan and Clear creeks (Figure 4.4-5). Spacing of these wells would determine the amount of drawdown due to pumpage. Wells within the radius of influence (effective drawdown area due to pumpage) of adjacent wells would result in a cumulative drawdown between each well. Estimated cumulative drawdowns could range from 7 to 20 feet between production wells in the field.

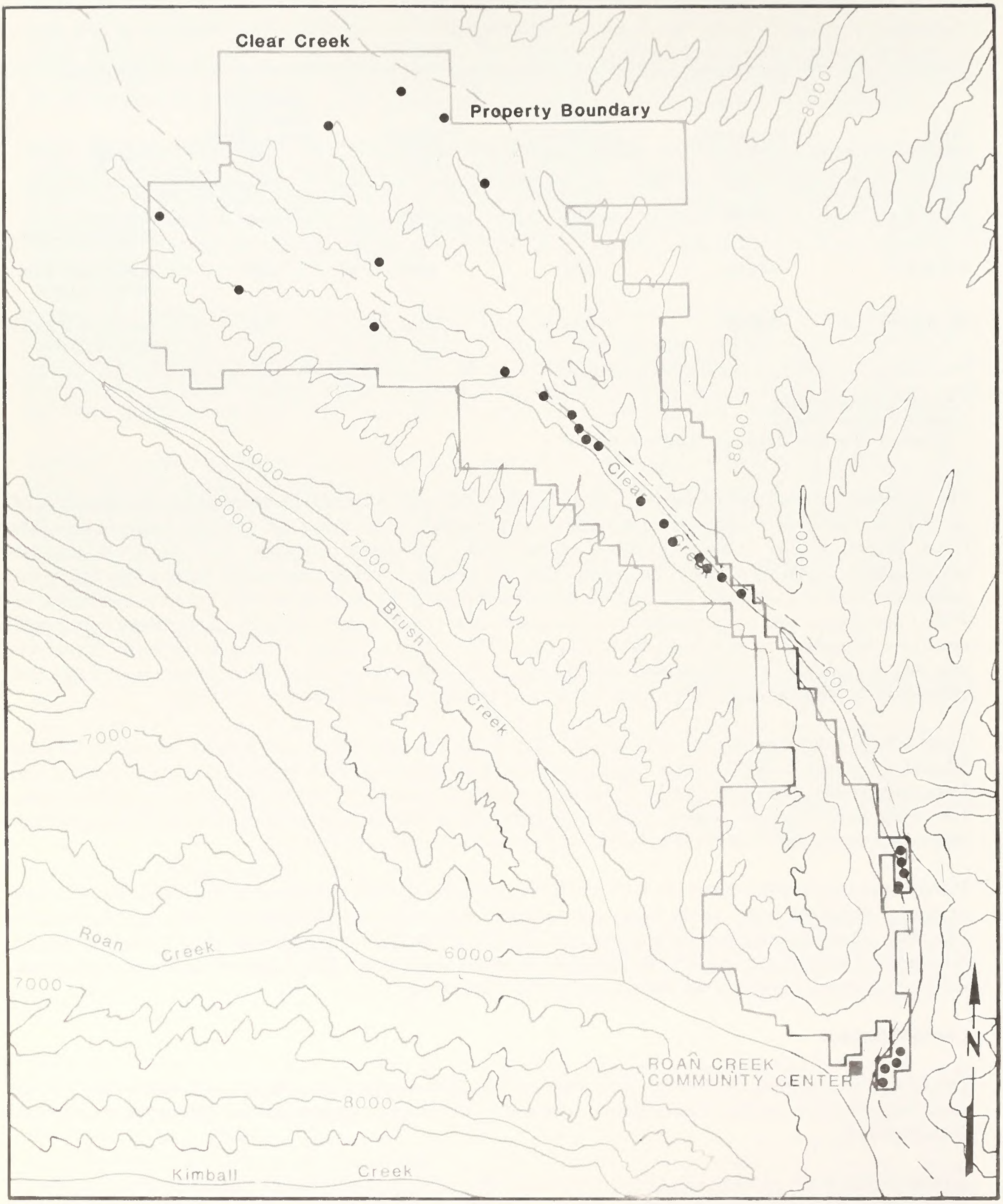
Long-term (7 days) pumping test data for the Clear Creek alluvium suggest that a direct connection between alluvial ground water and Clear Creek surface water does not exist upstream from Scott Gulch (Chevron 1982w). Data suggests that the proposed well field pumpage would not effect upper and middle Clear Creek surface water flow. As in Roan Creek, the reach of Clear Creek surface water just upstream of the confluence with Roan Creek may exhibit interconnection between surface and ground waters (Chevron 1981a).

Direct impacts in the alluvium of lower Clear Creek canyon (below Scott Gulch) could result from the extraction of large volumes of water in the upper and middle valley. Proposed pumpage may decrease the level of saturation, thereby decreasing the available contribution of the Roan Creek alluvial system. Additionally, as presented in Section 3.4.2, several wells have been permitted to withdraw alluvial ground water adjacent to Clear Creek. Reductions in water levels and/or well yields could occur.

Corridor Impacts

The Roan Creek corridor is not likely to impact ground water except during the construction. Ground water could incur minor temporary impacts during construction due to infiltration of higher TDS surface runoff from disturbed areas.

Aquifer disruption or ground water degradation along the La Sal syncrude pipeline corridor is unlikely. Ground water along the route is limited to recharge from infiltration of precipitation into the sandy soils and underlying Uinta Formation (Chevron 1982g).



● Proposed Ground Water Supply Well

Scale 1/2"=1 Mile

Figure 4.4-5 Location of Proposed Ground Water Supply Wells

Impact to the ground water resources of Big Salt Wash due to the construction of the water pipeline corridor would be minor. The potential for surficial disturbances to influence the water quality or quantity of the bedrock aquifers is unlikely. However, the infiltration of higher TDS surface runoff from disturbed areas is possible, although this potential impact would be minor and short-term.

Reservoir Impacts

The Roan Creek and Big Salt Wash drainages contain large quantities of useable ground water. The quality of the ground water is adequate for irrigation and stock watering uses. High TDS values and bacterial counts eliminate its safe use for domestic purposes (Chevron 1982h). Alluvial ground water quality should exhibit similar quality characteristics to surface water because of the interrelationship of these relatively small drainages.

Surface water quality data indicate that the Colorado River is generally of much higher quality than Roan Creek. Storage of water from the Colorado River in any of the proposed reservoirs along the lower Roan Creek drainage should positively affect the existing ground water quality. Assuming no severe upstream impacts, changes in the ground water quality could include decreased concentrations of bacteria, dissolved solids, and sulfates.

Surface Water Diversion Points (De Beque and Fruita)

No long-term impact is expected to occur to the ground water system at the De Beque and Fruita diversion points. Short-term impacts could occur locally during the construction phase due to fuel spillages.

Nonprocessed Shale and Spent Shale Storage and Disposal

Leachate generation from the nonprocessed shale storage piles would be minimal due to the constant use of nonprocessed shale for retorting. With proper surface runoff control, the constant addition and removal of these materials from storage piles should help reduce the potential for saturation from infiltration of surface runoff or precipitation. Further, the stored materials must first reach field capacity before leachate seepage can be generated. As a result, the potential for ground water contamination in the vicinity of these temporary storage piles is slight.

The disposal of spent shale and solid wastes in the Clear Creek drainage could be a significant source of leachate or seepage. The actual amount of leachate generated (if any) by the proposed disposal system would depend on water balance conditions in the pile, solute release and interaction with pore waters, and transport of water and reacting and nonreacting solutes in an unsaturated flow system.

Significant leachate generation at the spent shale disposal site is unlikely due to the design of the proposed disposal at the Clear Creek mine site (Section 2.3). Disposal site design could reduce surface recharge to the completed disposal cells in the short term. The soil layers and the capillary barrier (Figures 2.3-12 and 4.4-4) overlying the highly compacted spent shale top liner (permeability $= 1.4 \times 10^{-4}$ feet/day) would prevent direct infiltration of water into the disposal cells (Chevron 1982cc). Influx of ground water into the disposal cells at the Clear Creek surface site through the bottom liner would be unlikely due to the lowering of ground water levels beneath the disposal site caused by underground mining and the impermeable nature of the shale bottom liner. Ground water influx into the open-pit disposal cell is not likely because anticipated ground water levels would be below the bottom of the disposal cell.

Two possible sources of water influx to the disposal cells include (1) water infiltrating during the construction of the disposal cell and prior to completion of the compacted shale top liner and (2) possible long-term weathering effects on the top and/or bottom liners that may result in leaks in these liners. If leachate did occur in the disposal cells, the relatively impermeable nature of the spent shale would retard migration of leachate within the cells.

Potential leaks of leachate from the open-pit disposal cells would migrate to the underdrain at the base of the backfilled mine. Once the leachate reached the underdrain it would be diluted by ground water flowing through the drain, discharge into Willow Creek, and flow into the sedimentation pond at the confluence of Willow and

Clear creeks. If this series of events were to occur, it is likely that the concentrations of elements in the sedimentation pond would be unaffected due to dillution of the leachate by surface and ground waters.

If leachate migrated beneath the proposed Mesa Valley Fill disposal site, it could reach the underlying upper Parachute Creek aquifer by two mechanisms: (1) porous flow and (2) fracture controlled conduit flow. Leachate migration through the unsaturated portions of the upper Parachute Creek Member would be very slow due to the low permeability of the material (hydraulic conductivity range of 0.07 to 85.80 feet/day). After the leachate migrated to the upper Parachute Creek aquifer, low ground water flow velocities (ranging from 1.1×10^{-3} to 8.9×10^{-7} feet/day) would transport the leachate to the aquifer discharge area in the canyon walls of Clear Creek. Given this range of flow velocities, it could take approximately 250 to 310,000 years for the contaminant to migrate 100 feet within the aquifer.

If leachate encountered an open fracture system in the bedrock unit beneath the disposal site, the fracture system could transmit the leachate as conduit flow to the aquifer below. Fracture conduit migration would be much faster than migration through the porous matrix of the bedrock unit. However, it is impossible to estimate leachate migration through conduit flow due to the variable nature and occurrence of fracture systems at the site.

The mineralogic composition of STB spent shale is presented in Table 2.3-6. The results of leach testing conducted on spent shale samples from the CCSOP process test are presented in Table 4.4-7. The concentration of total dissolved solids from the initial pore volume(s) (pore volume 1; 10,900 mg/l) is much greater than for subsequent pore volumes (pore volume 3; 4,120 mg/l). The high concentration observed in pore volume 1 is probably due to the initial rinsing of very soluble salts from the spent shale during leaching by the first pore volume of the test (Chappele 1980). Pore volume 1 therefore probably represents a worse-case impact due to the rinsing of soluble salts. Sample pore volume 3 is potentially more representative of leachate generated over long periods at the disposal site.

Comparison of Table 3.4-5 and the results of the aforementioned leach testing to baseline bedrock (CCA) and alluvial (CC-All 12) ground water quality yields several conclusions. The A-Groove aquifer (CCA) and the alluvial aquifer (CC-All 12) have been identified as possible recipients of small volumes of spent shale leachate. Examination of total dissolved solids (TDS) for leach test water (pore volume 3) indicates that concentration of TDS (4,120 mg/l) in the leachate water is more than seven times the TDS concentration of baseline ground waters (550 mg/l). Should the liner fail, the concentrations of sulfate, cyanide, ammonia, and calcium could increase in the ground water due to leachate contamination. Hardness and pH may also increase. Regionally, salts (sodium, calcium, sulfate, and chloride), monovalent cations (potassium and lithium), reduced sulfur, mobil trace ions, (boron, fluoride, and molybdenum), and organic compounds have been identified as potential contaminants in leachate generated by spent shale disposal (Ferrard and Nazaryk 1982).

Alternative Production Rates (PA-50, CC-50)

Ground water impacts due to a 50,000-bpd production rate with an all underground mine include aquifer disruption, ground water withdrawal due to mine inflows, and ground water quality degradation. This alternative would result in less impacts to the ground water system than the combined underground/open pit mine plan (PA-100) due to the lack of aquifer destruction resulting from an open pit mine. The increased area of the underground mine would result in greater mine inflows and potentially more contamination due to the underground mining operation. Again, these cumulative impacts would still be less than the underground/open pit mining alternative. Spent shale disposal, ancillary facilities, and water supply needs are assumed to be the same as for the 100,000-bpd alternative and are addressed in previous sections.

4.4.2.3 Grand Valley and Associated Siting Activities

FI-100, FII-50, and FI-50 Facility Sites

Based on limited data, impact to the regional ground water regime due to an alternate upgrade and/or retort facility in the Grand Valley would be unlikely. Locally, the ground water resources may be negatively impacted by spills or leaks originating at the upgrading facility. These ground water resources include shallow ground water contained in the Mancos Shale (which underlies the site) or ground water contained in the alluvial deposits of Big Salt Wash, one mile east of the facility.

Table 4.4-7 SPENT SHALE LEACH TEST RESULTS COMPARED TO BEDROCK AND ALLUVIAL WATER QUALITY

	Run 45 A[a]	Run 45 B[b]	Mean CCA	Mean CC-ALL 12
Sulfur Species				
H_2S (Hydrogen Sulfide)	3.5	1.1	NA	NA
Thiol	30	4.2	NA	NA
Sulfate	3,250	1,133	85	130
Thiosulfate	140	21	NA	NA
CN (Cyanide)	1	4.5	ND[c]	ND
Nitrogen				
NH_3 (Nitrate)	415	37	ND	0.585
Metals				
Antimony	0.03	0.03	ND	ND
Arsenic	0.03	0.01	ND	ND
Barium	0.2	0.3	0.1	0.1
Beryllium	0.01	0.01	ND	ND
Boron	3.2	1.9	.3	0.5
Cadmium	0.03	0.03	ND	ND
Chromium	0.02	0.02	ND	ND
Copper	0.05	0.03	ND	ND
Iron	0.1	0.1	.06	0.04
Lead	0.12	0.05	ND	ND
Mercury	1 ppb	1 ppb	ND	ND
Nickel	0.08	0.04	ND	ND
Potassium	NA	NA	2.0	4.0
Sodium	1,700	84	160	92
Selenium	0.03	0.02	ND	ND
Silver	0.02	0.01	ND	ND
Thallium	0.1	0.1	ND	ND
Zinc	0.14	0.01	.4	.03
General Water Quality				
BOD (Biochemical Oxygen demand)	500.	80	ND	ND
COD (Chemical Oxygen demand)	1,100	120	16	11
TDS (Total dissolved solids)	10,900	4,120	550	550
TSS (Total suspended solids)	14	15	NA	NA
O and G (oil and grasses)	12	12	ND	ND
Chloride	17	5.5	6	1.0
Calcium/as $CaCO_3$	85/212	180/450	25/57	53/132
Magnesium/as $MgCO_3$	0.06/0.24	0.12/0.48	21/NA	41/NA
Hardness	212	450	154	248
CO_2 (Carbon dioxide)	26	6	NA	NA
pH	10.9	10.8	7.5	7.88
Organics				
TOC (Total organic carbon)	660	230	18	16
Phenol	18		0.01	ND

[a] A = First 1280 ml collected (1 pore volume)
[b] B = Third 1280 ml
[c] ND = Not detected, below detection limits

16 Road Corridor

The 16 Road corridor (Fruita to upgrade) for railroads, access road, natural gas and water supply pipelines, and a transmission line are underlain by the Mancos Shale. The potential for migration of contaminants (due to leaks or spills) into deeper regional aquifers is considered low. Disruption of ground water movement or water quality degradation is very unlikely.

Shale Transfer System - Railroad/Tunnel Route

Utilizing data available for adjacent areas, it appears that changes in ground water could occur during construction of the Railroad/Tunnel Route. The impacts to ground water quality would be short-term and would probably consist of increased TDS concentrations and slight degradation due to introduction of bedrock ground water to the alluvial ground water system as tunneling operations occur through water-bearing rocks. Disruption of ground water flow or spring discharging characteristics is not considered likely because of the small tunnel diameter when compared to the total hillside area and the short term over which construction would occur.

4.4.2.4 Alternative Siting Activities

Rangely Corridors

No significant impact would likely occur to the ground water resources along the corridors. The lower end of Rangley A lies in the Douglas Creek drainage. The placement of the pipeline in this drainage would affect the alluvial ground water system in a manner similar to those corridors which include Roan and Clear creeks. Some minor, short-term impact to the shallow, alluvial ground water resources could occur during the construction phase if higher TDS surface runoff from disturbed areas infiltrates the alluvial aquifer. This impact would diminish with time. No impact would be expected to occur to water-bearing bedrock units.

Spent Shale Disposal

Ground water impacts at the Mesa Valley Fill spent shale disposal site include disruption of the existing Clear Creek alluvial aquifer system, potential ground water quality degradation due to leachate, and spring discharge/recharge removal. Impacts discussed in Section 4.4.2.2 are valid for Clear Creek disposal alternatives. Impacts of Stove/Buniger canyons and nearby sites (FII-50 configuration only) are minimal since there are no existing alluvial aquifers in the canyons. Potential leachate may enter into the Big Salt Wash alluvial system and degrade water quality.

4.4.2.5 Transportation Alternatives

The transportation alternatives are not expected to affect ground water resources.

4.4.2.6 Solid and Hazardous Waste Disposal

Two methods of waste disposal are proposed for this project, (1) disposal with the spent shale in the appropriate disposal area and (2) disposal in a landfill adjacent to the spent shale disposal area on upper Clear Creek. The waste material may be 2-4 percent of the volume of the spent shale material. Potential impacts due to leachate generated by waste disposal would migrate as spent shale leachate described in earlier sections. Assuming disposal practices and site design would prevent leachate generation under natural conditions, adverse impacts are expected to be minor for the solid and hazardous waste disposal site.

4.4.2.7 Secondary Impacts

Secondary impacts due to population growth may have a minor effect on ground water resources in selected areas. The quantity of ground water in these areas may decrease due to the growth of demand for domestic and support industry water supplies. Water quality may be impacted in areas of landfill disposal of solid and hazardous wastes, as generated by the growth of domestic and support industries. Overall, the effect of population increase on the ground water resource may be isolated to areas of extreme increases.

4.5 Topography, Geology, and Paleontology

4.5.1 Topography

4.5.1.1 General Impacts

Topographic impacts associated with development of the Proposed Action and any of the major siting alternatives should not be significant.

Mining of shale oil on Clear Creek mesa will impact topography from the initial construction through reclamation phases of the project. Topographic disturbances are associated with construction of transportation networks, temporary construction routes, facilities, and mining, particularly by surface methods. Most topographic disturbances will be local and temporary since contours will be re-established during reclamation. Additionally, subsidence over mined-out areas will occur with time, as remaining shale oil pillars become incapable of supporting overburden materials above the mine. Studies have indicated, however, that the surface expression of subsidence will be on the order of 1 foot or less and is therefore not considered significant.

Development of roads, railroads or pipelines to transport the mineral resource will affect topography locally within the corridors. The amount of disturbance will depend upon which corridors are utilized, the location of the selected route within the corridor, and the transport alternative selected. Overall, topographic impacts associated with roads, railroads, and, pipelines should not be significant.

Reservoir construction will impact topography locally through construction of embankments, water conveyence systems, and fluctuating water levels. Although construction of reservoirs may affect a stream's capacity to erode in its course, topographic impacts should not be major.

Topographic impacts will be discussed below as they relate specifically to the major project siting alternatives.

4.5.1.2 Clear Creek Mesa and Associated Siting Activities

Mine and Plant Site

The most marked impacts upon the topography on the Clear Creek mesa will occur during the construction phase of the project. During this phase, approximately 800 acres on the divide between Clear Creek and Willow Creek will be graded to approximately 8000 ft in elevation for project facilities (Chevron 1981a). The underground mine will have no direct affect upon the topography. Waste rock from the underground mine will be used as fill material at the plant site (Chevron 1981a). The surface mine will consist of an initial box cut along Willow Creek and will expand at an approximate rate of 86 surface acres per year (Chevron 1981a). Waste rock from the cut will be placed in Willow Creek canyon. The fill will be placed with overall end slopes planned to be 3:1 (horizontal:vertical) with intermediate slopes between benches of 1.5:1 (Moore 1982b). Additional impacts will occur to an undetermined area through the construction of related facilities such as ventilation adits, shafts, and drainage control structures.

Most of the topographic impacts at the Clear Creek property will continue during project operation. Additional impacts will result from the disposal of about 604,000,000 cubic yards of spent shale in the Clear Creek drainage. The fill will be constructed with 40-foot-wide benches at 50-60 foot vertical intervals, with an overall slope of about 4:1 (Moore 1982b). The surface mining operation will be advanced at a rate of about 600 ft per year. Overburden, waste rock, and spent shale will be used to backfill previously mined areas during the operational phase (Chevron 1981a).

Even after grading and recontouring, the topographic configuration at the Clear Creek site will be altered. The overall effect of the mining operation will be a reorganization of the land surface and a general re-establishment of relief over the site. Final regrading efforts should minimize these effects by blending into the surrounding landscape. The re-establishment of drainages and natural geomorphic processes should further mask these alterations.

Topographic impacts will be more pronounced for a combination surface/underground mine (100,000 bpd) compared to all underground mining (50,000 bpd). Construction of roads to serve the open pit and the overall greater disturbance associated with surface mining accounts for the increase in adverse impacts for the 100,000-bpd alternative.

The effect of subsidence due to the underground mine is difficult to estimate. The amount, extent, and the time of occurrence of subsidence is related to the thickness of the seam mined, the strength and distribution of remaining pillar supports, the physical character of the material, and the amount of overburden cover. Up to 12 inches of yield with a surface deflection of probably less than 6 inches after 10 years has been estimated for pillars in the Clear Creek underground mine. (Moore 1982a). Gentle depressions and swales may occur over the mine in the long-term. Subsidence could result in the creation of surface fractures, disruptions of surface drainages, and collapse pits, especially where cover material is thin.

Spent Shale Disposal

The use of side valley fills for spent shale disposal would maintain the existing Clear Creek drainage, and would not create an enclosed depression in the Upper Clear Creek valley. However, the side slope fills may be more susceptible to instability induced by geomorphic processes, such as erosion of toe slopes, unless protective measures are employed to maintain the long-term stability of the fills. Natural erosion processes would, after an indeterminant period of time, affect the surface spent shale disposal area. Proper construction of the shale pile, as well as proper reclamation of the pile, will decrease the possibility of any serious impact. As with the topographic impacts of the mine, spent shale disposal plans and impacts will be addressed in greater detail in the mining and reclamation permit application, to be filed with the Colorado Mined Land Reclamation Board.

Corridors

Roan Creek Corridor. The Roan Creek corridor would be significantly impacted by cut-fill operations related to access and construction. The total area affected is unknown, and cut slopes are as yet unspecified. Impacts will probably be most significant within the Clear Creek canyon, where the narrow canyon and steep slopes will require the most grading. Along this portion of the route, landslide deposits and possibly unstable talus slopes are present (Johnson 1977). Construction activities could initiate sliding in these areas, which might continue into the operational and even post-operational phases. Most of these disturbances would eventually stabilize, and the residual topographic impact should be slight given the geomorphic environment of the canyon.

The De Beque-to-Clear Creek portion of the corridor will be affected only during the construction phase of the project by trenching operations. Since the route is paralleled by an existing road, additional impact for construction access will not occur. Once the pipeline is backfilled and reclaimed, no adverse impacts should occur during the operational or post-operational phases.

La Sal Corridor. The La Sal corridor (Clear Creek mesa to Davis Point) will be affected by trenching operations and development of access roads during construction. There should be no impact related directly to the pipeline during the operational and post-operational phases. However, unless new access roads developed for pipeline construction are recontoured, residual impacts would occur over about 8.7 miles of the pipeline route.

De Beque Railroad Spur. The proposed railroad spur at De Beque would be located in nearly flat terrain. Little topographic impact would result from its construction.

Reservoirs

A 210-ft-high embankment and reservoir dam at the Upper Dry Fork site would directly affect topography of the area. Additional impacts will occur locally in areas where borrow materials are extracted for the dam embankament. A large, flat, delta-like deposit will probably form from sediments carried into the reservoir by surface drainages; this may eventually fill the reservoir unless measures are undertaken to prevent or remove the deposition.

4.5.1.3 Grand Valley and Associated Siting Activities

The Grand Valley upgrading site, about 800 acres, is located in an area of generally low relief. Slopes are gentle to nearly flat, with low hills at some locations. Topographic impacts from grading, operations, and site preparation would be small. Due to the relatively flat nature of the Grand Valley site, topographic impact from the plant site construction should be less than if these facilities were located at the Clear Creek site.

For the Fruita II 50,000-bpd alternative, feed preparation, upgrading, and retort facilities would be located on an 800-900 acre tract. Only the primary crushing facilities would remain at the Clear Creek site. A small amount of grading would be required at the Clear Creek site, and due to relatively flat nature of the Grand Valley site, impacts would be less at the Grand Valley site than at the Clear Creek site.

The Big Salt Wash corridor will have impacts similar to those for the Roan Creek corridor. The route will require construction of several miles of new road for access if this alternative is selected, and will be located within or adjacent to steep terrain where significant grading may be required. If only the water pipeline route is used, topographic impacts should be slight.

4.5.1.4 Alternative Siting Impacts

Water Supply Storage

Three reservoir sites in the Roan Creek drainage were studied in addition to the proposed Upper Dry Fork site. All of the alternative sites are topographically similar to the proposed site. Impacts will be similar for all of the sites with minor variations depending upon dam height and the area inundated.

Spent Shale Disposal

Some insignificant topographic impacts are associated with waste disposal in Stove/Buniger canyons. Similarly, the Munger Creek, Dry Gulch, and Garvey Canyon would experience minor topographic impacts. Of these, the Dry Gulch site would impact existing topographic conditions the most because of its relative location. Construction of ancillary roads will probably be necessary to facilitate access into the canyons. Disposal will fill at least portions of the valleys.

Corridors

Topographic impacts for construction of the various alternative corridors will vary depending on length, relief, and facilities being constructed. Noteworthy are the Straight-Line tunnel and Roan Creek tunnel routes if the Fruita II alternative is selected. These would involve several miles each, through areas of high relief, and could cause some topographic changes. Following regrading and reclamation, however, none of the corridors should cause major topographic changes.

4.5.1.5 Transportation Alternatives

Since transportation alternatives will follow existing contours in valley bottoms or on top of ridges, topographic impacts resulting from their development should not be significant. Local topographic impacts will be associated with construction of any transportation alternative, particularly in cut and fill areas along possible alignments within identified corridors.

4.5.1.6 Solid and Hazardous Waste

If the shale oil is extracted by open pit methods, solid and hazardous waste may be placed in the pit concurrent with reclamation activities. From a topographic standpoint, placement of waste in the pit will benefit the reclamation process by providing additional materials to re-establish existing and/or proposed contours after mining is completed.

Disposal of solid and hazardous waste in a new facility either on-site or in the general area of project should not significantly affect topography. Local disturbances associated with facility construction and establishment of haul roads will occur but should not represent long-term impacts of any significance.

Disposal of solid and hazardous waste in an existing facility off-site should not significantly impact topography.

4.5.1.7 Secondary Impacts

The population and economic growth associated with development of this project will result in the expansion of existing residential centers and possible development of new areas. Topography will be impacted locally, by construction-related activities for roads, houses, shopping areas, and other structures built to support the growing population.

4.5.2 Geology

4.5.2.1 General Impacts

Development of the proposed facilities on Clear Creek mesa or any of the major siting alternatives should have no significant impact on regional geology.

Locally, mining activities will disrupt the existing stratigraphic section, particularly if the shale oil is acquired by surface extraction. Mining of the shale oil and use of local aggregate sources are considered beneficial uses of these mineral resources.

Additionally, construction of haul roads, railroad spurs, and/or pipelines within alternative transportation corridors may produce locally unstable slope conditions in the numerous steep-sided valleys in the project area. Construction of these transportation alternatives may inhibit but not totally preclude future development of potential mineral resources such as sand and gravel and, to a much lesser extent, coal. The local use of sand and gravel in the corridors represents a beneficial application of the materials, since these deposits probably cannot be transported economically to existing commercial markets.

Reservoir construction will require use of locally available construction materials, representing a beneficial use of these resources.

The impacts in this section will be discussed below as they relate to major project siting alternatives.

4.5.2.2 Clear Creek Mesa and Associated Siting Activities

The construction of the plant facilities, access road, and railroad spur will require use of locally available industrial minerals. The alluvial deposits in the Colorado River valley appear to be the probable source of sand and gravel, either through existing commercial outlets or new development of these deposits. The quality of these materials is presently unknown and, if inadequate, materials would be imported by rail and/or truck transport. Additional demands would be placed upon these resources through area-wide growth related to this and other projects. The commerical use of sand and gravel resources is a beneficial use of these materials.

Areas of alluvial and gravel terrace deposits in the Roan Creek and Colorado River drainages may be affected by the proposed reservoir, corridors, and load-out facilities. Talus and alluvium have been developed at two locations in the service corridor (Chevron 1982a) for local use, probably as road base. Significant quantities of similar materials are located at nearby locations, which would be unaffected by the project. If commercial quantities of industrial minerals are recognized to be associated with these deposits in the future, mineral extraction might be inhibited by the proposed facilities, but should not preclude development of these resources.

The combination of underground and surface mining anticipated to produce 100,000 bpd will extract more resource than underground mining at a rate of 50,000 bpd. Extraction of underground shale would deplete approximately 60 percent of the total resource. Surface mining should extract a much higher percentage, therefore resulting in a higher beneficial impact (see details below).

The CCSOP area is located in Seismic Risk Zone 1, where distant earthquakes may cause damage, corresponding to intensities V and VI. Recent studies have identified potentially active faults on the northeast flank of the Monument Uplift (Kirkham and Rodgers 1978) and in the central part of the Piceance Basin (McGuire et al. 1982). The CCSOP facilities should be designed to adequately withstand anticipated or potential seismic events. If this is the case, impacts associated with properly estimated seismic events should not be significant.

Two small, northwesterly trending faults have been mapped near the proposed reservoir (Johnson 1975), one of which is located within the western abutment of the proposed dam. This fault may adversely affect the integrity of the dam foundation unless proper engineering designs are employed to mitigate its potential effects. The faults do not appear to be potentially active and were probably developed during uplift of the Piceance Basin.

Portions of the Roan Creek corridor and mine site are located along narrow, steep-sided cliff-lined canyons. Existing landslides and potentially unstable slopes affect portions of the corridor (Johnson 1975, 1977, 1981). Construction and operational activities could increase the potential for slope movement. Sliding of these slopes may inhibit reclamation efforts, and could adversely affect the integrity of the water pipeline. Based on existing data, the proposed syncrude pipeline route is unaffected by these phenomena (Chevron 1982a).

For the 100,000-bpd combination underground/surface mine, recovery of the oil shale resource left as roof supports in the underground mine appears unlikely due to the hazards of pillar removal and a probable increase in the degree of surface subsidence. An additional 236-foot interval of lower grade oil shale will be left in place overlying the surface mine (Chevron 1981a). Mining of this interval is not economically viable, based on forseeable economic criteria. Subsidence into the underground mine will probably fracture and disrupt these strata, and probably inhibit or preclude its extractability by underground methods in the future. Extraction by surface methods, however, should not be inhibited. The surface mine would extract nearly 100 percent of the oil shale resource that exceeds a minimum grade of 15 gallons per ton. Unmined portions of oil shale left on the property adjacent to the mines could still be mined by future operations, but their extraction would probably be inhibited by lack of a continuous area to mine. Low grade oil shale would be disposed of in the waste rock dump in Willow Creek, and could be recovered in the future if economic conditions become favorable.

The Big Salt Wash reservoir (Garvey Gulch) site is underlain by the Sego Sandstone and the Mount Garfield Formation. The Mount Garfield Formation contains thick persistent coal seams which are mined in nearby areas. If economically mineable coal seams are identified in the reservoir area, their mineability may be inhibited or precluded at the site and adjacent areas.

4.5.2.3 Grand Valley and Associated Siting Impacts

An area of about 400 acres at the Clear Creek mesa site would become available under the Fruita I alternative for mining of oil shale by either underground or surface methods if the upgrading facilities are located at the Grand Valley site. Additional syncrude oil could be developed, representing a more efficient use of the oil shale resource. No mineral resources are known to be present which would be adversely impacted by development of the Grand Valley site.

Under the Fruita II alternative, an area of 800 acres on the Clear Creek site would become available for mining by either underground or surface methods if the upgrading and retort facilities are located at the Grand Valley site.

As with the Fruita I alternative, additional syncrude oil could be developed, representing a more efficient use of the oil shale resource.

4.5.2.4 Alternative Siting Impacts

Reservoirs

Three alternative reservoir sites in the Roan Creek drainage were considered in addition to the proposed Upper Dry Fork site. All of the sites will probably require the extraction of approximately equal amounts of materials for dam construction, from local sources. The quantities of materials should be similar to those required for the Upper Dry Fork site. All of the reservoir sites would inundate alluvial and terrace deposits which may represent potential sources of sand and gravel. Extraction of these materials would be inhibited, but not precluded, if any of these reservoirs were constructed.

Spent Shale Disposal

Disposal in Stove-Buniger canyons, Dry Gulch, Garvey Canyon, and Munger Creek may impact future use of alluvial aggregate resources. Aggregate may be used during construction or removed to facilitate placement of waste on more impermeable strata. The aggregate in these valleys does not represent a major resource because of the haul distances to possible markets. Aggregate resources in greater quantities and of better quality are probably located in larger valley bottom areas closer to the population centers of Fruita and/or Grand Junction.

4.5.2.5 Transportation Alternatives

Project area and regional geologic conditions should not be significantly impacted by development of any or all transportation alternatives. Local impacts should result from use of aggregate resources, construction-induced slope instability, and cut/fill activities. Additionally, construction over mineral resources, such as coal or sand and gravel, may inhibit but should not preclude future economic development.

4.5.2.6 Solid and Hazardous Waste Disposal

The proper placement of solid and/or hazardous waste in the open pit resulting from surface shale oil mining may have a slight potential to lessen the stability of the replaced materials. Development of new facilities on-site or use of existing facilities off-site should be designed to contain the disposed waste properly, and therefore should not significantly impact geology.

4.5.2.7 Secondary Impacts

Population growth associated with the proposed development will increase utilization of mineral resources in the area. The use of mineral resources, such as sand and gravel, or coal, supplied by local commercial outlets represents a beneficial use of these materials. Development of these resources should be environmentally sound to minimize potential for adverse impacts.

4.5.3 Paleontology

4.5.3.1 General Impacts

The development of the Proposed Action on Clear Creek mesa or any of the major siting alternatives should have no significant impacts on regional paleontology.

Paleontological resources may be impacted locally during construction of both temporary and permanent facilities. The mining of shale oil, particularly by surface methods, may expose presently unidentified fossil collection localities. Reservoir and landfill construction may inhibit and possibly preclude potential fossil collection sites from being excavated by both professional and amateur collectors.

4.5.3.2 Clear Creek Mesa and Associated Siting Activities

Fossil occurrences are likely in most of the geologic units within the project area, except for the Douglas Creek Member of the Green River Formation and Molina Member of the Wasatch Formation. A small potential exists for fossil occurrence in the Garden Gulch Member of the Green River Formation. The significance of these occurrences would depend upon the type, geologic age, and degree of preservation of the individual fossil. As a result, fossils within a unit where their occurrence is unlikely may be more significant than units where fossils are common. The proposed mining and grading operations performed during construction of the project facilities will undoubtedly damage or destroy fossils in nearly all of the geologic units affected. Conversely, these operations may unearth fossils which otherwise would have remained buried.

Due to increased disturbance and possible development of more waste material, paleontological resources may be impacted more during a combination of surface and underground mining (100,000 bpd). Overall, impacts are not expected to be significant under either scenario.

Mines, road-cuts, and other excavations are preferred fossil collection sites by professionals, and may be useful as such during construction and operation of the project. The potential for fossil collection activity would probably be reduced by regrading and revegetation efforts after operation.

One important fossil locality has been identified within the proposed project area. The locality parallels the existing Roan Creek Road on the northeast side. The locality has produced bird fossils from the Shire Member of the Wasatch Formation. It is not known if the actual alignment of the proposed access road, water pipeline, or transmission line will affect this locality.

Another fossil locality may also be present within the proposed Roan Creek corridor in the Garden Gulch Member of the Green River Formation; however, its exact location is unknown (TRW 1981).

4.5.3.3 Grand Valley and Associated Siting Activities

Spent shale disposal in the Stove/Buniger canyons may impact potential fossil collection sites. The disposal of waste represents an irretrievable use of the land and any fossil beds beneath these materials will be totally inaccessible under normal circumstances.

4.5.3.4 Alternative Siting Impacts

See Sections 4.5.3.1 and 4.5.3.2.

4.5.3.5 Transportation Alternatives

Paleontological resources should not be adversely impacted by development of these transportation alternatives. As a result of road and/or railroad construction, fossil collection sites may be exposed for retrieval by both professional and amateur collectors. Conversely, in fill areas certain potential and presently unidentified fossil sites may be masked, inhibiting the possibility of collection.

4.5.3.6 Hazardous and Solid Waste Disposal

Excavation for borrow material and overall site preparation for new hazardous or solid waste disposal facilities may expose presently unidentified fossil collection sites within and adjacent to the existing project area. The operational phases of these facilitites will potentially cover sites and inhibit or possibly preclude future collection. Due to the widespread distribution and common nature of most fossil collection sites in the area, no significant adverse effects on paleontological resources are anticipated. Additionally, no additional impacts are associated with the use of existing permitted disposal areas in the vicinity of the project area.

4.5.3.7 Secondary Impacts

Area population growth associated with the CCSOP will result in increases in construction-related activities for residential and commercial dwellings, hospitals, wastewater treatment facilities, landfills, and local roads and highways. Regrading activities, excavations and development of earth building materials may expose fossil collection localities which otherwise might remain undetected. Conversely, development over unidentified fossil beds may inhibit or preclude exploration for and collection of significant fossil types.

4.6 Soils

4.6.1 General Impacts

Construction and operation activities associated with the development of the CCSOP would result in changes in soil erosion rates and losses, temporary or permanent loss of prime farmland, physical and chemical changes, and changes in soil (agricultural) productivity. Generally, impacts to the soil resource would be a function of the acreage of disturbance; hence, the greater the disturbed area, the greater the impact.

Project development activities would tend to accelerate wind and water erosion rates. Accelerated wind erosion during construction and operation phases would result from one or a combination of the following: (1) loss of vegetation, (2) degradation of surface soil aggregates into sizes more susceptible to detachment and transportation, (3) soil dessication, and (4) surface horizon textural change. Accelerated water erosion could be caused by loss of surface vegetation, increase in slope, change in surface texture, change in surface soil structure, smoothing of the surface horizon, or failure to implement water erosion control measures. Accelerated erosion would begin during construction and level off during operation. Erosion would decrease during postoperation, as natural conditions are reestablished or reclamation occurs.

Physical and chemical characteristics of the soils would be changed during disturbance regardless of the project phase. It is anticipated that the texture and chemical characteristics of a given profile would become more homogeneous as a result of stripping, mixing, handling, and replacement activities. Runoff would increase significantly during disturbance, then decrease to near predisturbance levels after revegetation. Soil drainage would remain roughly the same during disturbance and after reclamation. The available water-holding capacity of the soil could either increase or decrease depending upon specific textural changes. The infiltration and percolation of the soil would change as a result of differences in porosity, pore geometry, and pore size distribution. Although some of these impacts would be positive, the overall impact to the physical and chemical characteristics of the soils could be slightly adverse.

Nearly all available topsoil would be stripped and stockpiled during construction activities. Stockpiled topsoil would lose its predisturbance vegetative productivity after about a year due to decreased microbial activity below the surface of the stockpile. When this material is replaced during topsoiling activities, it could take up to 6 years to return to predisturbance productivity levels and microbial activity rates.

4.6.2 Clear Creek Mesa and Associated Siting Activities

Project development for the PA-100 and CC-100 alternatives would cause a temporary loss of 205 acres and residual losses of up to 51 acres of prime farmland, according to SCS prime farmland maps (SCS 1979a, 1979b, 1979c). There would be no loss of unique farmland. Potential prime farmland losses are summarized in Table 4.6-1. Since Colorado Land Mine Reclamation Board reclamation procedures and standards for prime farmland disturbed by mining or associated facilities are generally quite stringent, it is expected that the agricultural productivity in temporary loss areas should be at or near predisturbance levels within 5 years after reclamation is initiated.

Incremental tons of soil loss (units lost under disturbed conditions minus units lost under undisturbed conditions) would be highest, although still insignificant, for the PA-100 and CC-100 alternatives (Table 4.6-1). These alternatives would also have the greatest incremental percentage of soil loss, approximately 370 and 355 acres, respectively. The project component with the greatest potential incremental tons of soil loss would be the surface mine (1.9 million tons). Relative to other project components this would be a significant impact. The surface mine would also have the greatest incremental percentage of soil loss at 1,295 percent (Table 4.6-1). The Mesa Valley Fill site would have a −97 percent incremental soil loss (positive impact) because erosion losses would cease once spent shale filling commences. In other words, soil losses under disturbed conditions would be less than natural conditions.

Table 4.6-1 APPROXIMATE PRIME FARMLAND AND SOIL LOSS COMPARISONS

	Naturally[a] Occuring Soil Loss (tons)	Incremental Soil Loss for Disturbed Conditions (tons)	Incremental Soil Loss for Disturbed Conditions (percent)	Prime Farmland Losses (acres)[b]
Major Project Configurations				
Proposed Action - 100,000 bpd	830,000	3,090,000	372	780/630/630
Proposed Action - 50,000 bpd	686,000	1,097,000	160	780/630/630
Clear Creek - 100,000 bpd	651,000	2,034,000	354	580/580/580
Clear Creek - 50,000 bpd	497,000	308,000	62	580/580/580
Fruita I - 100,000 bpd	860,000	3,185,000	370	890/740/740
Fruita I - 50,000 bpd	700,000	1,170,000	167	890/740/740
Fruita II - 50,000 bpd	4,636,000	−2,728,000[c]	−59[c]	820/660/660
Project Siting Alternatives				
Surface Mine	147,272	1,907,847	1,295	0/0/0
Mesa Plant Site and Underground Mine Portals	14,080	182,400	1,295	0/0/0
Fruita Plant Site	18,880	96,320	510	0/0/0
Mesa Valley Shale Disposal	358,820	−348,382[d]	−97[d]	0/0/0
Dry Gulch Shale Disposal	4,289,820	−4,270,486[d]	−100[d]	0/0/0
Garvey Gulch Shale Disposal	12,920,000	−12,907,840[d]	−100[d]	0/0/0
Stove/Buniger Canyon Shale Disposal	18,638,880	−18,621,258[d]	−100[d]	0/0/0
Munger Creek Shale Disposal	14,178,000	−14,164,656[d]	−100[d]	0/0/0
Upper Dry Fork Reservoir	65,436	414,428	633	0/0/0
Lower Dry Fork Reservoir	78,555	497,638	633	0/0/0
Upper Conn Reservoir	74,328	470,744	633	0/0/0
Lower Conn Reservoir	71,421	452,333	633	0/0/0
Garvey Gulch Reservoir	9,975	5,565	56	0/0/0
Parachute Gulch Reservoir	284,138	12,809	5	0/0/0
Roan Creek Corridor	78,036	330,724	423	0/0/0
Big Salt Wash Corridor to CC	179,504	780,152	434	205/0/51
Fruita to Fruita Plant Site Corridor[e]	10,870	175,490	1,614	205/0/51
Douglas Pass to Fruita Plant Site Corridor	7,616	140,896	1,850	168/0/56
Deer Creek Corridor	7,923	136,767	1,726	16/0/16
Overland Corridor	77,484	211,320	273	260/0/80
La Sal Pipeline	1,208	11,419	945	0/0/0
Parachute Creek Pipeline	16,982	65,146	384	0/0/0
Dorchester Coal	714	13,203	1,849	7.6/0/0
Rangely A Pipeline	5,486	9,602	175	4.2/0/0
Rangely B Pipeline	2,285	10,743	470	0/0/0
Buck Gulch Pipeline	1,762	14,078	799	0/0/0
Sheep Gulch Pipeline	13,842	12,371	89	0/0/0
Lisbon (SOPS) Pipeline	4,845	6,395	132	0/0/0
La Sal Transmission Route	502	4,765	949	0/0/0

[a] Natural erosion over a 100 year period without the CCSOP
[b] Short term/long term/residual
[c] Natural soil losses are less than disturbed losses by this amount
[d] Disturbed condition soil losses are less than undisturbed (no action) conditions
[e] Part of the Big Salt Wash Corridor to the Clear Creek Property

Temporary accelerated erosion would occur for nearly all project alternatives (except possibly in some of the drier areas of the Roan Creek Valley and Grand Valley). Assuming revegetation efforts are successful, expected erosion rates should return to predisturbance levels within 3-6 years after revegetation, except possibly on steep reservoir embankments.

Compaction of soil from heavy machinery traffic would occur during the installation of pipelines and power transmission structures and operation of maintenance roads alongside railroad routes. The magnitude of compaction would likely be minimal, and the overall impact would be insignificant.

Disturbance to the soil profile in railroad and reservoir areas would result in either changes in soil chemical and physical characteristics or burial of the existing undisturbed profile. Reservoir water could increase the salinity and sodium content of shoreline soils through the upward migration of soluble salts. These impacts would be insignificant.

Since development of the underground mine would potentially disturb less than 15 acres, impacts to the soil resource would not be extensive. Where surface disturbance does occur, it is expected that the impacts would be similar to those which would occur at the plant site.

Combustor off-gases from the retorting facilities, including SO_2, NO_x, NO, NO_2, and particulates, would be deposited upon the soil surface as a result of direct fallout or from absorption by rain. The effect of these phenomena on the soil resource is not fully understood, but preliminary assessments of exisiting data indicate that short-term impacts would be insignificant. The upland plateau would be the area most susceptible to impact. Soils in this area have the lowest buffering capacity to acid rain.

Coal debris, raw shale, or spent shale dust could be deposited on the soils along transportation routes during operation. Impacts would be insignificant and cause minimal changes in present soil characteristics.

The 50,000-bpd production rate alternatives would involve all underground mining, thereby reducing surface impacts. Considering the significantly fewer acres of surface disturbance, the impacts to the soil resources would be insignifiant.

4.6.3 Grand Valley and Associated Siting Activities

Types of impacts to soils resulting from the Fruita plant site, pipeline, power transmission, road, railroad, and reservoir construction, operation, and postoperation activities for the Grand Valley alternatives would be very similar to those discussed in Section 4.6.2. The magnitude of the impacts would vary. Prime farmland acreage losses and erosional impacts are presented in Table 4.6-1.

Incremental soil loss (tons and percentage) would be greatest, although insignificant, for the FI-100 alternative, at 3.1 million tons and 370 percent (Table 4.6-1). The area disturbed for the FI-50 and FII-50 alternatives would be approximately the same, incremental soil losses would be different (1.1 and −2.7 million tons, respectively). Of the siting alternatives not addressed in Section 4.6.2, the greatest incremental soil loss would be for the Fruita to Fruita plant site corridor at approximately 0.18 million tons (or 1,614 percent).

4.6.4 Alternative Siting Activities

Impacts to soils during construction and operation would be similar to those discussed in Sections 4.6.1 and 4.6.2. Potential erosional impacts and prime farmland acreage losses are detailed in Table 4.6-1. In addition to the impacts already discussed, considerable soil disturbance would occur during construction of railroad tunnels and bridges across several small valleys en route to Clear Creek mesa. Where cut and fill slopes exceed 30 percent, water erosion rates could be very high. Due to the difficulty of re-establishing vegetation on such slopes, these erosion rates could decrease very slowly with time. The alternative siting activity that would incur the greatest soil loss would be the Lower Dry Fork reservoir. The greatest incremental soil loss percentage would occur in the Douglas Pass road and Dorchester Coal corridors (1,850 and 1,849 percent, respectively). However, incremental tons of soil loss would be 0.14 and 0.013 million tons, respectively, for these two siting alternatives. These impacts would be higher than for other corridors, but would be insignificant overall.

4.6.5 Transportation Alternatives

These alternatives would not change erosion rates or to cause additional loss in prime farmland acreages from those already discussed in Sections 4.6.1 and 4.6.2.

4.6.6 Hazardous Waste Disposal

The soils in and around the hazardous waste disposal area (the location of which has not yet been identified) would not be contaminated should the regulatory requirements for sealing and containment be implemented. Should hazardous wastes be spilled on soils along roadways, a contingency spill plan would be implemented.

4.6.7 Secondary Impacts

Some secondary impacts upon soils would occur as a result of implementation of the CCSOP. Some of these impacts would be short-term (less than 3-6 years after construction) and others would be residual.

Housing for project employees and associated support facilities in the Fruita, Grand Junction, and Rifle areas would result in residual impacts to prime farmland. It is estimated that residual prime farmland losses in the Grand Valley and around Rifle would be approximately 550 acres for the Clear Creek alternatives and 700 acres for the Grand Valley alternatives.

Short-term erosion would occur during construction of housing and community facilities. It is anticipated that these accelerated erosion rates would decline within 5 years after development when landscaping of yards, parks, and other community areas has been completed. Disturbance condition erosion rates would be comparable to other project disturbances in the Grand Valley.

4.7 Aquatic Ecology

4.7.1 General Impacts

The Fish and Wildlife Service (FWS) is presently fulfilling the requirements of the Fish and Wildlife Coordination Act (P.L. 85-624) and the Endangered Species Act (Code of Federal Regulations 16:1531-43)). Chevron and GCC are providing the FWS with significant additional information. For this reason, the contents of this section should be regarded as a first approximation of the likely impacts associated with the CCSOP, including all of its alternative configurations. It is anticipated that the additional information available to FWS will allow them to further refine both the probability and magnitude of these impacts.

Impacts to aquatic biota will occur during both construction and operation phases of the CCSOP. Project construction activities would eliminate some aquatic habitat and would expose the area to surface erosion and could increase sediment and silt loadings to surface water. Specific amounts of sediment entering these water bodies would depend on their proximity to the construction area, the frequency and magnitude of storm/runoff events, and the kinds of sediment abatement practices employed during construction activities. Significance of the impacts is dependent on the value of the aquatic biota inhabiting the water bodies. The effects of sediment on aquatic biota are well documented (Iwamoto et al. 1978) and can include the following: the destruction of fish and aquatic invertebrate communities through the smothering of fish eggs and aquatic organisms; decreased fish feeding efficiency due to turbidity and loss of visibility; reduction in available fish habitat due to the "filling in" of pools; and displacement of fish and aquatic organisms downstream to more favorable conditions.

Impacts resulting from operations are primarily those caused by the water supply system, the surface water control system, and corridors. Other than the surface water control system, mine-induced impacts are essentially those described for construction activities. Upgrading and retorting facilities are designed for zero discharge and, thus, should have little impact on aquatic life.

The water supply system would likely have a significant detrimental effect on organisms in the Colorado River as a result of direct losses from impingement and entrainment at the point of water diversion, as well as loss of downstream habitat from flow depletions. Habitat could also be reduced in other streams as a result of flow depletion caused by pumping of alluvial aquifers and low discharges from water storage reservoirs associated with water supply and surface water control systems.

Potential impacts from use of corridors may result from sediment and dust suppression chemicals contained in runoff from unpaved roads; deicing and other chemical treatments contained in runoff from paved roads; materials spilled as a result of vehicle (truck or railroad) accidents, pipeline breaks, and windborne losses from trucks and railroad cars; and surface disturbance caused by repair and maintenance of the corridor. The potential for impacts resulting from these activities increase with the length of the corridor, the amount of use the corridor receives, the proximity of the corridor to surface water, and the sensitivity (importance) of potentially impacted water bodies.

During both construction and operation phases, the potential exists for significant secondary impacts. These would likely result from the increases in fishing pressure, increased flow depletion for domestic water supplies, and increases in both point and nonpoint sources of pollution which will result from project-induced population increases.

Each of the general types of impacts, as they apply to the various project alternatives, are discussed in the following sections. Discussion is limited to the aquatic ecosystems potentially directly impacted by project activities. The Colorado River is considered only as far downstream as Westwater Canyon (R.M. 116 to R.M. 124).

4.7.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action (PA-100)

Mine and Plant Site. Activities at these sites would include the damming of East and West Willow Creek, Willow Creek, and Upper Clear Creek to control mine water. No release of water to these streams from the resultant impoundments, from the lower Clear Creek sedimentation control reservoir, or from the diversion water impoundment to be located on lower Clear Creek is planned, except when necessitated by runoff greater than that caused by a storm lasting 24 hours with a probability of occurring once in every 100 years. Thus, the dams, associated water diversions, and mining activities would essentially eliminate the aquatic biota presently found in the mesa portions of these streams (see Section 3.7). Flows would also be reduced or eliminated in the portions of these streams downstream of the lower Clear Creek dams. Flow reductions would reduce aquatic habitat, increase duration of no flow periods in ephemeral stream reaches, and increase the extent of these ephemeral portions of Clear Creek.

During construction of water control facilities, increased suspended solids can be expected in the controlled streams. Impacts of suspended solids would be greatest in the portions of these streams immediately downstream of the construction sites, both because of proximity to the sources of the suspended solids and because the trout species found in those stream segments are especially sensitive to increased suspended solids (Garton et al. 1979). However, as noted in the preceding paragraph, these stream segments would be eliminated when the control system is completed. Downstream reaches of Clear Creek and Roan Creek are not likely to be significantly impacted by these increases in suspended solids, since they are inhabited primarily by fish species (suckers, sculpin, and dace) which are less sensitive than trout.

Because the sedimentation reservoir is designed for the 100-year, 24-hour storm event, discharges from the reservoir can be expected at least once during the 100-year life of the project. The probability that discharges would occur more than once should be considered for storms lasting longer than 24 hours, storms superimposed on runoff from snowmelt, or if more than one storm of lesser rainfall occurs within a short time period. Discharge from the sedimentation reservoir would be high in suspended solids and would cause flood flows in Clear and Roan Creeks (see Section 4.4). Because the high water velocities associated with the discharge would tend to keep solids suspended, and because the stream substrates presently found in Roan and Clear Creeks are generally high in sediment (Woodling 1977 and Chevron 1981e), the suspended solids in sedimentation reservoir discharges are not likely to have significant impacts. Impacts from flood flows are likely to be similar to those occurring from natural causes.

Corridors. The La Sal pipeline route (Clear Creek Mesa east to Davis Point) will cross Willow Creek, No Name Creek, Mud Springs Creek, and the West Fork of Parachute Creek. Construction and operation of a pipeline using this route would most likely affect Willow Creek and the West Fork of Parachute Creek which are known to harbor cutthroat trout populations (Section 3.7); no fish are thought to reside in No Name Creek or Mud Springs Creek. The route is sufficiently distant from the Colorado River to minimize the chance of a pipeline break impacting endangered species there.

Construction of a water pipeline and maintenance road from the Loma diversion to the Clear Creek mesa could potentially impact several aquatic systems including the Colorado River, Big Salt Wash, Mack Mesa Reservoir, Highline Lake, Ruby Lee Reservoir, and West Douglas Creek. With the exception of the Colorado River, Mack Mesa Reservoir and Highline Lake, the above systems offer little fishery potential.

A multiple use corridor is also proposed for the Clear Creek and Roan Creek valleys. Multiple uses will include water pipelines, a road, and a transmission line. The corridor is proximate to Roan and Clear creeks for its entire length, thus increasing chances of impacts to these streams. However, as noted in Section 3.7, aquatic resources in Clear Creek and the lower, potentially impacted, portion of Roan Creek are not unique or especially valuable. Although cutthroat trout have been found in lower Clear and Roan creeks, use appears to be seasonal at most. These stream segments would be impacted by reservoir operation and construction, pumping of alluvial aquifers, and diversion of headwater streams. The incremental impacts of corridors adjacent to these streams would likely be minimal.

A transmission line intertie from the mine, retorting, and upgrading site to Davis Point is part of the Proposed Action. Although construction-related impacts to Mud Springs Creek, West Fork Parachute Creek, and Willow Creek are possible, they should be extremely minor, both in terms of extent and duration, because only small land areas will be disturbed.

Reservoirs. A 175,000-acre-ft storage reservoir is proposed within the Roan Creek drainage. Depending upon the site selected, this reservoir would eliminate stream habitats in portions of Roan Creek, Dry Fork Creek, Conn Creek, or Clear Creek. Table 4.7-1 provides a comparison of potential stream miles flooded for the four reservoir sites; the maximum is 7.3 miles at the Lower Dry Fork site, and the minimum is 5.8 miles at the Upper Dry Fork site. The inundation of upper Roan Creek, which would occur with a dam located at the Upper Conn or Lower Conn sites, is regarded as having the greatest impact since it would reduce or eliminate the rainbow and cutthroat trout populations there (Chevron 1982a). No trout have been collected from Roan Creek at the Upper or Lower Dry Fork sites (Chevron 1981f).

In addition to the loss of stream habitat, the construction of a reservoir on Roan Creek could also alter downstream water quality characteristics, including water temperature, turbidity and dissolved oxygen (see Section 4.4.1 Water Resources). Resulting water quality changes could be either positive or negative, depending on the reservoir's physical and chemical conditions and the depth from which water is released. Positive chemical changes could include a reduction in suspended solids and water temperature and an increase in dissolved oxygen. However, if anoxic (oxygen-limiting) conditions develop in the deeper portions of the reservoir and water is discharged from these levels, discharged water could be low in dissolved oxygen and high in ammonia and hydrogen sulfide (Hynes 1972). This condition could have toxic effects on downstream biota.

The Operator plans to release water from the reservoir at a rate of 15 cfs to meet senior downstream water rights; however, no minimum stream flow releases are proposed. Thus, portions of Roan Creek below the reservoir could occasionally be completely dewatered when releases to downstream users are not required. Aquatic biota within this reach of stream could be eliminated during these periods. However, the aquatic habitat and water quality characteristics of lower Roan Creek are presently marginal for supporting aquatic life during much of the year (Chevron 1981f; Woodling 1977). Thus, the dewatering of a small portion of Roan Creek during certain times of the year would probably not result in a serious loss of aquatic biota. Additionally, the potentially affected stream segment would be subjected to impacts from flow depletion caused by alluvial aquifer pumping and from headwater diversions.

The Operator proposes no recreational fishery for the storage reservoir since water withdrawals could be highly variable and could result in extreme fluctuations in water level. Biological productivity in such an environment would be extremely low. Thus, the reservoir is not likely to ameliorate any of the lost or impacted aquatic environments.

The Big Salt Wash reservoir would inundate portions of Garvey Gulch and Big Salt Wash. However, no fish are thought to reside in Garvey Gulch, and aquatic biota in Big Salt Wash have limited value (Section 3.7). As was the case for the Roan Creek reservoir, variable reservoir levels in the Big Salt Wash reservoir would probably preclude a fishery.

Table 4.7-1 COMPARISON OF STREAM MILES LOST DUE TO CONSTRUCTION OF ROAN CREEK RESERVOIR SITES

Site	Affected Streams	Miles Flooded	Total Miles
Upper Conn	Roan Creek	5.50	7.2
	Conn Creek	1.65	
Lower Conn	Roan Creek	4.80	6.2
	Conn Creek	1.40	
Upper Dry Fork (Proposed Action)	Roan Creek	4.80	5.8
	Conn Creek	0.98	
Lower Dry Fork	Roan Creek	4.60	
	Conn Creek	0.36	7.3
	Dry Fork Creek	2.30	

Water Supply. The water supply system proposed by the Operator includes the use of alluvial wells within the Clear Creek property as well as water diverted from three locations on the Colorado River: near De Beque, downstream from De Beque at the Finley Ranch, and near Loma (Figure 4.4-2). Utilization of the alluvial wells may reduce the flows in both Clear Creek and Roan Creek (see Section 4.4). The amount of the flow reduction is unknown and it is, therefore, impossible to predict the biological impacts associated with the reduction. However, this flow reduction would be in addition to reductions caused by damming the headwater tributaries to Clear Creek. This would increase the severity of previously described flow-induced impacts to Clear Creek and Roan Creek. As noted in Section 3.7, the aquatic habitats found in the potentially affected portions of these streams are not regarded as valuable resources.

The Finley Ranch diversion will be used to provide water to holders of water rights senior to Chevron, should this be required as a result of pumping alluvial wells. Water diverted at the Finley Ranch will be piped directly to irrigation ditches, and thus will not mitigate impacts to the aquatic biota in Roan and Clear Creeks resulting from flow reductions.

The Loma and De Beque diversions would require new construction in the Colorado River and adjacent lands. For the conventional De Beque intake (Chevron 1982u), construction of a cofferdam, placement of precast weir panels, casting of cast-in-place weir sections, and near river land disturbance associated with sedimentation ponds, pump house, and regulation pond would be required. In-river disturbance would occur during low flow periods (Chevron 1982u). Construction plans for the Loma porous dike intake have not been provided, but in-river disturbance is likely to be limited since the existing river bank would serve as the porous dike. These construction activities would cause temporary increases in suspended solids. As most of the aquatic biota in the Colorado River are adapted to turbulent and muddy conditions (see Section 3.7), impacts from diversion construction are likely to be insignificant.

More significant impacts would be expected to be caused by water diversions. Specifically, organisms entrained in the diverted water would be removed from the Colorado River, others would be impinged against components of the diversion structure, and habitat would be reduced by flow depletion. An approximation of estimated losses due to impingement and entrainment can be determined by comparing quantities of water withdrawn to river flow. This approximation requires the assumption that organisms are either randomly or evenly distributed in the river and that none can escape either because of behavioral or mechanical (diversion design) reasons. Estimated legally divertible water volumes by GCC during each of the average monthly flows at De Beque are given in Table 4.7-2. It should be noted that the river flows shown are based on 30 years of record, and do not fully reflect recent diversions. As can be seen from this table, an estimated average of 21 percent and a maximum of 32 percent of the organisms in the vicinity of the diversion would be lost as a result of water withdrawals at De Beque.

This estimate of losses can be refined by considering the degree to which the assumptions of random (or even) distribution and escape potential are valid. With respect to random distribution, the weir could produce a relatively unique habitat, such as a refuge from the riverine environment characteristic of the Colorado River near De Beque (Chevron 1981m), which could attract organisms sufficiently motile to make use of this habitat (EPA 1976b). This would increase the concentration of organisms potentially entrained or impinged by the De Beque diversion, and would likely increase the losses of organisms above simple proportional losses.

However, some of these organisms are capable of escaping entrainment, even though the design intake velocity of 2 feet per second (fps) is more than double that suggested by EPA (1976b). For example, adult Colorado squawfish are capable of swimming at 3 fps for extended periods of time (Miller et al. 1982). Thus, at least some of the organisms considered lost by the proportional analysis could escape from the water being withdrawn. It should be noted that other indigenous fish and young squawfish are less capable swimmers than adult squawfish, and that fish swimming ability is impaired at the temperatures found in the Colorado River when the proportion of withdrawn river water is greatest (Miller et al. 1982).

No features which would help lessen impingement and entrainment losses have been incorporated into the De Beque diversion design. Thus, there is no mechanical reason to suggest that losses of aquatic biota would be less than those suggested on the basis of the proportional water withdrawal analysis. However, as described in Section 3.7, existing information suggests that the Colorado River habitat near De Beque is little used by endangered fish species. Impacts to the aquatic biota from operating the De Beque diversion, although severe, would likely be limited to those species commonly found in large river habitats. Miller et al. (1982) conclude that the endangered Colorado squawfish spawn in upstream areas and that young squawfish drift downstream. Neither the studies by Miller et al. (1982), nor those sponsored by the GCC provide data regarding the presence or absence of fish fry which would test this hypothesis as it applies to potential impacts from operation of the De Beque intake. The lack of squawfish caught above De Beque (Section 3.7), however, provides an indication that spawning does not occur above the intake location. Concentrations of Razorback suckers have occasionally been reported in the De Beque area (Chevron 1983a). However, elimination of backwater habitats in the area reduced numbers found in recent studies to occasional individuals (Chevron 1983a).

Spawning of Colorado squawfish is thought to occur in the vicinity of the proposed intake near Loma (Valdez et al. 1982). The Colorado River near Loma is also within those portions of the river where other endangered species have been found (Section 3.7). For these reasons, the Operator proposes the use of an infiltration dike at this location, which should reduce direct intake impacts to aquatic biota if properly designed and operated

(Schrader and Ketschke 1978). Insufficient information is available regarding operation of the diversion, especially with respect to low flow periods and backflushing, to assess the likelihood of achieving the goal of minimum impacts to aquatic biota.

The maximum water withdrawal proposed at the Loma diversion is 125 cfs. Although the Operator will generally balance water withdrawal between the two diversion points (De Beque and Loma), at times the diversion of water may be maximized at both points, resulting in a combined withdrawal of 567 cfs. In addition to those impacts resulting from diversion operation described in the preceding paragraphs, impacts to downstream aquatic biota could also result from flow depletion. Analysis to date by GCC suggests that none of the withdrawn water will be returned (Chevron 1982w). This could reduce available fish habitat, change water quality (see Section 4.4), and, in conjunction with other water diversions, impact downstream locations thought to be critical to the survival of endangered species. Recommended flows for the maintenance of present production levels of Colorado squawfish and humpback chub for the stream reaches from Loma to the Utah border, Westwater Canyon, and Black Rocks are given in Table 4.7-3. It is possible that water withdrawals could result in flow reductions below these recommended levels.

Table 4.7-2 WATER WITHDRAWAL RATES AND COLORADO RIVER FLOWS[a]

Month	Average River Flow at De Beque (cfs)	Diversion Rate (cfs)	Percent of River Flow Diverted
October	2,028	431	21
November	1,611	433	27
December	1,330	410	31
January	1,230	388	32
February	1,271	404	32
March	1,419	429	30
April	2,508	442	18
May	6,471	442	7
June	8,716	442	9
July	3,968	436	11
August	2,224	380	17
September	1,972	399	20
Average			21

[a] Based on GCC river flow data and their analysis of water rights and legally divertible water (Chevron 1982w).

Spent Shale Disposal. No water discharges are planned from spent shale disposed in the valley fills or from spent shale disposed in the open pit mine. Runoff from the spent shale areas will be routed to sedimentation ponds prior to reuse. However, capacity of the sedimentation ponds may be exceeded during extreme storm events, as described in the preceding paragraph.

Sometime after reclamation and project abandonment, failure of the spent shale disposal areas would occur as a result of natural erosional processes (Shelton 1982). Chemical concentrations in runoff and/or ground water

Table 4.7-3 FLOW RECOMMENDATIONS FOR THE COLORADO RIVER TO MAINTAIN PRESENT PRODUCTION LEVELS FOR COLORADO SQUAWFISH AND HUMPBACK CHUB

Location	Species	Period	Life Stage	Flow (cfs)
Loma-Utah Line	Colorado Squawfish	6/15-7/31	Spawning	5,000-10,000
Loma-Utah Line	Colorado Squawfish	8/1-8/31	Larvae	3,000-5,000
Black Rocks Canyon	Humpback Chub	5/1-6/30	Spawning	10,000-13,000
Westwater Canyon	Humpback Chub	5/1-6/30	Spawning	10,000-13,000

Source: Miller et al. (1982).

contributions to surface water after penetration of the capillary barrier cannot be predicted. However, in a worst-case analysis, it is conceivable that failure of spent shale disposal areas could result in significant impacts to downstream aquatic biota (Roan Creek, Clear Creek, Colorado River).

Clear Creek Alternative (CC-100)

Since the Loma diversion and Big Salt Wash corridor would not be constructed for the Clear Creek Alternative configuration, aquatic ecology impacts would be limited to those associated with the diversion and depletion of Colorado River water near De Beque, and to the streams affected by mine development and operation, the La Sal pipeline, the Clear Creek/Roan Creek multiple use corridor, and the Clear Creek mesa to Davis Point transmission line intertie.

Production Rate Alternatives (PA-50, CC-50)

According to the Operator (Chevron 1982v), the water system and water supply plans remain essentially the same for the 50,000-bpd alternatives. Therefore, spent shale disposal, the quantity and rate of water diversion, size of water storage facilities, and pumping of alluvial aquifers remain unchanged. Thus, potential impacts caused by these project activities persist at the lower production rate.

Underground mining should eliminate much of the water control facilities planned for the headwater tributaries of Clear Creek. Impacts in Roan and Clear creeks caused by flow depletion would be somewhat lessened. However, depletion in these streams would still result from alluvial aquifer pumping and reservoir operation. Reduced corridor utilization will lessen the chance of spills caused by vehicular accidents. Reduced surface disturbance would decrease the potential for construction-related impacts to aquatic biota by sedimentation. A reduced work force would lessen the secondary impacts caused by flow depletions from domestic water supplies, point and nonpoint discharges associated with the population increase, and fishing pressure.

Except for the reduction of secondary impacts, changes in impacts associated with a reduced production rate would not be significant when compared to the 100,000-bpd alternatives. In the case of corridor utilization and retorting and upgrading facility construction, impacts would likely be minor even at 100,000 bpd. In the case of impacts from water depletion in Roan and Clear creeks, depletion caused by alluvial aquifer pumping and reservoir operation would still persist.

4.7.3 Grand Valley and Associated Siting Activities

Fruita I Alternative (FI-100)

Construction activities associated with development of upgrading facilities in the Grand Valley area could potentially affect several adjacent aquatic systems; Mack Mesa Reservoir, Highline Lake, Big Salt Wash, Little

Salt Wash, Reed Wash, and Highline Canal. As with most construction activities, the primary impacts to the aquatic ecosystem would be related to sedimentation and/or the direct destruction of habitat. With the use of proper sediment abatement practices, minimal impact to existing aquatic systems should result from the construction and operation of these facilities.

One of the more significant construction and operation impacts to the aquatic systems from this alternative could result from the increase in fishing pressure (resulting from the influx of construction workers and families) on Mack Mesa Reservoir and Highline Lake. These two lakes provided fishing opportunities for a combined estimate of 28,000 people in 1981, who fished for about 72,000 hours and captured 37,000 fish (CDPOR 1982).

Other potential impacts associated with this alternative are related to corridors and corridor utilization. In addition to the corridors described for the Proposed Action, product and raw shale oil pipelines, transmission lines, and an all-weather road would be added to the Fruita to Clear Creek (Echo Lake) corridor. A corridor for a road, transmission line, and railroad would also be required to provide access to the Fruita site. These additional uses for corridors would subject potentially affected streams to greater construction impacts for more extended periods of time than would be the case if the corridor were used for a water pipeline only (as in the Proposed Action). However, these impacts would still not be significant, providing care was exercised during construction.

This alternative provides an increased potential for accidental spillage caused by train or truck accidents, or pipeline breaks, than the Proposed Action. This is a result of the increased length of oil pipelines and traffic between the upgrading and retorting facilities required by this alternative. Impacts associated with a spill are more likely to be significant than is the case for the Proposed Action, since portions of the pipeline route are much closer (7 miles versus 30 miles) to the Colorado River and because the portion of the Colorado River near Fruita is critical habitat for endangered fish species, while the Colorado River near De Beque is not.

All of the impacts to aquatic biota associated with water diversion, reservoirs, and corridors described for the proposed action would also occur with the Fruita I alternative.

Production Rate Alternatives (FI-50, FII-50)

As above, impacts of the 50,000-bpd production rate alternatives for Fruita I and Fruita II would be essentially the same for aquatic biota, according to information provided by the Operator (Chevron 1982v).

The Fruita II 50,000-bpd production rate alternative would involve transportation of raw shale to the Fruita plant site for retorting and upgrading, with disposal of spent shale in one of four alternative locations near the plant site. Generally, potential for impacts to aquatic biota would be greater with this option since accidents causing raw shale spills near surface waters during transport could occur, and because eventual (in geologic time) spent shale pile failure would have a greater chance of affecting endangered fish species in the Colorado River than would the Mesa Valley Fill alternative. Endangered fish species are in greater jeopardy from Fruita disposal sites because the sites are closer to the Colorado River than the Clear Creek mesa site, and because that portion of the Colorado River near Fruita is important to Colorado squawfish as a spawning location (Section 3.7).

4.7.4 Alternative Siting Activities

Water Supply

Four alternative diversion locations near Loma have been identified as feasible by the Operator. However, no site-specific data are available regarding differences in aquatic habitats or species utilization of habitats adjacent to each location. Without such data, impacts associated with each location cannot be distinguished. It is assumed that all impacts would be essentially the same as those discussed previously for the Loma intake.

As an alternative to the De Beque diversion and Roan Creek valley water storage reservoir, the Operator proposes a diversion at Parachute and a reservoir on Parachute Creek. Again, site-specific data for the Colorado River near the diversion locations are insufficient to differentiate them. Furthermore, design information for the

Parachute Creek reservoir is not adequate to address the number of miles of stream habitat lost as a result of reservoir construction. However, on a preliminary basis, the De Beque location would likely have lesser impacts to aquatic biota. The proportion of withdrawn water to total flow in the Colorado River would be less at De Beque because total flow is greater there. Also, the pipeline from De Beque would make use of a corridor which would also be disturbed by a road and transmission line. Disturbance of the Parachute Creek corridor would only be required if the Parachute diversion was chosen. Similarly, a water storage reservoir on Roan Creek would disturb creeks (Roan and/or Clear) which would be subjected to flow depletion as a result of surface water control facilities and alluvial pumping (Section 4.7.2). If the reservoir were not located on Parachute Creek, it would remain undisturbed by the CCSOP.

Corridors

The manner in which impacts to aquatic biota may be caused as a result of construction and operation of linear facilities was described in Section 4.7.1. As was noted in that section, impacts would be dependent not only on the type of linear facilities, but the length of each, proximity to surface waters, and the value of those surface waters. The value of surface waters potentially impacted by corridors was described in Section 3.7. Corridor length is illustrated in Figures 2.3-1 to 2.3-4. Surface waters potentially affected by corridors are identified in Table 4.4-3 (Section 4.4 Water Resources). A synthesis of comparative corridor impacts is given in Section 2.4 (Impact Comparisons).

4.7.5 Transportation Alternatives

Alternative means of transporting people, material, and products should not significantly change impacts to aquatic ecology. Corridors preferred (from the perspective of aquatic ecology) are short and are distant from surface water, especially those water bodies containing important aquatic biota.

Truck or rail haulage of coal cannot be differentiated in terms of potential for impacts to aquatic ecology on the basis of existing information. Assuming that the road and railroad would be equally distant from surface water and that airborne losses of bulk material would be similar, impacts would be similar and minimal. Differences might exist due to different accidental spillage rates and any difference in chemical treatments (e.g., deicing chemicals) which may be required. Construction impacts could also be increased if a railroad is added to a corridor, rather than upgrading a road in that corridor.

4.7.6 Hazardous Waste Disposal

Only general information is available regarding hazardous waste disposal alternatives. Impacts associated with normal operation of a facility should be similar whether located on or off-site. Differential impacts between the alternatives could result from transportation accidents or failure of the disposal facility containment system. Transportation accidents would have a greater chance of occurring if the off-site facility was used. Severity of potential impacts caused by containment system failure would be dependent on facility location and proximity to water bodies.

4.7.7 Secondary Impacts

The most significant secondary impacts would be those resulting from increased fishing pressure and water consumption caused by project-induced population growth. Increased water consumption would further impact flows, which are already projected to be less than optimal for endangered species. These impacts were discussed in Sections 4.7.1 through 4.7.4. Increased fishing pressure would impact those surface waters which are already heavily utilized, such as Carr Creek and Mack Mesa Reservoir.

Other secondary impacts would result from increases in point and nonpoint discharges associated with sewage treatment plants, housing developments, construction, and other activities necessary to support the increased population.

4.8 Terrestrial Ecology

4.8.1 General Impacts

Construction and operation of project facilities and disposal of spent shale would impact vegetation and wildlife habitat through direct removal or through partial destruction by off-road construction equipment and vehicles. Impacts on plant productivity, nutrient cycling, and the physical habitat structure that plants provide would directly affect water runoff, soil erosion, and wildlife habitat quality. Modification of the existing topography and vegetational cover in the project area would affect habitat quality for most wildlife groups. At most project facility sites, changes in the extent and distribution of habitat types may result in long-term reduction of the abundance of some species. In general, these environmental changes would affect populations of wildlife species which (1) require access to multiple cover types, (2) occupy relatively large home ranges, and (3) have relatively low reproductive rates (e.g., big game, raptors, and some mammalian predators). Project impacts to populations of species which exhibit higher reproductive capacities and occupy smaller home ranges (e.g., amphibians, small mammals, and songbirds) would be much less significant within the region.

Although vegetation removal would be an impact similar for most project alternatives, the extent of this impact would vary widely among different project activities. Construction of roadways, railroads, and reservoirs as permanent facilities would result in residual impacts on productivity. Disturbance areas associated with pipeline burial, transmission tower construction, and slopes adjacent to access routes would be revegetated in the short term. Mining and plant site revegetation would occur over the long term. Spent shale disposal areas would undergo long-term revegetation followed by possible degeneration of the vegetation occurring as spent shale is gradually uncovered by natural processes of erosion. Ongoing research in spent shale revegetation indicates that even weathered spent shale may be incapable of supporting native or desirable vegetation (Redente 1981).

In addition to direct removal and destruction of vegetation, less predictable impacts to vegetation and wildlife could occur over the course of the 100-year project life. Human population growth and increased access to previously inaccessible areas could result in increased off-road vehicle (ORV) use and accidental range and forest fires on a local and regional basis. Oil and other chemical spills, with attendant toxic contamination, could impact wildlife habitats, soils, and vegetation. Upslope erosion could impact undisturbed vegetation at the margins of the open pit mine, the plant sites, reservoirs, and transportation routes.

4.8.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action - 100,000 bpd (PA-100)

Vegetation and Productivity. Direct impacts of the proposed action on vegetation and productivity are summarized in Table 4.8-1. Vegetation removal and disturbance would occur during the construction and operational phases of the project within a potentially affected area of approximately 44 square miles. If project decommissioning includes all sites except roadways and reservoirs, then approximately 12 percent of the potentially affected area, or 5 square miles, would be residually affected by vegetation removal. Revegetation would be attempted on the remaining affected areas. Most of the vegetation of the area has moderate or high revegetation potential. However, desert shrublands, barren areas, Douglas-fir forests, and riparian woodlands, covering approximately 4,508 acres or 16 percent of the area, have low revegetation potential. Re-establishment of vegetation would be more difficult and more costly in these areas.

Impacts to productivity could be locally significant to some ranching operations but would be insignificant on a county or regional basis. Affected productivity is presented in Table 4.8-1. During the construction and operational phases of the project, available data suggest that up to 29,000 Animal Unit Months (AUMs) may be lost each year within the project area. Productivity is unevenly distributed within the area. Agricultural lands yield approximately 87 percent of utilizable production but only represent 7 percent of the potentially affected area. Up to 1,588 acres of agricultural lands, including pasture and cropland and exclusive of rangelands, could be directly and permanently impacted (Table 4.8-1). For perspective, this acreage is equivalent to about 2 percent of the irrigated agricultural acreage in the Grand Valley west of Grand Junction and east of the Colorado-Utah border.

Table 4.8-1 DIRECT IMPACTS OF THE PROPOSED ACTION ON VEGETATION AND PRODUCTIVITY

Project Components	Acreages of Vegetation Types[a]												Total Potentially Affected Acreage	Affected Annual Production	
	RI	GL	GS	SS	SB	PJ	BL	MS	SSS	AW	DF	AG		MOP[b]	AUM[b]
Open Pit Mine	60				2		106	1,548	7,787	1,160	432		11,095	3.9	2,120
Underground Mine							2	14	1,237	274	4		1,531	0.6	324
Mesa Valley Fill Spent Shale Disposal								86	1,251	286			1,623	0.6	333
Clear Creek Mesa Plant Site								7	366	1			374	0.1	62
Upper Dry Fork Reservoir	132		310	438	366	309						741	2,296	10.0	11,622
Reservoir at Garvey Gulch			127		37	46							210	0.2	87
Roan Creek Corridor[c]	279		49	619	956	656	9	217	173	12	99	647	3,716	8.8	10,174
Echo Lake Corridor[c]	90		307	122	2,687	602		429		679	397	38	5,672	1.7[d]	942[d]
Fruita to Grand Valley Plant Site 16 Road Corridor		207	66	651								629	1,553	2.3[d]	2,872[d]
La Sal Syncrude Pipeline Corridor	1	2	1					22	130	27			183	0.1	251
La Sal Transmission Line Corridor[e]													76	0.1	18
TOTALS	562	209	860	1,830	4,048	1,613	117	2,323	10,944	2,439	932	2,055	28,329	28.3	28,805
Percent of Total	2	1	3	5	14	6	1	8	39	9	3	7			

[a] RI = Riparian
GL = Grassland
GS = Greasewood Shrubland
SS = Shadscale Shrubland
SB = Sagebrush shrubland
PJ = Pinyon-Juniper Woodland
BL = Barren Lands
MS = Mixed Shrublands
SSS = Sagebrush-Snowberry Shrubland
AW = Aspen Woodland
DF = Douglas-fir Woodland
AG = Agricultural

[b] MOP = Millions of Pounds
AUM = Animal Unit Months

[c] Acreages expressed represent a 1,000-foot wide corridor

[d] Assumes 30 percent of corridor removed from productivity

[e] Tower locations and actual vegetation affected are not known.

Wildlife. Regional big game carrying capacity would be reduced as a result of direct habitat loss in areas of project development. Data descriptive of the total (herbaceous + woody) primary productivity are not available for potentially affected big game winter ranges in the region. Therefore, impacts of the PA-100 alternative on regional big game carrying capacity have been addressed based on the acreage of critical winter range that would be lost as a result of each project alternative. For PA-100, loss of critical winter range (CWR) for mule deer would be approximately 3,251 acres in the Clear Creek area and 210 acres in the Big Salt Wash area (Table 4.8-2). Approximately 1,365 acres of elk CWR in the upper Clear Creek drainage would also be impacted. Approximately 952 acres of pronghorn habitat in the Grand Valley would be altered as a result of construction of the Big Salt Wash corridor, assuming a corridor width of 1,000 feet.

Approximately 14,600 acres of summer and transitional ranges for deer and elk would be permanently altered within the heads of the Clear Creek and Roan Creek drainages. The value of affected areas following reclamation and cessation of activities would be dependent upon the degree to which existing patterns of topographic and vegetational diversity could be restored and maintained over geologic time. Re-establishment of springs, streams, and other sources of free water would be integral to reclamation success and restoration of big game habitat in areas affected by these activities. Although the big game habitat value of surface mined lands could be partially, and perhaps temporarily (over geologic time), restored though revegetation with native plants, a long-term reduction in seasonal big game use and productivity would occur. Based on the Operator's revegetation plans for the CCSOP, restoration of vegetation type interspersion would be minimal. Spent shale disposal activities near the head of Clear Creek would reduce the value of this area to big game as a result of reduction of topographic relief, changes in vegetational composition, and availability of free water. This area is presently a deer and elk spring concentration area (Chevron 1982x) and may be used for fawning and calving.

The Operator has proposed safeguards to prevent surface and ground water contamination through contact with spent shale and upward migration of trace and toxic elements into the plant rooting zone (Section 2.3). Therefore, spent shale disposal in the Clear Creek and Willow Creek drainages would not be likely to result in uptake or bioaccumulation of toxic elements in plants or herbivorous wildlife.

Competition among ungulate species may occur as a consequence of reduction in size of big game winter ranges. The magnitude of this impact would be site-specific and could be minimized through compensatory off-site habitat enhancement. However, the general effects could be significant. Available carrying capacity on deer and elk winter ranges in the region is limited by the extent of such areas, fluctuating levels of forage productivity and availability, and utilization by domestic stock, deer, and elk.

Reductions in the quantity and quality of mountain lion and black bear habitat would also occur as a result of the CCSOP. Both of these species characteristically utilize large home ranges and occur at relatively low densities. Therefore, potential impacts on mountain lion and black bear populations would most likely be restricted to the project area and would be of low intensity.

Road kills of deer, antelope, and elk would increase above existing levels due to increased vehicle traffic along well-traveled roads during the life of the project. Based on the Operator's estimates of the demand for and operational schedules of trucks and trains required for materials transport, the Roan Creek corridor would pose the greatest potential for significant site-specific increases in big game road kills. On a regional basis, increased traffic volume on existing major highways resulting from the CCSOP could be less significant due to their routing relative to big game (mule deer) concentration areas and established levels of vehicular use.

Reduction of upland gamebird populations within the project area would occur as a direct result of surface disturbances. At least 11 historical sage grouse leks could may be lost on the Clear Creek mesa. Since sage grouse densities in the project area are characteristically low compared to other areas of Colorado (Chevron 1981i), project activities would result in only local reduction of sage grouse densities. Approximately 1,120 acres of potential blue grouse nesting and brood habitat, consisting of aspen woodlands, would be lost from impacted areas on Clear Creek mesa. Blue grouse are locally abundant in the region and could re-establish themselves if restoration of aspen swales was incorporated in the reclamation plan for the mesa. Chukar, which inhabitat portions of lower Clear Creek canyon and Big Salt Wash, could be displaced as a result of habitat alteration

Table 4.8-2 SUMMARY OF ESTIMATED POTENTIALLY AFFECTED ACREAGES OF BIG GAME CRITICAL WINTER RANGE FOR MAJOR FACILITIES ASSOCIATED WITH PROJECT ALTERNATIVES

	Potentially Affected Acreage		
Alternative/Components	Mule Deer CWR	Elk CWR	Antelope WR/CWR
Proposed Action (100,000 bpd)			
Open Pit Mine	---	68	---
Roan Creek Multi-Use Corridor	1,439	800	---
Big Salt Wash Multi-Use Corridor	795	567	952
Garvey Gulch Reservoir	210	---	---
Upper Dry Fork Reservoir	807	---	---
Syncrude Pipelines	Unknown	Unknown	Unknown
	3,251 +	1,367 +	952 +
Clear Creek (100,000 bpd)			
Open Pit Mine	---	68	---
Roan Creek Multi-Use Corridor	1,439	800	---
Access Corridor			
Upper Dry Fork Reservoir	807	---	---
Syncrude Pipelines	Unknown	Unknown	Unknown
	2,246 +	800 +	0 +
Fruita I (100,000 bpd)			
Open Pit Mine	---	68	---
Roan Creek Multi-Use Corridor	1,439	800	---
Big Salt Wash Multi-Use Corridor	795	567	952
Garvey Gulch Reservoir	210	---	---
Upper Dry Fork Reservoir	807	---	---
Upgrading Plant Site	---	---	400
Syncrude Pipelines	Unknown	Unknown	Unknown
	3,251 +	1,367 +	1,352 +
Fruita II (50,000 bpd)			
Dry Gulch Shale Disposal	Unknown	---	Unknown
Roan Creek Multi-Use Corridor	1,439	800	---
Big Salt Wash Multi-Use Corridor	795	567	952
Garvey Gulch Reservoir	210	---	---
Upper Dry Fork Reservoir	807	---	---
Retort and Upgrading Plant Site	---	---	400
Railroad Mine to Plant Site	Unknown	Unknown	---
Syncrude Pipelines	Unknown	Unknown	Unknown
	3,041 +	1,367 +	1,352 +

associated with reservoir inundation and construction of access roads and pipelines. Impacts to mourning doves, which are abundant and widespread in the project area, would likely be insignificant and short-term since this species uses a wide range of habitats for cover. Pheasant and Gambel's quail populations in the Grand Valley would not experience any significant reduction as a direct result of the PA-100.

Open water habitat created by construction of the CCSOP reservoirs could attract increased numbers of waterfowl and shorebirds to the project area during migration and winter. Fluctuating water levels resulting from continuous inflow or withdrawal of water from these reservoirs could result in maintenance of open, ice-free water throughout the winter. Deep water conditions could benefit diving ducks (primarily mergansers and goldeneyes) as a feeding and staging area. Gently sloping shorelines and associated shallow water could attract dabbling ducks including mallards, blue-wing teal, and cinnamon teal.

Densities of most mammalian predators and furbearers within the project area would probably decrease in response to localized reductions of rodent prey populations. Small game, including cottontails and jackrabbits, could experience localized, short-term population reduction as a result of the construction and operation of most project facilities. Beaver and muskrat could benefit from the net increase in aquatic habitat following reservoir construction.

Riparian habitats along Clear Creek and Roan Creek could be directly impacted through removal of vegetation during project construction and through potential dewatering of these streams (Section 4.4.2). Any alterations of riparian communities as a result of the PA-100 would result in loss of riparian and wetland habitat utilized by game and nongame wildlife species. Habitat quality for many other terrestrial vertebrates would also be adversely affected by removal of riparian habitat. Increased abundance of amphibians and shorebirds could occur at reservoir sites in response to increased availability of food and cover.

Raptors, including three species of high federal interest (golden eagle, Cooper's hawk, prairie falcon), would be impacted through physical alteration of cliff nesting sites, disturbance resulting from increased levels of human activity, noise generated by project operations, and short-term reduction of rodent prey populations.

Baseline data for the Clear Creek property and the Book Cliffs area indicate that several active and inactive golden eagle nests would be impacted through direct or indirect disturbance from the PA-100. Open pit mining and subsequent shale disposal activities in the Willow Creek drainage would result in loss of at least one active golden eagle nest and several inactive nests maintained during 1981-82 (Chevron 1981i; 1982p). At least three active golden eagle nests would be directly affected by increased human activity and reduction in rodent prey densities in the lower 4 miles of the Big Salt Wash corridor. Four additional nests, including one active one, would be impacted in a similar manner by construction and inundation of the Big Salt Wash reservoir. At the present time, the taking of active golden eagle nests is forbidden by the Eagle Protection Act. Final rulemaking which will govern issuance of permits for the taking of inactive and active, unoccupied golden eagle nests may be issued during 1983 (Webb 1983). The most current regional golden eagle population data compiled by the Colorado Division of Wildlife (1981) indicate that a minimum of 114 nesting pairs occupied northwestern Colorado during 1981. Nesting success was 85 percent and production averaged 1.2 per nest. These data suggest that loss of up to five nest sites within the CCSOP area would not jeopardize the regional status of the golden eagle.

Two active prairie falcon eyries (USFWS 1983) located within one air mile of the Echo Lake multi-use corridor could also be impacted by CCSOP activities. Abandonment of these nest sites could result; however, the regional significance of the loss of two prairie falcon nests can only be determined based on regional nesting population estimates. Impacts of the PA-100 alternative on prairie falcons and other nesting raptors will be addressed in additional detail in the U.S. Fish and wildlife Service Coordination Act report which is currently in preparation.

Prairie dog towns, which are the preferred habitat of the burrowing owl (a species of high federal interest), and the black-footed ferret (federally listed as endangered) may be impacted by project construction activities in the Grand Valley. Impacts to prairie dog towns can be minimized through siting options available within the Grand Valley access corridor. Since no concentration areas for other terrestrial vertebrates listed by the Colorado Natural Heritage Inventory (CDNR 1981b) as sensitive species were identified during baseline surveys, impacts resulting from the PA-100 are not likely to jeopardize populations of these species within the project area.

Endangered Species. Detailed descriptions of potential impacts of PA-100 on threatened and endangered species will be presented in the BLM Biological Assessment and the USFWS Biological Opinion in accordance with requirements of Section 7 of the Endangered Species Act. The following discussion of impacts to threatened and endangered species is based on presently available data.

The PA-100 would significantly affect populations of several candidate or listed threatened or endangered plant species. Recently completed baseline studies permit the identification of some of the site-specific impacts to these populations. Since only the Roan Creek reservoir sites, Roan Creek corridor, and portions of the Clear Creek mesa were searched, it is possible that additional populations of certain species would also be affected. Table 4.8-3 identifies known and likely occurrences of eight plant species with respect to the major component areas of PA-100.

A relatively large population of the Uinta Basin hookless cactus (*Sclerocactus glaucus*), including an estimated 300 individual plants, would be affected by construction of the Upper Dry Fork reservoir. A second population of this cactus, which is of similar size, would be affected by the construction of the access road just east of this reservoir. A third population occurs within the Roan Creek corridor but could be avoided during construction of ancillary facilities. Other known populations of *Sclerocactus glaucus* include ten locations in five Colorado counties and a similar number of locations in eastern Utah (CDNR 1982).

During the early summer months of 1982, several thousand individuals of the annual phacelia (*Phacelia submutica*) were found in two populations which would be inundated by the Upper Dry Fork reservoir. A third population of this plant species occurs within the Roan Creek corridor just north of De Beque. Two additional phacelia populations occur within 200 feet of the proposed reservoir's western shoreline. These populations could be damaged by peripheral disturbances during reservoir construction. Four additional locations, all in Mesa County outside of the project area, represent the only other known populations of this plant (CDNR 1982).

Barneby columbine (*Aquilegia barnebyi*) and sullivantia (*Sullivantia purpusii*) populations would be affected by the development of the open pit mine and spent shale disposal area in Willow Creek and No Name Creek. A third area containing populations of both species would be affected by spent shale disposal in Clear Creek canyon.

Table 4.8-3 RELATIONSHIPS OF PROPOSED ACTION COMPONENTS WITH ENDANGERED PLANT SPECIES

			Facility Site[b,c]								
Plant Species	Common Name	Status[a]	UM	SM	PL	RU	RG	RC	SW	LS	DP
Sclerocactus glaucus	Uinta Basin hookless cactus	Threatened				X	NS	X	NS	NS	NS
Phacelia submutica	Phacelia	Category 1				X	NS	X	NS	NS	NS
Aquilegia barnebyi	Barneby columbine	Category 2	X	X			NS		O	NS	O
Astragalus lutosus	Dragon milkvetch	Category 2					NS	X	NS	NS	NS
Festuca dasyclada	Fescue	Category 2		X			NS	O	O	NS	NS
Cirsium perplexans	Thistle	CNHI Concern				Xy	NS	X	NS	NS	NS
Sullivantia hapemanii v. purpusii	Sullivantia	CNHI Concern	X	X			NS		O	NS	O
Thalictrum heliophilum	Meadow rue	CNHI Concern	0	0				0	0		

[a] Status based on USFWS (1980) and CDNR (1982).
[b] Facility Sites:
UM = Underground Mine
SM = Surface Mine and Spent Shale Disposal
PL = Plant
RU = Reservoir - Upper Dry Fork
RG = Reservoir at Garvey Gulch
RC = Multiple Use Corridor - Roan Creek
SW = Water Pipeline and Secondary Access Road Corridor - Big Salt Wash
LS = Syncrude Pipeline Corridor - La Sal Route 1
DP = Transmission Line Corridor - Davis Point
[c] Occurrence:
X = verified population affected
Xy = tentatively identified population affected
O = possibly present based upon habitat suitability
NS = preliminary study negative, mitigation will include field search prior to construction

Based upon 52 population location records for Colorado, CNHI has suggested that Barneby columbine not be listed as threatened or endangered. *Sullivantia purpusii* is known only from 16 population locations in four Colorado counties (CDNR 1982).

Dragon milkvetch (*Astragalus lutosus*) occurs in a population which could be affected by the construction of the access road within the Clear Creek drainage. Numerous other localities with populations of this plant species are also known and it is unlikely that the proposed project would place the species in jeopardy.

A population of unknown size of *Festuca dasyclada* would be affected by the spent shale disposal and open pit operation. In December 1982, the CNHI computer file listed 24 other population locations for this plant within Rio Blanco and Garfield counties.

Many thousands of basal rosettes of a plant tentatively identified as *Cirsium perplexans* were observed during field surveys of the Upper Dry Fork Reservoir area. Additional field study would be required to verify the identity and status of this population. *Cirsium perplexans* is endemic to four western Colorado counties.

PA-100 would not likely result in any direct, long-term or significant impacts to state or federally listed endangered wildlife species. Direct project-generated disturbance of wintering bald eagles along the Colorado River could be effectively mitigated through siting of intake facilities to avoid important roost sites in the vicinities of both the De Beque and Loma intake locations and timing construction to avoid peak periods of eagle concentration. Habitat enhancement for wintering bald eagles could be possible at reservoir sites through stocking of rough fishes and establishment of roost and perch sites. Disturbance of prairie dog towns in the 16 Road corridor would be limited to the periphery of one established colony (Chevron 1982a) and therefore would not jeopardize the viability of the local population of the white-tailed prairie dog. Hence, direct impacts to potential black-footed ferret habitat would be negligible.

No impacts to the whooping crane (federally listed endangered) or greater sandhill crane (state listed endangered) would be likely as a result of project development.

Although the upper Roan Creek drainage is considered as essential habitat for the peregrine falcon, nesting activity has not been documented in the drainage (Craig and Enderson 1981). Potentially suitable cliff nesting sites within the area of direct project impact are limited due to the instability of ledges. However, habitats supporting high densities of medium-sized avian prey in close proximity to cliffs with a wide field of unrestricted view are common in the Roan Creek drainage (Craig et al. 1978). Therefore, potential impacts of PA-100 on peregrine falcons would be limited to reduction of potential habitat for feeding and disturbance of potential nesting cliffs (in the lower Roan Creek valley) which could be utilized by an expanding peregrine poulation or following future peregrine reintroduction efforts.

Proposed Action - 50,000 bpd (PA-50)

Vegetation and Productivity. Vegetation removal and consequent effects on productivity for PA-50 would be significantly less than PA-100 alternative due to use of all underground mining. The size of the spent shale disposal area would be increased by approximately 1,400 acres, but the overall area likely to be disturbed would be reduced by more than 50 percent. Vegetation impacts associated with ancillary facilities would be essentially the same as those described for PA-100.

Wildlife. Direct impacts to big game winter ranges for the PA-50 alternative would be similar to those of the PA-100. Loss of spring transitional range as a result of shale disposal activities in Upper Clear Creek would be increased by a maximum of approximately 1,377 acres. Spring transitional deer and elk range in the area of the proposed open pit mine totaling approximately 11,095 acres (Table 4.8-1) would be left essentially in tact under this the PA-50 alternative. Three historical sage grouse leks and an active golden eagle nest site would not be physically removed as would be the case under the PA-100 alternative. A reduction of less than 50 percent in road kills (compared to the PA-100 alternative) within the Roan Creek corridor can be anticipated under this alternative as a result of decreased materials transportation needs.

Endangered Species. Potential impacts to candidate and listed threatened and endangered plant species would be primarily associated with ancillary facilities and would be the same as the PA-100 alternative. However, impacts to cliff and talus habitats which support several candidate plant species could be avoided or reduced depending on underground mine portal location and other siting alternatives.

Potential impacts to threatened and endangered wildlife species from the PA-50 alternative would be as described for PA-100. Loss of potential peregrine falcon hunting habitat would not occur in the Upper Willow Creek area; however, noise and human activity in this area would likely preclude any potential for nesting in the Roan Creek drainage.

Clear Creek Mesa - 100,000 bpd (CC-100)

Vegetation and Productivity. The total area potentially affected by vegetation removal or disturbance for the CC-100 alternative would be approximately 21,000 acres, significantly less than that potentially affected by the PA-100 alternative due to the absence of the Big Salt Wash corridor. Most of the affected area has moderate or high revegetation potential. However, vegetation types with low revegetation potential cover approximately 2,668 acres or 13 percent of the area.

Annual productivity affected by the CC-100 alternative would be approximately 24,900 AUM, or 3,900 AUM less than for the PA-100 alternative. Approximately 1,388 acres of irrigated agricultural lands would be potentially affected, 32 percent less than for PA-100.

Wildlife. Direct impacts to big game resulting from the CC-100 alternative would be confined to the Roan Creek and Clear Creek drainages where an estimated 2,246 acres of deer CWR would be lost (Table 4.8-2). The magnitude of secondary impacts resulting from displacement of big game from the Clear Creek area to surrounding areas would be lower as a result of the CC-100 alternative than for the PA-100. Likewise, the extent, magnitude, and duration of impacts to winter, summer, and transitional range for deer and elk would be lower as a result of this alternative, in direct proportion to the reduction in extent of surface disturbance.

Impacts of the CC-100 alternative on game birds, predators, furbearers, and small game mammals would be similar in nature to those discussed in Section 4.8.2. However, the magnitude and extent of these impacts would be of lower magnitude under this alternative than for PA-100 since surface disturbance would be more limited in extent. Chukar habitat in Big Salt Wash, sage grouse leks, and habitat for sage and blue grouse transected by the Big Salt Wash corridor would not be affected by CC-100.

Nongame birds, mammals, reptiles, and amphibians would be affected by this alternative as discussed for PA-100. However, impacts to most raptors (including golden eagles) would be of lower intensity than for the PA-100 alternative since the extent and magnitude of reduction of nongame mammal and bird prey populations would be more localized. A minimum of one active golden eagle nest, and associated inactive nests which have been maintained during 1981 and 1982, would be affected in upper Willow Creek as a result of this alternative. Alteration of preferred cliff nesting sites of raptors would likewise be confined to those near the heads of Roan Creek and Clear Creek.

No long-term or significant impacts to CNHI "sensitive species" are anticipated from CC-100.

Endangered Species. Effects of this alternative on candidate and listed threatened or endangered plant species would be the same as the PA-100 alternative.

Impacts to wintering bald eagles along the Colorado River near De Beque and peregrine falcon habitat in the Roan Creek drainage can be expected to be of similar magnitude for PA-100. The potential for disturbance of wintering bald eagles would be less than for the PA-100 alternative since the Loma intake would not be constructed or maintained. Potential black-footed ferret habitat (prairie dog towns) in the Grand Valley would likewise not be disturbed by CC-100 project operations.

Clear Creek Mesa - 50,000 bpd (CC-50)

Vegetation and Productivity. Long-term vegetation and productivity impacts associated with the open pit mine would be eliminated under this alternative and the total disturbed area would be less than for any other alternative. Impacts associated with permanent facilities would be the same as the CC-100 alternative and approximately 4 square miles would be residually affected.

Wildlife. Potential wildlife impacts resulting from this alternative would be the least extensive and of the lowest magnitude in comparison to impacts of all other alternatives under study. Direct project impacts in the Big Salt Wash area and Game Management Unit 30 would be essentially eliminated. Reduction in the extent of surface disturbance and the scale of project operations in the Roan Creek drainage could be expected to result in lessening of impacts to wildife.

Endangered Species. Potential impacts to candidate and listed threatened and endangered plant species would be the same as the PA-100 alternative. However, impacts to talus and cliff habitats of several candidate species could be reduced under this alternative, depending on the specific configuration of underground mine portal development.

Potential impacts to threatened and endangered wildlife from CC-50 would be of the lowest magnitude and the most limited extent of all project alternatives

4.8.3 Grand Valley and Associated Siting Activities

Fruita I - 100,000 bpd (FI-100)

Vegetation and Productivity. Direct impacts of the FI-100 alternative are identified in Table 4.8-4. The construction and operation of the project in this configuration could involve the removal or disturbance of vegetation within a potentially affected area of approximately 49 square miles. Additional impacts associated with FI-100 include the upgrading plant site; intertie and syncrude pipelines between Clear Creek mesa and the upgrading plant site; and a transmission line, natural gas pipeline, and railroad between the town of Fruita and the upgrading plant site. The various ancillary facilities which would be included within the 16 Road corridor would traverse highly productive irrigated agricultural land. The permanent commitment of vegetation resources for the FI-100 alternative would be the highest of all alternatives.

The shift of project activities to lower altitude sites for the FI-100 would increase acreage of disturbance of desert shrubland vegetation types with low revegetation potential. Approximately 6,000 acres, or 19 percent of the potentially affected area, is included within riparian woodland, desert shrublands, barren areas, or Douglas-fir forests, which would be difficult to re-establish.

The potential impact of the project on agricultural production is higher for the FI-100 alternative than for any other configuration (Table 4.8-1). A difference of approximately 9,000 AUM between the FI-100 and PA-100 alternatives is largely due to impacts on agricultural lands, with siting within the Grand Valley resulting in greater potential impacts.

Wildlife. Impacts to game species affected by the Fruita I alternative would be similar in nature, extent, and duration to those discussed for the proposed action (100,000 bpd; Section 4.8.1). Construction and operation of a railroad between Fruita and the Grand Valley plant site would affect habitat use patterns of the remant pronghorn herd in this area. In addition to direct loss of habitat resulting from its construction, noise generated by this railroad could be expected to modify game movements and game use of habitats transected. An estimated 1,352 acres of pronghorn habitat would be lost (Table 4.8-2) for the duration of the project as a result of project-related activities in the Grand Valley. Ancillary facilities developed in conjunction with the Grand Valley plant site would be expected to incur only short-term, minimal impacts to local game populations since no critical ranges or other sensitive habitats for game would be physically altered.

Table 4.8-4 DIRECT IMPACTS OF THE FRUITA I ALTERNATIVE ON VEGETATION AND PRODUCTIVITY (in acres)

Project Components	Vegetation Types[a]												Total Potentially Affected Acreage	Affected Annual Production	
	R1	GL	GS	SS	SB	PJ	BL	MS	SSS	AW	DF	AG		MOP[b]	AUM[b]
Open Pit Mine	60				2		106	1,548	7,787	1,160	432		11,095	3.9	2,120
Underground Mine							2	14	1,237	274	4		1,531	0.6	324
Mesa Valley Fill Spent Shale Disposal								86	1,251	286			1,623	0.6	333
Clear Creek Mesa Plant Site								7	366	1			374	0.1	62
Grand Valley Plant Site			1,216	384	1,600								3,200	0.5	247
Upper Dry Fork Reservoir	132		310	438	366	309						741	2,296	10.0	11,622
Reservoir at Garvey Gulch			127		37	46							210	0.2	87
Roan Creek Corridor[c]	279		49	619	956	656	9	217	173	12	99	647	3,716	8.8[d]	10,174[d]
Echo Lake Corridor[c]	90		307	122	2,687	602		429		679	397	38	5,672	5.6	3,142
Fruita to Grand Valley Plant Site 16 Road Corridor[c]		207	66	651								629	1,553	7.8	9,573
Parachute Creek Syncrude Pipeline Corridor	1	2	1					22	130	27			183	0.1	251
Parachute Creek Transmission Line Corridor[e]													76	0.1	18
TOTAL	562	209	2,076	2,214	5,648	1,613	117	2,323	10,944	2,439	932	2,055	31,529	38.2	37,953
Percent of Total	2	1	7	7	18	5	1	7	35	8	3	7			

[a] R1 = Riparian
GL = Grassland
GS = Greasewood Shrubland
SS = Shadscale Shrubland
SB = Sagebrush shrubland
PJ = Pinyon-Juniper Woodland
BL = Barren Lands
MS = Mixed Shrublands
SSS = Sagebrush-Snowberry Shrubland
AW = Aspen Woodland
DF = Douglas-fir Woodland
AG = Agricultural

[b] MOP = Millions of Pounds
AUM = Animal Unit Months

[c] Acreages expressed represent a 1,000 foot corridor

[d] Assumes all of corridor removed from productivity

[e] Tower locations and actual vegetation affected are not known.

In addition to impacts described for PA-100, construction and operation of the Grand Valley facility and corridors would result in localized wildlife impacts of low magnitude and relatively short duration. Based on information available concerning raptor use in this area, displacement of nesting raptors for areas directly impacted by the FI-100 alternative would not be detrimental to the regional viability of these species. Additional loss of riparian habitat along Big Salt Wash from corridor construction could be a long-term impact, displacing several nongame species and reducing of habitat quality for many others. Further details concerning specific impacts of the FI-100 alternative on raptors and other nongame species will be presented in the FWS Coordination Act Report.

Endangered Species. The populations of candidate and listed threatened and endangered plant species and Colorado Natural Heritage Inventory plant species of special concern which would be impacted by implementation of the PA-100 would also be affected by the FI-10 alternative.

Potential effects of the FI-100 alternative on endangered wildlife species and their habitats would be similar in extent, duration, and magnitude to those described for the PA-100 alternative. Construction and maintenance of an upgraded road, the railroad, pipeline, and power transmission facilities along 16 Road between Fruita and the Grand Valley plant site could involve disturbance of additional acreage of white-tailed prairie dog towns. The resultant disturbance to potential habitat for black-footed ferrets would be a local, insignificant impact which could be mitigated through siting alternatives available. Further discussion of potential impacts to endangered species which could result from the FI-100 alternative will be addressed in the BLM Biological Assessment and USFWS Biological Opinion.

Fruita I - 50,000 bpd (FI-50)

Vegetation and Productivity. The impact of the FI-50 alternative would be greater than the PA-50 or CC-50 alternatives but much less than the FI-100 alternative. The qualitative characteristics of the vegetation and productivity impacts are the same as the FI-100 alternative. However, the elimination of the open pit mine (11,095 acres) with a relatively moderate (1,400 acre) increase in the size of the spent shale disposal area would yield a significant reduction in total vegetation disturbance under the FI-50 alternative relative to the FI-100 alternative.

Wildlife. Wildlife impacts resulting from the FI-50 alternative would be reduced in magnitude and extent (as compared to FI-100) as a result of decreased surface disturbance for the PA-50 alternative. As would be the case under any of the 50,000-bpd production rate alternatives, approximately 1,400 acres of deer and elk spring transitional ranges would be affected by expansion of spent shale disposal activities on the mesa.

Endangered Species. Potential impacts on populations of candidate or listed threatened and endangered plant species would be the same as the FI-100 alternative. However, habitats of *Sullivantia hapemanii* var. *purpusii, Aquilegia barnebyi, Festuca dasyclada,* and *Thalictrum heliophilum* would not be impacted due to the absence of the open pit mine and flexibility in the siting of ancillary facilities.

Potential impacts to threatened and endangered wildlife species and their habitats would be as described for the FI-100 alternative for the Grand Valley region. Reduction in the magnitude of potential impacts to peregrine falcon habitat in the Roan Creek drainage would be the same as for other 50,000 bpd alternatives.

Fruita II - 50,000 bpd

Vegetation and Productivity. Vegetation and productivity impacts of the FII-50 alternative would be similar to the FI-50 alternative, but this alternative would involve addition of a railroad route within the Big Salt Wash and Straight Line Tunnel corridor and storage of spent shale at the Stove/Buniger canyons site rather than at the a Mesa Valley Fill site. The impact on productivity would be potentially less than the FI-50 alternative since the a spent shale disposal site on Clear Creek mesa is more biologically productive than a Grand Valley site. Due to the railroad, impacts to riparian and agricultural areas would be increased and the total acreage disturbed would probably be higher than any other 50,000-bpd alternative. Revegetation of the spent shale disposal site would be more difficult under this alternative and would probably require irrigation. Beyond the life of the project, a residual impact would be the lack of useful vegetation where spent shale is the soil parent material. On this longer time scale, sacrifice of the Stove/Buniger canyons site would involve less permanent productivity loss than the Mesa Valley Fill site which is proposed for the PA-50 and CC-50 alternatives.

Wildlife. Construction and operation of the proposed shale haulage railroad would result in impacts to big game movements and distribution which would likely be long term and regionally significant. The magnitude of railroad-related impacts to big game would be dependent upon the operational characteristics (e.g., speed, frequency of passage) of the railroad and the extent to which existing patterns of daily and seasonal big game movement could be maintained through mitigation. In addition to habitat loss resulting from railroad construction and operation, loss of approximately 1,352 acres of pronghorn habitat would occur if both the retort and upgrading facilities were located in the Grand Valley (Table 4.7-2). The loss of an additional 400 acres of pronghorn habitat over that which would be lost under the FI-100 alternative is not considered a significant impact, since the area which would be lost does not include habitat with high primary productivity or persistent free water (both of which may limit the rate of population increase of this resident herd). An unknown quantity of elk CWR would also be impacted by the shale haulage railroad in the Brush Creek area. This alternative poses the greatest potential for regional impacts to big game movements and winter ranges. Short-term, insignificant regional impacts to local gamebird and other small game populations would be similar to those for FI-100, although somewhat greater in extent as a result of the railroad.

Habitat loss and reduction of the densities of most nongame species would be short-term impacts similar to those for FI-100. The major impact would be loss of 800 acres of raptor foraging habitat at the Grand Valley plant site and increased human disturbance near raptor nesting areas in the Book Cliffs. Potential for displacement of these nesting raptors exists within the Brush Creek area as a result of railroad construction and operation. Craig et al. (1978) documented golden eagle and prairie falcon nesting activity on the southwest aspect around Brush Creek. Based on available information, displacement of these nesting raptors from areas directly impacted by the FII-50 alternative would not be expected to be detrimental to the regional viability of these species. As previously noted, searches of all corridors associated with the FII-50 alternative have not been completed; hence, the extent of raptor impacts could be more extensive than described here. The FWS Coordination Act Report will discuss the extent and magnitude of these impacts in greater detail.

Endangered Species. Impacts of the FII-50 alternative on endangered plant populations would be similar to those for FI-100. No additional known plant populations would be affected.

Loss of potential habitat for the black-footed ferret could be incurred through construction of the FII-50 alternative. As previously noted, this would not be anticipated to be a significant regional impact. With respect to potential impacts to peregrine falcons and bald eagles, this alternative would result in impacts similar to those described for the PA-50 alternative. A potential peregrine reintroduction and nesting location has been identified within the Brush Creek drainage (Craig et al. 1978). Although this site is not ranked as a highly suitable reintroduction site compared to other locations identified in the area (Craig et al. 1978), project-generated disturbance (shale haulage railroad) would probably preclude peregrine nesting at this site for the life of the project.

4.8.4 Alternative Siting Activities

Impacts of facility siting alternatives on vegetation are summarized in Table 4.8-5. These data provide a basis for ranking of alternatives. However, only impacts to candidate and listed threatened and endangered plant populations are considered significant.

Alternative Pipeline Corridors

Vegetation and Productivity. Acreages affected by pipeline construction and operation would be relatively small and the impact of these activities on vegetation would be insignificant. From the Clear Creek mesa point of origin, the pipeline routes to the nearby SOPS pipeline would have the lowest adverse impact, the La Sal

Table 4.8-5 IMPACTS OF FACILITY SITING ALTERNATIVES UPON VEGETATION ACREAGE, PRODUCTIVITY, REVEGETATION POTENTIAL, AND ENDANGERED PLANT POPULATIONS

Project Components	Width of Corridor Analysis (ft)	Potentially Affected Acreage	Affected Annual Production		Duration of Impacts (S,L,R)[a]	Revegetation Potential	Endangered Plant[b] Population Occurrences	
			MOP	AUM			Listed Species	Candidate Species
Shale Disposal Locations								
Mesa Valley		1,623	0.6	333	R	Moderate to high	NS	NS
Dry Gulch		3,021	1.1	496	R	Low to moderate	NS	NS
Garvey Canyon		1,900	0.5	236	R	Low to moderate	NS	NS
Stove/Buniger Canyons		2,741	0.4	193	R	Low to moderate	NS	NS
Munger Creek		2,085	0.9	571	R	Low to moderate	NS	NS
Multiple-Use Access and Railroad Routes to Clear Creek Mesa								
Roan Creek Corridor	1,000	3,716	8.8	10,174	S,R	Low to high	X	X
Echo Lake Corridor	1,000	5,672	5.6	3,142	S,R	Low to high	NS	O
Overland Route	1,000	2,348	9.0	10,295	S,R	Low to high	O	O
Straight Line Tunnel Route	1,000	689	0.1	47	S,R	Low to high	O	O
Alternative Multiple-Use Access and Railroad Routes to the Grand Valley Plant Site								
Colorado-Ute RR Corridor	100	170	0.5	608	R	Low to high	NS	NS
Douglas Pass Road to Grand Valley Plant Site	1,000	1,088	8.1	10,066	S,R	Low to high	NS	NS
Fruita to Grand Valley Plant Site 16 Road	1,000	1,553	7.8	9,573	S,R	Low to high	NS	NS
Reservoirs								
Upper Conn Creek		2,608	11.8	13,671	R	N/A	X	X
Lower Conn Creek		2,506	9.7	10,795	R	N/A	X	X
Upper Dry Fork		2,296	10.0	11,622	R	N/A	X	X
Lower Dry Fork		1,757	10.6	12,225	R	N/A	X	X
Big Salt Wash at Garvey Gulch		210	0.2	87	R	N/A	NS	NS
Kimball Creek		2,303	2.9	1,367	R	N/A	O	NS
Parachute Creek		2,329	9.9	10,704	R	N/A	NS	O

Table 4.8-5 IMPACTS OF FACILITY SITING ALTERNATIVES UPON VEGETATION ACREAGE, PRODUCTIVITY, REVEGETATION POTENTIAL, AND ENDANGERED PLANT POPULATIONS (Continued)

Project Components	Width of Corridor Analysis (ft)	Potentially Affected Acreage	Affected Annual Production		Duration of Impacts (S,L,R)[a]	Revegetation Potential	Endangered Plant[b] Population Occurrences	
			MOP	AUM			Listed Species	Candidate Species
Pipeline Corridors								
Mesa Plant Site to SOPS Pipeline		NA	NA	NA	NA	NA	High	NS
Grand Valley Plant Site to SOPS Pipeline (syncrude)	50	38	0.1	6	S,R	Low	NS	NS
Rangely A (syncrude)	50	254	0.3	82	S,R	Low to high	NS	O
Rangely B (syncrude)	50	282	0.3	144	S,R	Low to high	NS	O
LaSal (syncrude)	50	183	0.1	251	S,R	Moderate to High	NS	NS
Buck Gulch (syncrude)	50	33	0.1	5	S,R	Low to high	NS	O
Sheep Gulch (syncrude)	50	29	0.1	5	S,R	Low to high	NS	O
Parachute Creek (water)	50	232	0.7	854	S,R	Low to high	O	O
Transmission Corridor (345 KV)								
Davis Radial		76	0.1	18	S,L	Moderate to high	NS	NS

[a] S = Short term; L = Long term; R = Residual.
[b] Occurrence:
x = verified populations affected
O = possibly present based upon habitat suitability
NS = preliminary study negative, mitigation will include field search prior to construction

alternative would have slightly higher adverse impact (183 acres of vegetation with moderate to high revegetation potential), and the Rangely A and B alternatives would have the highest adverse impact (254 and 282 acres, respectively) on vegetation. From the Fruita point of origin, the Fruita to SOPS alternative is shortest. The Fruita to Rangely and Fruita to Davis Point (via Big Salt Wash) alteratives would have similar impacts to vegetation, but would have much higher impacts than the Fruita to SOPS alternative. For all pipeline routes, right-of-way specifications would require threatened and endangered plant surveys and routing to avoid impacts to protected plant populations. No unavoidable impacts to threatened and endangered plants are known for any proposal route.

Wildlife. A total of 13 alternative pipeline corridors were identified for analysis (Table 2.2-1). On the basis of the estimated extent of potential surface disturbance impacts on wildlife habitats, the Clear Creek mesa plant site to SOPS corridor would create the lowest level of adverse impacts to wildlife resources followed by (in order of ascending, potential adverse impact) the Rangely B, Rangely A, and Roan Creek multi-use corridors. Potential impacts of the La Sal corridor could include loss of big game spring/summer habitat and disturbance of sage grouse leks.

Four alternative product transport pipeline corridors originating from the Grand Valley plant site were identified for analysis (Table 2.2-1). Comparison of these corridors was based on general knowledge of areas traversed and their length. The lowest level of impact would be expected from the SOPS corridor with relatively greater impacts followed (in order of ascending potential adverse impact) by the La Sal corridor, Rangely B, and Rangely A routes.

Three intertie pipeline routes were identified for analysis: Big Salt Wash, Deer Creek, and Overland. The Big Salt Wash route traverses a significant amount of riparian habitat (2,624 acres) in addition to elk winter range. Both the Deer Creek and Overland routes taverse deer and elk winter range and elk CWR. The Overland route was judged to have the least potential for adverse impacts, with the Deer Creek and the Big Salt Wash routes having a greater level of potential impact.

Four water pipeline alternatives were identified for analysis: the 16 Road pipeline (multi-use corridor, the Roan Creek pipeline (multi-use corridor), the Parachute Creek water pipeline corridor, and the Loma intake to 16 Road water pipeline corridor. Additionally, four subalternate water pipeline corridors connecting the Loma intake with the 16 Road water pipeline have been identified. Available data suggest that pipeline corridor impacts would be minimal.

The USFWS Coordination Act Report and the BLM Biological Assessment will provide additional detail concerning potential impacts of these routes.

Alternative Water Intake Locations

Vegetation. The alternative intake diversion locations would probably have an insignificant impact on vegetation productivity. However, because wetlands would potentially be affected, the sites should be surveyed to ascertain the degree of impact to wetlands.

Wildlife. Wintering bald eagles are common in the vicinities of all alternative intake locations; however, levels of eagle winter use at these sites are below that identified within areas of concentrated eagle use (Fisher et al. 1981). The Parachute and De Beque intake locations are not located close to established eagle roost sites; however, the Loma "C" alternative lies within 0.5 air mile of a roost. Impacts resulting from construction, operation, and maintenance of intakes at any of these locations would be determined by levels of human activity and canopy cover at each site (Stalmaster and Newman 1978).

Alternative Reservoir Sites

Vegetation and Productivity. The productivity values impacted by construction of any of the four Roan Creek reservoirs would be similar. However, the alternative reservoir sites would differentially impact populations of candidate or listed threatened or endangered plant species. Impacts of the Upper Dry Fork reservoir have been previously discussed. The Lower Dry Fork reservoir would have the least impact to endangered plants of the alternative reservoirs. However, even the Lower Dry Fork site would inundate one large population of the Uinta Basin hookless cactus and one population of *Phacelia submutica.* The Lower Dry Fork site would allow construction of corridors on the east site of the reservoir without additional impact to endangered plant species. The Upper and Lower Conn Creek sites would be similar to one another in impact to endangered plant populations and are intermediate in impact to such populations with respect to the Upper and Lower Dry Fork sites. The Upper and Lower Conn Creek sites would inundate one large and two small populations of the Unita Basin hookless cactus and would involve further impacts to another large population on the access corridor east of the reservoir. The Upper and Lower Conn Creek alternative would also inundate four known populations of *Phacelia submutica.*

Wildlife. Construction and operation of the Upper Dry Fork reservoir would result in significant regional impacts resulting from inundation of 807 acres of deer CWR. Impacts would include inundation of about 210 acres of CWR for the Big Salt Wash reservoir, 325 acres at the Lower Conn Creek site, 379 acres at the Upper Conn Creek site, and 234 acres at the Lower Dry Fork site. The acreage of CWR which could be inundated by the Parachute Creek reservoir alternative is unknown.

Alternative Multi-use Access and Railroad Corridors

Vegetation. The Roan Creek, 16 Road, and Dorchester Coal railroad corridors traverse agricultural lands and would impact the productivity of these areas. However, the Dorchester Coal alternative would support other projects and CCSOP use of the route would not add to the vegetation impacts of construction of this railroad route. Of the various railroad corridors under consideration, only the Roan Creek route would potentially impact listed and candidate threatened and endangered plants. Impacts to populations of these plant species could possibly be avoided in routing the railroad within the Roan Creek corridor.

Wildlife. Due to its length and position relative to riparian habitat and CWR, project construction and operation activities in the Roan Creek corridor could result in locally significant impacts to wildlife. Truck and train traffic levels projected by the Operator (Chevron 1983b) to meet operational needs for coal and limestone may effectively preclude use by most wildlife species in this corridor and a buffer zone surrounding it. The 16 Road corridor would have lower adverse impacts due to the extent of big game (antelope) winter range and other sensitive habitat types present. Potential impacts to wildlife resources from the Douglas Pass Road corridor would be similar in nature and magnitude to those of the 16 Road multi-use corridor. The potential for the occurrence of white-tailed prairie dog towns (potential habitat for endangered black-footed ferret) exists within the Dorchester Coal corridor.

Potential impacts of railroad construction and operation were studied for two alternative shale transport railroad corridors which could be incorporated in the FII-50 alternative. Specific baseline data concerning construction-related impacts to the two tunnel route alternatives were not available ; however, the following judgments were made based upon regional information and general knowledge of the area. While the Straight Line Tunnel route would have less potential for surface disturbance and related wildlife habitat impacts, it would transect critical elk winter range in Brush Creek and other presently undisturbed areas. By constrast, the Roan Creek tunnel route would parallel the existing Roan Creek Road before joining the proposed Roan Creek multi-use corridor near the confluence of Roan Creek and Clear Creek. Either of these alternatives would generate moderately adverse impacts to wildlife in the project area resulting primarily from habitat loss and noise.

Spent Shale Disposal Alternatives

Vegetation. Of the four alternative spent shale disposal sites, the Dry Gulch site would potentially impact the greatest amount of vegetation (3,021 acres). No agricultural lands would be affected. The remaining alternative spent shale disposal sites: Garvey Canyon, Stove/Buniger canyons, and Munger Creek would affect up to 1,900, 2,741, and 2,085 acres, respectively, of native vegetation. No agricultural land would be affected by these alternative sites. The Munger Creek site has the highest annual plant productivity and the Stove/Buniger canyons site has the lowest productivity based on worst-case estimates. No known populations of special concern plant species would be impacted by the four alternative sites. However, the sites should be searched for such species prior to development. Insignificant adverse impacts to vegetation would result from the selection of any of the four alternative spent shale disposal sites.

Wildlife. All four spent shale disposal sites include either mule deer critical winter range, active raptor nest sites, or both. The Dry Gulch site includes two active golden eagle nests, one active prairie falcon nest, and an unknown acreage of critical winter range for mule deer. The Garvey Canyon site also includes two active golden eagle nests, and an unknown acreage of CWR. It is likely that active raptor nest sites and mule deer CWR would also be encountered at the Stove/Buniger canyons and Munger Creek sites.

4.8.5 Transportation Alternatives

Vegetation

Site-specific adverse impacts to vegetation and annual productivity would result from truck or rail transport of coal due to the permanent elimination of vegetation along the corridor route. Low adverse impacts to vegetation could result from fugitive dust coating plants adjacent to the corridor which could result in reduced photosynthesis and annual productivity.

Wildlife

Of the alternatives under study, trucking of coal to the retort-upgrading facilities at the Clear Creek mesa or Fruita plant sites would result in the most significant adverse impacts to wildlife due to increased road kills. Rail transport would result in greater operational noise, but disturbance would be more predictable and less frequent than that generated by trucking coal.

Potential impacts of truck transport of coal within the Clear Creek access corridor were judged to be moderately severe and of regional significance. Passage of 90 haul trucks per day would effectively exclude most wildlife from areas impacted by the resultant noise. In addition, this schedule of operation would undoubtedly result in permanent alteration of big game movement and range use patterns throughout the Roan Creek drainage (Unit 31). Construction of a railroad for materials transport within the Roan Creek corridor would result in loss of an unknown quantity of riparian habitat. Operational impacts of one unit train (required for coal transport) making one round trip per day along this route would be moderate in comparison to those resulting from the truck transport alternative.

Mass transit of workers would result in less road kill of wildlife and would reduce the potential for harassment which could be associated with transportation by means of personal vehicles.

4.8.6 Solid and Hazardous Waste Disposal

On-site solid waste disposal would minimize the potential for vegetation removal and wildlife habitat loss or road kills elsewhere and is, therefore, preferred. On-site hazardous waste disposal would be preferred to off-site disposal for the same reasons.

4.8.7 Secondary Impacts

Vegetation

Secondary impacts to vegetation and productivity would occur as a result of the construction of permanent housing, roadways, and numerous other facilities which would be required to support an induced population of approximately 28,000. Preliminary calculations suggest that several square miles of agricultural lands (mostly in the Grand Valley) may be converted to other uses, resulting in permanent losses of productivity.

Wildlife

Indirect loss of wildlife and wildlife habitat would result from secondary impacts of the proposed project. A long-term reduction of wildlife densities from road kills and poaching could occur throughout the region. Direct loss of wildlife due to poaching could be locally significant, especially for deer and pronghorn, where concentration areas are accessible. Direct regional impacts on wildlife habitat would result from housing and community infrastructure development. The magnitude of long-term reduction in the regional carrying capacity for many species would be minimized if such habitat losses are concentrated in areas of existing community development. Indirect impacts to wildlife would occur as a result of increased levels of noise, harassment by domestic pets, and human activity (including ORV use) in the area of secondary impact. A simultaneous increase in the demand for consumptive and nonconsumptive wildlife-related recreation would occur throughout the area.

4.9 Visual Resources

4.9.1 General Impacts

Visual resource impacts result from a contrast introduced into the natural landscape by a landscape alteration. The degree of impact is directly related to the amount of contrast. Contrasts are described in terms of changes to the elements of form, line, color, and texture. Form contrasts result from the introduction of a structure (e.g., building or tank) dissimilar in form from the natural landscape. Line contrasts result from the introduction of a linear feature (e.g., powerline, roadway, pipeline). Color contrast results either from exposing soil or bedrock of a different color than the surrounding landscape, or through the introduction of a structure (e.g., roadway) of a different color than the landscape. Textural contrast results from changes to vegetation, vegetation pattern, or landform features that visually change overall texture.

Construction of CCSOP facilities would introduce major landscape alterations and reduce the overall scenic quality of the project area. Although architectural planning and reclamation activities can partially reduce the degree of impact, recommended visual resource management (VRM) goals for the project area would not be met for the life of the project for the major facilities. These include the surface mine, Clear Creek mesa retort and upgrade sites, and the Grand Valley upgrade and retort sites. Portions of corridors constructed with proper siting and design can meet recommended goals. Table 4.9-1 presents a listing of potential project sites in relation to visual resource management goals.

4.9.2 Clear Creek Mesa and Associated Siting Activities

Surface Mine

Development of the Clear Creek mesa site would result in major (adverse) form, line, and color changes to the area. The rolling landscape would be broken by the vertical, inverted box-form of the surface mine. The color of the open pit mine, spent shale, haul roads, and related facilities would contrast with the color of the surrounding landscape. The mine, roads, and powerlines would introduce straight lines into a landscape with curving lines. The sensitivity of the site is low and is seldom seen by the general public. Activities at the site would not affect views from existing or proposed activity centers (recreation areas, vistas, towns, or public roadways).

Underground Mine

The surface facilities related to the underground mine are contiguous with the plant facilities. Impacts are described under the plant site description.

Plant Site

Construction and operation of the retort and upgrading facilities would result in major (adverse) form, line, and color changes to the site area. Buildings, retorts, tanks, and other structures would introduce rectangular,

Table 4.9-1 PROJECT ACTIVITIES IN RELATION TO VISUAL RESOURCES MANAGEMENT GOALS

Site	Segment	VRM Class	Project Design[a] Meets VRM Goal
Surface Mine	All	IV	Yes
Underground Mine[b]	All	IV	No
Clear Creek Mesa Plant Site	All	IV	No
Grand Valley Plant Site	All	III	No
Roan Creek Corridor	Colorado River	II	No
	Lower Roan Creek	II	No
	Clear Creek Canyon	II	No
	Upper Roan Creek (RR Corridor)	III	No
Big Salt Wash Corridor	Colorado River	II	No
	Colorado River to Highline Canal	IV	Yes
	Highline Canal to Book Cliffs	III	Yes
	Book Cliffs to Roan Plateau	III	Yes
	Roan Plateau to Mesa Site	IV	Yes
La Sal/Parachute Creek Corridors	Roan Plateau	IV	Yes
	Parachute Creek	II	No
Rangely A Corridor	Mesa Site to Douglas Pass Road	IV	Yes
	Douglas Pass Road Corridor	II,III	Yes
	White River Crossing	II	No
Rangely B Corridor	Mesa Site to Cathedral Bluffs	IV	Yes
	Cathedral Bluffs Segment	II	No
	Cathedral Bluffs to White River	IV	Yes
	White River Crossing	II	No
Sheep Gulch Corridor	All	II	No
Buck Gulch Corridor	All	II	No
Straight Line Tunnel Route	All	II,III,IV	No

Table 4.9-1 PROJECT ACTIVITIES IN RELATION TO VISUAL RESOURCES MANAGEMENT GOALS (Continued)

Site	Segment	VRM Class	Project Design[a] Meets VRM Goal
Grand Valley Alternative Corridors	All	III,IV	Yes
Big Salt Wash Reservoir	All	II	Yes
Upper Dry Fork Reservoir	All	II	Yes
Parachute Creek Reservoir	All	II	Yes
Mesa Valley Spent Shale Disposal	All	IV	No
Stove/Buniger Canyon Spent Shale Disposal	All	II	No
Garvey Canyon Spent Shale Disposal	All	II	No
Munger Canyon Spent Shale Disposal	All	II	No
Dry Gulch Spent Shale Disposal	All	III,IV	No

Source: Chevron (1982s).

[a] Long-term analysis
[b] Surface facilities related to underground mine

oblong, and circular forms into the flat rolling topography. Color of the structures would contrast with the color of the existing landscape. Site structures and boundaries would introduce contrasting line. The degree of impact would depend on the final siting, design, and color of structures, but the overall impact would result in a major modification of the existing landscape. As with the mine site, the area is seldom seen by the general public and activities would not affect views from existing or proposed activity centers.

Corridors

Roan Creek Corridor. The visual resource impact of the corridor would be a low to moderate line and color contrast introduced by the upgraded road, powerline, and pipeline right of way. Existing natural and man-made line (e.g., roads and fences) within the corridor run the length of the route, and the new activities would complement these lines. The most sensitive portion of the corridor is where it rises out of Clear Creek canyon, since a diagonal line would be introduced into the steep canyon walls. The De Beque area is also sensitive, due to the presence of the town and the I-70 corridor.

Big Salt Wash Corridor. The right-of-way within this corridor would introduce straight linear impact (low adverse) into landscapes with curvilinear lines. The impact would be greatest at the point where the corridor rises out of the Big Salt Wash drainage and least within Big Salt Wash and on top of the mesa. The Clear Creek mesa to Ruby Lee reservoir corridor would be the least sensitive portion due to limited public access. The Ruby Lee reservoir to Fruita portion would be more sensitive. However, the corridors can be constructed to complement existing linear impacts.

La Sal. The powerline and pipeline right-of-way constructed on the Roan Plateau would introduce a straight linear impact (low adverse) in an area with curvilinear line. Some form and color contrast would also be evident. With proper siting and reclamation, the modification would be minor and VRM goals can be met. The corridor is seldom seen by the general public and will not affect views from an existing activity center.

Reservoirs

Upper Dry Fork Reservoir. The form of the dam face and reservoir surface, contrasting with adjacent rolling topography, would be the primary impact of the reservoir. The dam and reservoir would also create a color and line contrast. Although the reservoir would introduce a major modification into the landscape, it would not necessarily detract from scenic quality depending on design, operation, and revegetation efforts. The primary visual impact would occur during periods of water drawdown that expose the muddy surface of the reservoir bottom. The dam face will be visible from the De Beque and I-70 corridor area.

Big Salt Wash. Impacts due to the proposed Big Salt Wash reservoir will be similar to those described for the Upper Dry Fork reservoir. Sensitivity of the site is low due to limited access. The site would not affect views from a key activity center.

Production Rate Alternatives

The impact of a 50,000-bpd project would be less than the 100,000-bpd proposal due to less surface disturbance for the facilities and the absence of the surface mine. Facilities required for a 50,000-bpd project would still probably result in a high adverse impacts and not meet visual resource management goals. The 50,000-bpd facility does not include a surface mine for spent shale disposal; thus spent shale would be disposed of on a surface location. This would create an additional form and color impact. The degree of impact would be dependent on the location and size of the area covered, but is not expected to be as great as the impact of the surface mine.

4.9.3 Grand Valley and Associated Siting Activities

Construction and operation of the Grand Valley upgrading facility would create major (high adverse) form, line, and color impacts similar to those described for the Clear Creek mesa site. Sensitivity of the site is higher than the Clear Creek mesa site, since it can be seen from a public access road. The site would not affect quality of view from an established activity center, but can be observed from a BLM wilderness study area viewpoint adjacent to the Colorado National Monument, more than 10 miles to the south. The proposed access road would involve upgrading of 16 Road. Impacts would thus be minimal. Impacts of the Big Salt Wash and La Sal corridors have been described previously.

Both the Fruita I and Fruita II alternatives would have greater impacts than the Proposed Action and Clear Creek alternatives since major landscape modifications will occur in two locations (Clear Creek mesa and Grand Valley). In addition, the Grand Valley area is more sensitive due to greater public use. Impacts due to a 50,000-bpd production rate would be similar to those described above.

4.9.4 Alternative Siting Activities

Corridors

Rangely A Corridor. The Clear Creek Mesa site to Douglas Pass Road (north of the Pass) portion of the Rangely A syncrude transport corridor would introduce a linear impact (low adverse) into terrain with existing curvilinear line. The Douglas Pass Road and White River portions would be most sensitive, with the greatest potential for impact occurring where the corridor crosses the White River. Since the Douglas Pass Road portion runs parallel with an existing corridor, impacts would be minimal.

Rangely B Corridor. The Rangely B corridor differs from the Rangely A corridor in that the route follows Cathedral Bluffs, an area where existing visual resource impact is minimal. The corridor would create a moderate- to high-adverse linear impact along the axis of the Cathedral Bluffs. Due to less frequent viewer use, sensitivity of the Rangely B corridor is less than the Rangely A corridor. Scenic quality of the Rangely B corridor is higher and potential for visual impact therefore higher.

Grand Valley Alternative Corridors. The Douglas Pass Road corridor would have minimal impact due to the presence of the existing corridor. The alternative railroad corridor crosses farmland and native vegetation and will introduce a linear, low adverse impact into the landscape. Both corridors will be visible from activity centers within the Grand Valley. The Grand Valley site to SOPS corridor will have minimal impact due to its short length.

Roan Creek Tunnel Route Railroad. This alternative railroad route would have moderate adverse impacts within portions of the Big Salt Wash and Roan Creek due to cut and fill activities. The use of the tunnel will reduce some visual impact of the route.

Straight Line Tunnel Route Railroad. Due to the major fill, bridge, and tunneling requirements of the route, the Straight Line Tunnel corridor would have a potentially high adverse visual impact. The impact would be created by color contrast of fill and waste rock, form impact of fill and bridge, and linear impact of the route.

Reservoirs

Roan Creek. The three alternative Roan Creek reservoirs would have similar impacts as described for Upper Dry Fork reservoir (Section 4.9.2). The sensitivity of the reservoir sites decreases with distance from the De Beque and I-70 area.

Parachute Creek Reservoir. The Parachute Creek reservoir would have similar form, line, and color impacts as described for the proposed Upper Dry Fork and Big Salt Wash reservoirs. The proposed Parachute Creek reservoir site is visible from the Parachute Creek road, but not from an established community or recreation site. The water transport corridor from the reservoir follows the West Dry Fork of Parachute Creek drainage. The most sensitive portion of the route is where the corridor climbs out of Parachute Creek canyon, an area of high senic quality. A moderately adverse impact would occur here. The remainder of the route is on the Roan Plateau, an area of low quality, and visual impact would be low.

Spent Shale Disposal

Disposal of spent shale in the Mesa Valley Fill location would further reduce scenic quality of the Clear Creek mesa. Spent shale disposal would create moderate to high adverse form and color contrast that will remain until completion of reclamation activities. The form of the canyons would be permanently altered, with the degree of impact dependent on final contouring of the disposal area.

Disposal of spent shale within either Stove/Buniger, Munger Creek, or Garvey canyons would introduce major (high adverse) form and color impacts into a portion of the Big Salt Wash drainage. All canyons are narrow, steep, and V-shape in form. Disposal of spent shale would reduce the vertical relief side walls of the canyons and make the canyons U-shaped. Prior to reclamation, the dark-gray color of the spent shale would contrast with the lighter grays and greens of the existing landscape. Sensitivity of the canyons is low and fill activities would not affect view from an established activity center.

Disposal of spent shale in the Dry Gulch area would introduce a planar landform impact (moderate to high adverse) in an area with rolling dissected terrain. The dark-gray color of the shale would contrast with the light tans and yellows of the existing landscape. The Dry Gulch site has greater viewer sensitivity than the Big Salt Wash sites; it is visible from the Grand Valley and Colorado National Monument areas. However, depending on final reclamation design, the Dry Gulch site would have the greatest potential from meeting recommended visual resource management goals for the site.

4.9.5 Transportation Alternatives

Roadway and railroad right-of-ways would introduce a similar line and color impact with degree of impact dependent on siting, design, and need for cut and fill structures. A conveyor would have a greater impact than roads and railroads due to the linear box-like form of the conveyor. Coal transport by truck would require a coal loadout facility at the De Beque railroad spur, an area of high visual sensitivity. Rail transport of coal to the Clear Creek mesa site would require a railroad, in addition to a road, up the Clear Creek canyon corridor. A loadout facility within the canyon would impact an area of higher scenic quality but lower visual sensitivity than the De Beque area.

4.9.6 Hazardous Waste Disposal

The actual disposal site would have an adverse visual resource impact with the degree of impact dependent on location and size of the facility.

4.9.7 Secondary Impacts

Secondary impacts due to employee housing, support facilities, powerlines, and roads would have a significant visual impact on the Roan Creek and Colorado River valleys. The rural and agrarian nature of the valleys would be altered to an urban setting. Degree of impact would depend on the architectre, layout, and landscaping of the structures and roadways.

4.10 Cultural Resources

4.10.1 General Impacts

Although several archaeological and historical investigations have been undertaken within the region, the regional chronology and cultural affiliations of western Colorado are only roughly defined. Most of the work in the project area has resulted from recent research in the form of scattered surveys, resulting primarily from the requirements of federal and state cultural resources legislation.

When considered on a regional level, the impacts of the CCSOP to cultural resources are considered minimal. The Canyon Pintado Historic District is an exception (see Section 3.10). The rugged terrain and limited availability of water in the project area discouraged dense prehistoric and historic settlement. Those cultural resources which have been identified relate primarily to seasonal occupation of the area and travel corridors through the region.

Protective stipulations to mitigate potential impacts to sites considered eligible for the National Register of Historic Places (NRHP) are required by the Colorado State Historic Preservation Officer and the Bureau of Land Management. During consultation among the Bureau of Land Management, Colorado State Historic Preservation Officer, and the President's Advisory Council on Historic Preservation, it will be determined if these stipulations are adequate, or if additional or substitute measures need to be applied. As consultation efforts occur in light of specific project construction plans, mitigation will be developed for all identified eligible sites.

4.10.2 Clear Creek Mesa and Associated Siting Activities

Three prehistoric sites on the proposed Clear Creek plant site are considered eligible by the BLM for nomination to NRHP. Six sites were considered eligible by LOPA within the reservoir/corridors areas. See Section 3.10 for details regarding these sites.

Impacts to these sites could range from total destruction by mining, retorting, upgrading, and transporting the shale oil, to partial destruction or alteration of all or part of the sites as a result of construction activities. Additional damage could occur by vehicular traffic. Production rate alternatives will affect potential impacts to the extent that elimination of the surface mine for the 50,000-bpd alternative will probably not disturb the potentially eligible sites on the Clear Creek mesa, notably 5GF651, 5GF656 and 5GF657 (see Section 3.10).

4.10.3 Grand Valley and Associated Siting Activities

Impacts of construction and operation of the Grand Valley facilities and corridor are considered minimal. Two prehistoric sites are considered eligible for the NRHP at the alternative plant site and the corridor south to Fruita. However, further site-specific investigations would be required prior to construction activities. See Section 3.10 for details on the existing sites. Also, the 50,000-bpd production rate alternative would lessen disturbance on Clear Creek mesa (see 4.10.2 above). Impact differences due to less disturbance at the Fruita plant site and corridors from the 50,000-bpd production rate would be negligible.

4.10.4 Alternative Siting Activities

Detailed field surveys of alternative sites have not been undertaken as part of the CCSOP. Field survey work does not need to be undertaken until specific alternatives are selected for construction. What can be noted, however, is that the region has been inhabitated since 11,000 B.C. by numerous cultures who have lived in the area for various reasons. Archaeological and historical investigations in the region have generally uncovered low site densities and sites consisting primarily of lithics (stone tools and flakes), short-term campsites, trails, and homesteads. In general, these sites reflect a broad pattern of trade networks, migration patterns, and land uses in the region.

The Canyon Pintado Historic District, which would be affected by construction of the Rangely A pipeline route (see Section 3.10), is worthy of note. Because of the predominance of sites, BLM has considered prohibiting construction of additional pipeline routes in this area (Meacham 1982). Adverse impacts to cultural resources would probably be caused by construction here.

Other alternative corridors contain eight eligible or likely eligible sites. As indicated above, site density is low given the lengthy corridor areas studied. See Section 3.10 for details.

4.10.5 Transportation Alternatives

The construction of a railroad corridor or expansion of the existing road corridor for coal haulage from De Beque to Clear Creek mesa may affect cultural resources within the corridor. Actual determinations of impacts and appropriate mitigation measures will be developed according to agency requirements.

4.10.6 Hazardous Waste Disposal

Impacts resulting from hazardous waste disposal will be dependent on the location of the disposal area and the presence of cultural resources sites. Actual determinations of impacts and appropriate mitigation measures will be developed according to agency requirements.

4.10.7 Secondary Impacts

Population increases in the region due to construction and operation of the CCSOP could lead to increased destruction of cultural reources due to unauthorized collection and vandalism, both on and off the construction sites, and additional land disturbance associated with new housing and roads. Increased access to sites due to the formation of new access roads could also lead to potential damage to cultural resource sites which previously had been undsturbed or undiscovered.

4.11 Land Use, Recreation, and Wilderness

Details concerning the impact assessment methods and assumptions for this section are included in Appendix B-3. Table 4.11-1 identifies direct land use impacts for each of the proposed project altneratives.

Table 4.11-1 PRIMARY LAND USE IMPACTS BY ALTERNATIVE

Project Configuration	100,000 bpd	50,000 bpd
Proposed Action		
Rangeland (acres)	25,926	11,677
Agricultural (acres)	2,055	2,055
Residential (acres)[a]	—	—
TOTAL	27,981	13,732
Clear Creek		
Rangeland (acres)	19,689	5,440
Agricultural (acres)	1,388	1,388
Residential (acres)	—	—
TOTAL	21,077	6,828
Fruita I		
Rangeland (acres)	29,126	14,877
Agricultural (acres)	2,055	2,055
Residential (acres)	—	—
TOTAL	31,181	16,932
Fruita II		
Rangeland (acres)	NA	16,275
Agricultural (acres)	NA	2,055
Residential (acres)	NA	—
TOTAL	NA	18,330
No Action		
An insignificant amount of land will be disturbed in exploration; no additional acreage will be disturbed if the project is not constructed.		

[a] Residential acreages unavailable; however, they are assumed to be insignificant.

4.11.1 Land Use

4.11.1.1 General Impacts

Acreages given for the various alternatives represent "worst-case" disturbances. Acreages for multiple use corridors, for instance, were calculated based on a 1,000-foot-wide corridor. Placement of roads, pipelines, and other facilities within these corridors may disturb only 30 percent of the total acreages given. Because exact data were unavailable, worst-case assumptions were used. All quantitative estimates cited in this impact analysis should be considered with this in mind.

The oil shale industry may exert a powerful influence on the existing land uses in western Colorado. Oil shale development could alter well-established and traditional patterns of livelihood, such as farming and ranching, and significantly change the residential land use patterns within rural communities.

Primary impacts to agriculture would occur during construction and operation. The main concerns related to the Proposed Action and alternatives on agricultural lands are loss of crop production, reduction of grazing area, and long-term land use changes at surface facility sites. The impacts of these losses in potential crop production and cattle grazing capacity would be significant to the local economy but would be insignificant when viewed from a regional or national perspective.

The direct land use impacts from project development could be significant, since a large amount of land (approximately 29,000 acres) would be disturbed. Indirect land use impacts also would be significant. New residences would be built and additional community facilities would be developed to sustain increased population. New patterns of urbanization would occur on developable land in communities which are now primarily rural in nature. Furthermore, since much of this development would take place within communities which are predominantly located within valleys, it is likely that expansion of these communities would encroach upon irrigated cropland. The resulting loss of cropland acreage from this urban development could be more substantial than direct impact of construction and operation of the oil shale facilities. (See Section 4.8, Terrestrial Ecology, for a more detailed discussion of these issues).

4.11.1.2 Clear Creek Mesa and Associated Siting Activities

Proposed Action-100,000 bpd and 50,000 bpd (PA-100, PA-50)

Primary land use impacts due to construction and operation of the proposed facilities could potentially occur. The major direct adverse environmental consequences of PA-100 would be the reduction of livestock grazing and loss of wildlife habitat on the mine and facilities area (Clear Creek mesa) during the periods of construction, operation, and reclamation. The CCSOP would not directly displace significant tracts of fertile farm and grazing land. In the 100,000-bpd alternative, up to 26,000 acres of rangeland and 2,055 acres of agricultural lands could be lost to the areas occupied by the surface mine, plant site, Mesa Valley Fill, and associated corridors. Initially, the plant site would eliminate approximately 374 acres of rangeland and wildlife habitat. Incremental amounts of surface mined lands presently used as rangeland would be lost at a rate of 100-200 acres annually. For the 50,000-bpd alternative (which eliminates the surface mine), only 11,677 acres of rangeland and 2,055 acres of agricultural lands would be potentially affected. Details concerning prime farmland and productivity impacts of the project are addressed in Section 4.6, Soils, and 4.8, Terrestrial Ecology, respectively.

The influx of workers and their families due to increased employment opportunities provided by the CCSOP may alter land use characteristics in and adjacent to existing communities. This would be particularly evident in the smaller, more rural communities of Parachute and De Beque for the Proposed Action or Clear Creek alternatives. Battlement Mesa may also grow in population under these alternatives (see Section 4.12, Socioeconomics).

Clear Creek Alternative 100,000-bpd and 50,000-bpd (CC-100, CC-50)

The CC-100 alternative would consist of the same project components as the Proposed Action, with the exception that the Loma water diversion and pipeline would not be constructed. CC-100 would affect approximately 19,689 acres of rangeland (24 percent less than the Proposed Action) and 1,388 acres of agricultural land (32 percent less than the Proposed Action).

The Clear Creek configuration at a 50,000-bpd production rate would eliminate the 14,249-acre surface mine. Therefore, only 5,440 acres of rangeland would be potentially affected. However, because other project components would remain the same, 1,388 acres of agricultural land will still be affected.

4.11.1.3 Grand Valley and Associated Siting Activities

Fruita I - 100,000-bpd and 50,000-bpd (FI-100, FI-50)

FI-100 could result in more land use impacts than those associated with the Proposed Action and Clear Creek alternatives. Ancilliary facilities would traverse up to 1,565 acres of irrigated agricultural land. Reduction of livestock grazing and loss of wildlife habitat due to FI-100 would occur on 29,126 acres.

For FI-50, approximately 14,877 acres of rangeland would potentially be disturbed, assuming worst-case situations. Acreages of affected agricultural lands would be the same as those with the 100,000-bpd alternative. Impacts to vegetation and wildlife are discussed in Section 4.8.

Fruita II - 50,000-bpd (FI-50)

The Fruita II configuration (50,000 bpd only) would potentially affect 16,275 acres of rangeland and wildlife habitat. As with the Fruita I configuration, about 1,565 acres of irrigated (non-prime) farmland would be affected.

4.11.1.4 Alternative Siting Activities

Spent Shale Disposal Locations

For the Proposed Action, Clear Creek, and Fruita I alternatives, there would be a very slight adverse impact on land uses within and adjacent to the site area due to the disposal of spent shale on Clear Creek mesa (Mesa Valley Fill). Approximately 1,623 acres of rangeland and wildlife habitat would be affected; no agricultural land would be impacted. Although there certainly would be a change in land use characterization from open space to industrial, the change would be insignificant.

For FII-50, the Dry Gulch disposal site would potentially impact approximately 3,021 acres of rangeland and wildlife habitat. No agricultural lands would be affected. The site is currently open space and would be transformed into industrial uses. The three remaining alternative spent shale disposal sites, Garvey Canyon, Stove/Buniger canyons, and Munger Creek, would affect up to 1,900, 2,741, and 2,085 acres of rangeland, respectively. No existing agricultural cropland will be affected by these alternative sites; therefore, they would have an insignificant impact on land use.

Reservoirs

Slightly beneficial impacts to land use by construction of the alternative reservoirs within the Roan Creek drainage (Upper Conn Creek, Lower Conn Creek, Upper Dry Fork, and Lower Dry Fork) would be expected. The effects of the alternative reservoirs on land use would not be significantly different. Each would inundate about 2,500 acres (ranging from 2,296 to 2,757 acres) of land. The greatest amount of agricultural land would be affected by the Upper Conn Creek reservoir (865 acres); the Lower Conn Creek reservoir would affect the least amount of agricultural land (666 acres). Upper Dry Fork reservoir would inundate approximately 741 acres of agricultural land and Lower Dry Fork reservoir would inundate 775 acres. No prime farmland would be affected by these alternatives.

Major Facilities Corridors

Impacts to land use from the railroad and multiple-use corridors would vary as a function of corridor distance and width and type of land traversed. The corridor potentially affecting the most acreage is the Roan Creek corridor, which is applicable to all alternative project configurations. The total potentially affected acreage is 3,716 acres, of which 647 acres and agricultural lands. The remainder is rangeland.

The Dorchester Coal railroad corridor, only 14 miles long, would affect the least amount of land, 153 acres of rangeland and 17 acres of agricultural land. Intermediate impacts resulting from the Douglas Pass road to Grand Valley plant site multiple-use corridor, would potentially affect 607 acres of farmland and 421 acres of rangeland; the Big Salt Wash corridor would affect 629 acres of farmland and 924 acres of rangeland; and the Tunnel route, (railroad for Fruita II) would impact only 689 acres of rangeland.

Secondary impacts resulting from these corridors would occur due to increased accessibility to lands for hunting and other recreational purposes.

Pipeline Corridors

The most substantial pipeline corridor impacts to rangeland and agriculture would result from the Rangely A and B syncrude pipelines and the Parachute Creek water pipeline. Potentially the Parachute Creek water pipeline would affect the greatest amount of agricultural land and agricultural productivity (55 acres of farmland). Approximately 177 acres of rangeland would also be affected. The Rangely A corridor would have adverse impacts to 13 acres of farmland, and 241 acres of rangeland. The Rangely B corridor would potentially affect 6 acres of agricultural land and up to 276 acres of rangeland. None of the remaining syncrude pipelines (Grand Valley plant site to SOPS, La Sal, Buck Gulch, and Sheep Gulch) would intercept agricultural lands. Of these four, the La Sal pipeline would affect the largest amount of rangeland (183 acres), while the Sheep Gulch pipeline would affect the least amount of rangeland (29 acres). The Grand Valley Plant Site to SOPS pipeline and the Buck Gulch pipeline are essentially equivalent in impact, affecting 38 and 33 acres of rangeland, respectively.

Transmission Corridors

All alternative transmission line corridors would pose low adverse land use impacts. An insignificant amount of rangeland would be lost due to tower placement. Cattle grazing under high-voltage transmission lines may experience small electrical discharges, which can occur between plants and the noses of cattle under certain environmental conditions.

Water Intake Locations

Insignificant land use impacts would result from all of the alternative water intake locations.

4.11.1.5 Transportation Alternatives

These alternatives, whether associated with coal, workers, equipment, raw shale, or refined product, may affect land use patterns for the length of the corridor. Corridor width, noise, dust, and frequency and type of use could create impacts to adjacent land uses. However, much of the area which would be affected by development is already in a state of transition brought about by growth and development (BMML 1982).

4.11.1.6 Solid and Hazardous Waste Disposal

Solid waste disposal would create different land use impacts depending upon whether it was accomplished by landfill in the processed shale, partially incinerated (with attendant air impacts), or placed in a separate landfill. Hazardous waste disposal would also have different land use impacts if disposed off-site versus on-site. It is assumed that the transport and disposal of hazardous wastes would meet all appropriate regulations, thereby minimizing impacts.

4.11.1.7 Secondary Impacts

Industrialization may have very subtle effects on agricultural land use patterns within the region. The projected increase in energy development activity may cause an increase in demand for labor, thereby making it difficult for agricultural enterprises to compete directly for the existing labor pool. The inability of agriculture to economically compete directly with energy companies for labor, land, and water may lead to changing land values and eventually lead to indirect land displacement.

Workers and their families would affect land use patterns more directly in the vicinity of Fruita and Grand Junction and unincorporated areas of Mesa County if the Fruita I or II alternatives are implemented. Encroachment on agricultural lands by expanding communities may become a significant local issue. Impacts would still occur in Garfield County, but they would be minimized because of the presence of some project workers and families in the Fruita area. Socioeconomic impacts are discussed in detail in Section 4.12.

4.11.2 Recreation

The primary impact of the CCSOP on recreation would be increased numbers of people participating in and demanding recreational opportunities. Developed recreation sites within the region from Glenwood Springs to Grand Junction would receive additional use. Resulting overcrowding would lead to increased maintenance and repair costs. Municipal facilities, in particular, would be inadequate to meet local needs. While increases in local tax bases would occur, there could be a lag time between need and availabiity of funds (see Section 4.12, Socioeconomics).

If either the Proposed Action or Clear Creek alternatives were developed, the majority of non-local construction workers and operations workers would tend to relocate in the De Beque, Parachute/Battlement Mesa, and Rifle areas. Municipal facilities located in and near the Clear Creek area (Glenwood Springs, Silt, Rifle, and Parachute/Battlement Mesa) and outdoor recreation facilities such as the Naval Oil Shale Reserve Extensive Recreation Management Area (ERMA), Rifle ERMA, and Plateau Valley ERMA would experience increased numbers of visitor days (see Section 3.11). Impacts on municipal facilities would be greater than on the regional outdoor facilities (see Section 4.12).

If either Fruita I or Fruita II alternatives were developed, approximately 3,000 additional construction workers and 1,550 additional operations workers would reside within the Grand Valley area. Municipal recreational facilities in Fruita, Grand Junction and Palisade could expect increased use. Outdoor recreational facilities such as the Ruby Canyon, Black Ridge SRMA, the Grand Valley SRMA, the Book Cliffs ERMA, Highland Lake, and the Colorado National Monument (see Section 3.11) would be slightly impacted but able to absorb additional use.

As noted previously, municipal recreation facilities on the Western Slope would be affected by the increased populations brought about by the construction and operation of the CCSOP. This would be particularly evident in the smaller, more rural communities (e.g., De Beque, Parachute, Fruita) where facilities are currently inadequate or nonexistent. The larger communities such as Grand Junction and Glenwood Springs would be able to absorb additional residents, though they too would need to upgrade existing municipal facilities.

Attempts have been made to form one or more recreation districts in Garfield County. Two are currently proposed: one for the Parachute/Battlement Mesa area and one for the Rifle area. The Parachute/Battlement Mesa district could support a $5,000,000 recreation center, while the Rifle district could support a $1,500,000 recreation center. However, two recreation districts within 15 miles of each other duplicates costly facilities and, in this case, relies too heavily on one industry (oil shale) for its tax base. The status of any special district formation may depend on Colony's recent announcement to defer its oil shale project.

Big game hunting in the area would be significantly affected by construction of project facilities and corridors which would remove many acres of wildlife habitat. However, at the same time other hunting areas would be made more accessible by additional roads and corridors.

Water-related recreational activities (fishing, boating, swimming) are not expected to be affected by the CCSOP. Even though new reservoirs would be created for the project, these would be unavailable for recreational use due to fluctuating water levels during operation.

Overall, impacts to the recreation areas and facilities in the region would be substantial, particularly on municipal recreational facilities. Impacts may be greatest during the construction phase, when workers are mobile and expect to be in an area for only a short time. They would nevertheless desire use of municipal recreational facilities. Potentially impacted communities would be required to determine whether or not to construct facilities, since recreation may be an answer to many social concerns being experienced in smaller, expanding communities.

4.11.3 Wilderness

The primary impact of the CCSOP on regional wilderness areas on the Western Slope would be the increased demand placed upon these areas, particularly during peak construction, when approximately 9,000 construction and operations workers would be anticipated. Areas under wilderness study which would be impacted include Black Ridge Canyons West, Black Ridge Canyons, Demaree Canyon, Little Bookcliffs Wild Horse Area, and Bangs Canyon.

The Flat Tops Wilderness Area and Colorado National Monument could be expected to experience increased use; however, these areas can absorb some increased activity. Wilderness areas may record increased numbers of visitor days and perhaps increased maintenance and repair costs. BLM is aware of these potential impacts and will monitor visitor days and corresponding effects on the environment. Overall, however, the impacts to these areas would probably not be as substantial as those experienced by developed recreational facilities located within communities immediately affected by project development - such as De Beque.

4.12 Socioeconomics

4.12.1 Introduction

This section describes the social and economic impacts associated with construction and operation of the various alternatives of the CCSOP. Included are projections of the employment, demographic, economic, social, housing, education, public facilities and services, and fiscal impacts which may occur as a consequence of development of the CCSOP. These projections, for the most part, are based on recent work undertaken by Briscoe, Maphis, Murray, and Lamont, Inc. (BMML 1982) for the CCSOP.

As noted in Chapter 2.0, this EIS analyzes the impacts of seven major project alternative configurations: the Proposed Action at 100,000 (PA-100) and 50,000 bpd (PA-50), the Clear Creek alternative at 100,000 (CC-100) and 50,000 bpd (CC-50), the Fruita I alternative at 100,000 (FI-100) and 50,000 bpd (FI-50), and the Fruita II alternative at 50,000 bpd (FII-50) only. For this socioeconomic impact assessment, the Proposed Action and the Clear Creek alternatives have been analyzed as one alternative. This is due to the insignificant differences in the project design and socioeconomic impacts that would occur between the alternatives during construction and operation of the Project. *Thus, the reader should be aware that when the Clear Creek Mesa (CCM-100 and CCM-50) alternative is addressed in this section, it refers to both the Proposed Action and Clear Creek alternatives.*

4.12.2 Direct Project Employment

This section describes the direct project employment, salaries, and local purchases to be generated under all project alternatives. Under the higher production alternatives, direct employment would peak in 1994 at approximately 9,000 workers and extend through 1997. By full operation, 5,125 operations workers would be hired. Under the lower production alternatives, the peak year would be 1993, with the maximum direct project employment being 7,600 workers. By 2000, total employment would be 2,790 operations workers.

Average annual salaries for construction workers would be $32,422, and $30,736 for operation workers under all project alternatives. The salary estimates are from the Planning and Assessment System (PAS) used in the CITF process. All operations workers are assumed to be local residents (i.e., those who reside permanently within the project area). For the construction phase, it is assumed that 65 percent of the Operator's workers would be nonlocal (i.e., workers who assume new places of residence during the work week in order to be employed on the project). For nonlocal workers living in existing communities, the breakdown in marital status is:

With family present	60%
Married with family absent	15%
Single	25%

For construction workers living in the Operator's single-status camp, it is assumed that the workforce would be divided evenly between single workers and married workers with their families absent.

Local purchases would be greater under the higher production rate alternatives than under the lower production rate alternatives. Most local purchases would be made within the Grand Junction urban vicinity.

4.12.2.1 Clear Creek Mesa and Associated Siting Activities

Projected average annual employment requirements for constructing and operating CCM-100 are summarized in Table 4.12-1. As indicated by these data, the construction workforce would be expected to peak in 1993-94, when construction employment would average about 6,000 workers. The operations workforce would build steadily during that time, until reaching a steady state of about 5,125 operations workers. The peak total employment for the combined construction and operations workforce would be 9000 workers, beginning in 1994 and extending through 1997.

With CCM-50, there would abe a rapid build-up of workers in the early years, and no construction after 1994. The peak year for CCM-50 would be 1993 with the maximum project direct employment being 7,600 workers. By the year 2000, total project employment would be 2,790 operations workers. The population decline between the peak year and year 2000 would be relatively rapid, due to the drop off in construction workers. The decrease in employment would not be directly proportional to the lowered production.

Estimated local purchases (i.e., those purchases of materials and supplies made within Mesa or Garfield counties) by the CCSOP for CCM-100 during the construction and operations phases are provided in Table 4.12-2. Local purchases during construction would peak during 1991, immediately prior to the most intensive workforce buildup. No local purchases are allocated to the operations phase until 1997. For the 1997-2000 period, local purchases would be expected to total $66,881,000 per year (1981 dollars). Most of these local purchases would be made within the Grand Junction urban vicinity, the region's economic center. Estimated local purchases for CCM-50 would be less than for the CCM-100.

4.12.2.2 Grand Valley and Associated Siting Activities

Fruita I

Projected annual average employment figures for FI-100 are also presented in Table 4.12-1. Construction activity for the upgrading facilities in the Fruita area would peak in 1988, and then again in 1992-1996. Employment related to construction of the mine and retorts on Clear Creek mesa would peak in 1993 with employment anticipated at 4,760 workers. For the project as a whole, peak employment would occur in 1994-1997, when total employment would be 9,000 workers. Annual employment totals are similar for CCM-100 and FI-100. Project direct employment for FI-50 would follow a similar pattern as that described for CCM-50.

Fruita II

The Fruita II Alternative (FII-50) would be different from the other major alternatives in terms of location and production capacities (See Section 2.3 for details). Upgrading and retorting facilities would be located at the Grand Valley property, approximately 14 miles north of Fruita. A production capacity of 50,000 bpd would be reached by 1994.

Annual average employment for FII-50 is presented in Table 4.12-1. As noted, the total workforce would peak in 1993 at a total of 7,600 workers, and then level to an operations workforce of about 2,800 workers. The construction workforce build-up would be similar to that projected under the CCM-100 and FI-100 until 1994, when construction of retorting and upgrading facilities necessary for the 50,000 bpd capacity would be completed. The operations workforce for FII-50 would be about 55 percent of that required for the 100,000-bpd alternatives due to the reduction in production capacity.

Table 4.12-1 AVERAGE ANNUAL EMPLOYMENT FOR THE CLEAR CREEK MESA AND FRUITA I ALTERNATIVES AT 50,000 AND 100,000 BPD PRODUCTION AND FRUITA II ALTERNATIVE AT 50,000 BPD PRODUCTION

	Clear Creek Mesa Alternatives[a]					
	100,000 BPD Production			50,000 BPD Production[b]		
Year	Const	Oper	Project Total	Const	Oper	Project Total
1985	1,200	0	1,200	1,200	100	1,300
1986	3,125	0	3,125			
1987	3,625	500	4,125			
1988	4,025	1,000	5,025			
1989	2,845	1,480	4,325			
1990	1,020	1,480	2,500	1,000	1,400	2,400
1991	3,020	1,480	4,500			
1992	5,520	1,480	7,000			
1993	6,110	2,390	8,500	4,900	2,700	7,600
1994	5,980	3,020	9,000	1,026	2,790	3,816
1995	5,390	3,610	9,000			
1996	5,020	3,980	9,000			
1997	4,710	4,290	9,000			
1998	3,775	4,555	8,330			
1999	2,630	4,670	7,300			
2000	2,300	5,000	7,300	0	2,790	2,790
2001	2,195	5,105	7,300			
2002	0	5,125	5,125			
2003	0	5,125	5,125			

Table 4.12-1 AVERAGE ANNUAL EMPLOYMENT FOR THE CLEAR CREEK MESA AND FRUITA I ALTERNATIVES AT 50,000 AND 100,000 BPD PRODUCTION AND FRUITA II ALTERNATIVE AT 50,000 BPD PRODUCTION (continued)

	Fruita I Alternative[a]									
	100,000 BPD Production Rate							50,000 BPD Producton Rate[b]		
	Upgrading Facilities			Mines and Retorts				Upgrades, Mines and Retorts		
Year	Const	Oper	Total	Const	Oper	Total	Project Total	Const	Oper	Project Total
1985	0	0	0	1,200	0	1,200	1,200	1,200	100	1,300
1986	600	0	600	2,525	0	2,525	3,125			
1987	1,000	500	1,500	2,625	0	2,625	4,125			
1988	1,400	1,000	2,400	2,625	0	2,625	5,025			
1989	200	400	600	2,645	1,080	3,725	4,325			
1990	200	400	600	820	1,080	1,900	2,500	1,000	1,400	2,400
1991	600	400	1,000	2,420	1,080	3,500	4,500			
1992	1,350	400	1,750	4,170	1,080	5,250	7,000			
1993	1,350	735	2,085	4,760	1,655	6,415	8,500	4,900	2,700	7,600
1994	1,450	950	2,400	4,530	2,070	6,600	9,000	1,026	2,790	3,816
1995	1,350	1,035	2,385	4,040	2,575	6,615	9,000			
1996	1,350	1,120	2,470	3,670	2,860	6,530	9,000			
1997	600	1,175	1,775	4,110	3,115	7,225	9,000			
1998	0	1,220	1,220	3,775	3,335	7,110	8,330			
1999	0	1,220	1,220	2,630	3,450	6,080	7,300			
2000	0	1,245	1,245	2,300	3,755	6,055	7,300	0	2,790	2,790
2001	0	1,280	1,280	2,195	3,825	6,020	7,300			
2002	0	1,285	1,285	0	3,840	3,840	5,125			
2003	0	1,285	1,285	0	3,840	3,840	5,125			

Table 4.12-1 AVERAGE ANNUAL EMPLOYMENT FOR THE CLEAR CREEK MESA AND FRUITA I ALTERNATIVES AT 50,000 AND 100,000 BPD PRODUCTION AND FRUITA II ALTERNATIVE AT 50,000 BPD PRODUCTION (concluded)

	Fruita II Alternative (50,000 BPD Production Rate)[c]						
	Upgrading Facilities			Mines and Retorts			
Year	Const	Oper	Total	Const	Oper	Total	Project Total
1985	800	30	830	400	70	470	1,300
1986	2,500	50	2,550	500	150	650	3,200
1987	3,100	300	3,400	400	300	700	4,100
1988	3,500	500	4,000	300	500	800	4,800
1989	2,600	800	3,400	0	600	600	4,000
1990	1,000	800	1,800	0	600	600	2,400
1991	2,700	800	3,500	0	600	600	4,100
1992	4,500	1,000	5,500	0	700	700	6,200
1993	4,900	1,700	6,600	0	1,000	1,000	7,600
1994	1,000	1,750	2,750	0	1,050	1,050	3,800
1995	0	1,750	1,750	0	1,050	1,050	2,800
1996	0	1,750	1,750	0	1,050	1,050	2,800
1997	0	1,750	1,750	0	1,050	1,050	2,800
1998	0	1,750	1,750	0	1,050	1,050	2,800
1999	0	1,750	1,750	0	1,050	1,050	2,800
2000	0	1,750	1,750	0	1,050	1,050	2,800

Source: BMML (1982).

[a] Source: Chevron (1982dd).
[b] Only selected years provided for 50,000 BPD production rates.
[c] Source: Chevron (1982ee)

Table 4.12-2 LOCAL PURCHASES, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (IN 1,000 OF 1981 DOLLARS)

	Clear Creek Mesa and Fruita I Alternatives		Fruita II Alternative	
Year	Const	Oper	Const	Oper
1985	15,559	0	15,588	0
1986	31,796	0	31,795	0
1987	39,559	0	39,558	0
1988	79,121	0	79,121	0
1989	102,157	0	134,005	0
1990	127,397	0	63,697	0
1991	151,536	0	183,385	0
1992	136,257	0	136,257	0
1993	120,026	0	120,025	0
1994	112,332	0	112,331	0
1995	87,517	0	0	33,429
1996	75,486	0	0	33,429
1997	0	66,861	0	33,429
1998	0	66,861	0	33,429
1999	0	66,861	0	33,429
2000	0	66,861	0	33,429

Estimated local purchases by the Operator during the construction and operations phases of FII-50 are provided in Table 4.12-2. Purchases during construction would peak in 1991. No local purchases are allocated to the operations phase until 1995. For the 1995-2000 period, local purchases would be expected to total $33,429,000 per year (1981 dollars), half of that anticipated for CCM-100 or FI-100. Local purchases for FII-50 construction and operation phases would be distributed somewhat differently among local geographical areas than is the case for either CCM-100 or FI-100.

4.12.3 Employment, Population, and Economic Impacts

In this section, projections of the impacts of the CCSOP on employment, population, and income levels in Garfield and Mesa counties for the 1980-2000 time period are summarized. These projections are based on the assumptions which define the No Action alternative, the project alternatives, and the projection methods contained in the Planning and Assessment System (PAS). Appendix B-4 contains summaries of the basic activities in the six-county study area — Delta, Garfield, Moffat, Mesa, Rio Blanco, Routt — to be included in the No Action alternative. The data base is developed from the Basic Activity System (BAS) file of the PAS Model as of 1 May 1982. The data base includes projects that are currently operating or under construction, or that have publicly announced plans and are actually involved in licensing and permitting activities. Representatives from local governments on the Western Slope were active participants in determining which project should be included in the No Action alternative, reviewing data, and finalizing the data base. Perhaps the most significant feature of the No Action definition is the conservative approach taken toward oil shale development. Of the potential oil shale projects, the Union Oil Shale Project was the only one included.

In order to adequately evaluate the socioeconomic impacts of the project alternatives, it was necessary to project where the project-related population would be most likely to live. The spatial allocation assumptions are based on local government input, existing conditions and capacities, and known plans for creation and/or expansion of community infrastructure; local government policies and land use plans; characteristics of the workforce; the availability of services; and the CCSOP's housing objectives (BMML 1982). In the case of the corporation and the local governments, these considerations were based on policy statements and discussions with key staff. Representatives of local governments were very active in defining assumptions and reviewing spatial allocation analyses. The concerns and likely objectives of the future employees regarding residential choice are represented by past experience with other resource development projects and recent relevant baseline studies. The following specific factors were considered in determining the population allocation:

- In the case of Fruita II, location of the single-status camp in Mesa County instead of Garfield County; allocation of a higher proportion of project-related population in Mesa County than under either Clear Creek Mesa or Fruita I.
- The Grand Valley's attractiveness as the residential, commercial, educational, transportation, and service center for the region
- Existing and proposed utility capacity in the Grand Valley area
- Existing development capacity and local growth policies in the Grand Valley
- County land use and community development goals and policies in each county

In particular, two factors were highly significant in determining workforce allocation: (1) the Operator's proposal to develop a construction worker single-status camp which would house up to 1,500 workers under all alternatives and (2) the Operator's intention to encourage employee location in Battlement Mesa rather than De Beque. Battlement Mesa is a potentially attractive residential choice for workers and their families, with its approved plats, housing, planned infrastructure, level of improvements in place or under construction, and the delay in the Colony Project relieving housing demands on the development. If Colony were to proceed, capacity would still exist for the Operator's employees (see Appendix B-4 for communication between the Operator and Battlement Mesa, Inc.)

The residential allocation of the project workforce for Clear Creek Mesa, Fruita I, and Fruita II is presented in Table 4.12-3.

4.12.3.1 Employment

Employment in the two-county area would be positively affected by all project alternatives, particularly in the construction and mining sectors.

Within Garfield County, total employment levels would be highest under CCM-100. Under FI-100, levels in Garfield County would never reach those projected for CCM-100.

Within Mesa County, total employment levels would be slightly higher under FI-100 than under CCM-100. Due to the location of the upgrading and retorting facilities in Mesa County under FII-50, total employment would grow substantially, although at a lesser rate than FI-100, in Mesa County. Employment effects would be much smaller on an absolute basis in Garfield County under FII-50.

Table 4.12-3 RESIDENTIAL ALLOCATION OF PROJECT WORK FORCE, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES

	Clear Creek Mesa Alternatives			Fruita I Alternative					
	Construction		Operations	Mine & Retorts Construction		Mine & Retorts Operations	Upgrading Construction		Upgrading Operations
Allocation Areas	Local	Non-Local	Local	Local	Non-Local	Local	Local	Non-Local	Local
Garfield County									
Chevron Man-camp	-	.35[a]	-	-	.35[a]	-	-	-	-
Rifle	.13	.10[b]	.10	.13	.10[b]	.10	-	-	-
Battlement Mesa/ Parachute	.14	.50	.46	.14	.50	.50	-	-	-
Eastern Garfield[c] County	.03	-	.03	.03	-	-	-	-	-
Mesa County									
Chevron Man-camp	-	-	-	-	-	-	-	-	-
Grand Junction	.50	.15	.13	.50	.15	.15	.50	.50	.40
Palisade	.06	.06	.06	.06	.06	.06	.05	.05	.05
Clifton	.12	.06	.06	.12	.06	.06	.20	.20	.20
Fruita	.02	.03	.03	.02	.03	.03	.25	.25	.25
Collbran	-	-	.01	-	-	-	-	-	-
Redlands	-	-	.02	-	-	-	-	-	.10
De Beque	-	.10	.10	-	.10	.10	-	-	-

Table 4.12-3 RESIDENTIAL ALLOCATION OF PROJECT WORK FORCE, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (continued)

	Fruita II Alternative					
	Mining			Upgrading & Retorting		
	Construction		Operations	Construction		Operations
Allocation Areas	Local	Non-Local	Local	Local	Non-Local	Local
Garfield County						
Rifle	.15	.10	.10	-	-	-
Battlement Mesa/ Parachute	.15	.50	.50	-	-	-
Eastern Garfield County	-	-	-	-	-	-
Mesa County						
Chevron Man-camp	-	-	-	-	.52[d]	-
Grand Junction	.50	.20	.15	.60	.50[e]	.40
Palisade	.06	-	.05	.05	.05	.05
Clifton	.14	.10	.10	.20	.20	.15
Fruita	-	-	-	.15	.25	.30
Collbran	-	-	-	-	-	-
Redlands	-	-	-	-	-	.10
De Beque	-	.10	.10	-	-	-

[a] A maximum of 1,500 non-locals is allocated to the Garfield county man-camp. This allocation averages approximately .35 of the non-local workforce over the construction period, although it varies somewhat when the workforce is increasing or decreasing rapidly.

[b] Percentages for allocation areas reflect distribution *after* the non-local man-camp population is assigned, e.g., the proportion of the total non-local construction workforce is equal to (1.0 – % man-camp) × 10%.

[c] This area is from east of Rifle, and includes the municipalities of Carbondale, Glenwood Springs, New Castle, Silt, and the surrounding unincorporated areas.

[d] A maximum of 1,500 non-local workers is allocated to the Mesa County man-camp. This allocation averages about 5.2% of the non-local workforce over the construction period, although it varies somewhat during periods of workforce buildup or decline.

[e] Percentages for allocation areas reflect distribution after the non-local man-camp population is assigned, e.g., non-local workforce assigned to Grand Junction = (1.0 – % man-camp) × 50%.

Under CCM-50 and FI-50, total employment for both counties would be less than that projected for the higher production alternatives.

Clear Creek Mesa and Associated Siting Activities

Projected employment levels for selected years by economic sector for CCM-100, FI-100, and FII-50 are presented in Tables 4.12-4 and 4.12-5. Total employment in the two counties would be substantially and positively affected by project alternatives (BMML 1982).

Under CCM-100, total employment would increase to 24,088 in Garfield County (as compared to 15,861 under the No Action alternative) and to 54,145 in Mesa County (as compared to 45,260 under the No Action alternative) during peak construction activities in 1994. For the 1985-2000 period, the average annual rate of growth in total employment for Garfield and Mesa Counties under CCM-100 would be 3.8 percent and 1.8 percent, compared to 1.9 percent and 1.0 percent, respectively, for the No Action alternative.

Under CCM-50, total additional employment would peak at 14,565 in 1993 and drop dramatically to 8,200 in 1994. Peak employment under the 50,000-bpd alternative would be 84 percent of the 100,000-bpd production level employment.

Under the No Action Alternative, mining employment would increase at an annual average growth rates of 6.4 percent (1,182 to 2,991) and 3.9 percent (2,031 to 3.617) for Garfield and Mesa counties, respectively, between 1985 and 2000. The average annual growth rates in mining employment would be 11.4 percent and 7.1 percent in Garfield and Mesa counties under CCM-100. The average annual growth rate for construction employment over the 15-year construction period for CCM-100 would be understandably higher than for the No Action alternative. In 1994, for example, construction employment in Garfield County under the No Action alternative would represent 748 persons. Under the CCM-100 it would represent 4,447 persons.

Grand Valley and Associated Siting Activities

Fruita I. Projections of employment levels by sector for FI-100 within Garfield and Mesa counties are shown in Tables 4.12-4 and 4.12-5. As shown, total employment levels in Garfield County under FI-100 would never reach those projected under the CCM-100. In Mesa County, total employment levels would be higher under FI-100 than under CCM-100 from 1986 to 2000. Locating the upgrading facilities in the Grand Valley would increase the total employment levels in Mesa County. Average annual rates of growth in total employment would be only slightly different under FI-100 for Garfield (3.4 percent) and Mesa (2.0 percent) counties as compared to those projected under CCM-100 (3.8 and 1.8 percent, respectively). Average annual growth rates for mining, again, would be slightly different under CCM-100 and FI-100 for Garfield (11.4 and 10.4, respectively) and Mesa (7.1 and 8.0, respectively) counties. They would be nearly comparable within the construction sector.

Total additional employment for FI-50 would be comparable to that described for CCM-50, a peak in 1993 at 14,565 workers.

Fruita II. Due to the location of upgrading and retorting facilities in Mesa County under FII-50, total employment would grow substantially in Mesa County, while employment effects would be much smaller on an absolute basis in Garfield County. During peak construction (1993) under FII-50, total employment would be about 6.7 percent higher in Garfield County and 29.5 percent higher in Mesa County compared to the No Action projections. For Mesa County, this relative increase in employment would be substantially lower during the operations phase. In the year 2000, for example, total employment under FII-50 would be 9.8 percent higher for Mesa County than under the No Action alternative.

FII-50 would exert positive, but fairly modest effects on the growth rates in total employment in the two counties. Between 1985 and 2000, the average annual growth rate in employment would increase from 1.9 to 2.2 percent in Garfield County and 1.0 to 1.3 percent in Mesa County. The largest employment increases would occur in the mining sector. By 1993, mining employment would increase by about 20 percent in Garfield County and 6.1

percent in Mesa County. FII-50 would also affect the structure of employment in the two counties. Under the No Action alternative in 1993, mining would represent about 17.6 percent of total employment in Garfield County and 7.6 percent in Mesa County. These relative percentages would increase to 19.8 percent and 9.4 percent under FII-50. During peak construction activities, similar changes would be evident in the construction sector. In 1993, the relative share of construction employment would not have changed significantly in Garfield County (about 9 percent of total employment), but in Mesa County construction employment would increase from 7.6 percent to 14.7 percent of total employment. As construction is completed (after 1994), the relative share of construction in total employment would return to levels similar to the No Action alternative.

Table 4.12-4 GARFIELD COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES

	Agricultural Proprietors				Agricultural Labor			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	374	374	374	374	222	222	222	222
1985	342	342	342	342	198	198	198	198
1990	325	325	325	325	190	190	190	190
1993	315	315	315	315	185	185	185	185
1994	312	312	312	312	183	183	183	183
2000	294	294	294	294	174	174	174	174
Avg. Annual Growth Rate (%) 1985-2000	−1.0	−1.0	−1.0	−1.0	−0.8	−0.8	−0.8	−0.8

	Mining				Construction			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	683	683	683	683	1,241	1,241	1,241	1,241
1985	1,182	1,182	1,182	1,224	860	1,710	1,710	1,065
1990	2,177	3,050	2,814	2,537	3,016	3,712	3,574	3,030
1993	2,998	4,409	3,975	3,598	1,588	5,352	4,648	1,615
1994	2,991	4,773	4,212	3,621	748	4,447	3,671	772
2000	2,991	5,941	5,207	3,621	788	2,295	2,334	812
Avg. Annual Growth Rate (%) 1985-2000	6.4	11.4	10.4	7.5	−0.5	2.0	2.1	−1.4

Table 4.12-4 GARFIELD COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (continued)

	Manufacturing				Transportation, Communication, Public Utilities			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	213	213	213	213	773	773	773	773
1985	271	296	296	286	877	895	895	885
1990	405	508	496	446	1,044	1,098	1,085	1,060
1993	403	596	557	470	1,062	1,220	1,180	1,089
1994	368	564	519	426	1,043	1,214	1,167	1,071
2000	392	548	518	419	1,070	1,232	1,199	1,097
Avg. Annual Growth Rate (%) 1985-2000	2.5	4.2	3.8	2.6	1.3	2.2	1.9	1.4

	Trade				Finance, Insurance, Real Estate			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	2,256	2,256	2,256	2,256	358	358	358	358
1985	2,565	2,655	2,655	2,609	386	400	400	392
1990	3,191	3,493	3,435	3,292	462	501	492	473
1993	3,294	4,049	3,870	3,467	463	577	548	482
1994	3,193	4,003	3,794	3,367	449	572	538	469
2000	3,408	4,176	4,038	3,555	458	574	552	478
Avg. Annual Growth Rate (%) 1985-2000	1.9	3.1	2.8	2.1	1.1	2.4	2.2	1.3

Table 4.12-4 GARFIELD COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (continued)

	Services				Government			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	1,780	1,780	1,780	1,780	1,977	1,977	1,977	1,977
1985	1,978	2,035	2,035	2,003	2,092	2,150	2,150	2,118
1990	2,384	2,552	2,512	2,433	2,409	2,579	2,538	2,459
1993	2,447	2,934	2,809	2,529	2,408	2,898	2,773	2,490
1994	2,395	2,923	2,777	2,480	2,351	2,882	2,736	2,437
2000	2,551	3,047	2,950	2,634	2,384	2,874	2,787	2,467
Avg. Annual Growth Rate (%) 1985-2000	1.7	2.7	2.5	1.8	0.9	2.0	1.7	1.0

	Other				Total			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	1,450	1,450	1,450	1,450	11,328	11,328	11,328	11,328
1985	1,571	1,613	1,613	1,590	12,327	13,482	13,482	12,716
1990	1,842	1,965	1,935	1,877	17,449	19,978	19,400	18,126
1993	1,857	2,214	2,123	1,917	17,025	24,754	22,986	18,158
1994	1,824	2,210	2,103	1,866	15,861	24,088	22,017	17,029
2000	1,897	2,260	2,190	1,458	16,410	23,427	22,246	17,512
Avg. Annual Growth Rate (%) 1985-2000	1.3	2.3	2.1	1.3	1.9	3.8	3.4	2.2

Source: BMML (1982).

Table 4.12-5 MESA COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES

	Agricultural Proprietors				Agricultural Labor			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	1,257	1,257	1,257	1,257	639	639	639	639
1985	1,148	1,148	1,148	1,148	569	569	569	569
1990	1,091	1,091	1,091	1,091	543	543	543	543
1993	1,059	1,059	1,059	1,059	528	528	528	528
1994	1,048	1,048	1,048	1,048	523	523	523	523
2000	987	987	987	987	496	496	496	496
Avg. Annual Growth Rate (%) 1985-2000	−1.0	−1.0	−1.0	−1.0	−0.9	−0.9	−0.9	−0.9

	Mining				Construction			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	2,112	2,112	2,112	2,112	2,733	2,733	2,733	2,733
1985	2,031	2,031	2,031	2,089	3,953	4,345	4,345	4,999
1990	3,168	3,776	4,012	4,208	4,008	4,465	4,604	5,111
1993	3,425	4,406	4,839	5,526	3,449	6,169	6,870	8,656
1994	3,453	4,691	5,252	5,623	3,446	6,128	6,901	4,644
2000	3,617	5,667	6,401	5,787	3,800	4,949	4,904	3,925
Avg. Annual Growth Rate (%) 1985-2000	3.9	7.1	8.0	7.0	−0.3	0.9	0.8	

Table 4.12-5 MESA COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (continued)

	Manufacturing				Transportation, Communication, Public Utilities			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	2,664	2,664	2,664	2,664	2,421	2,421	2,421	2,421
1985	3,140	3,192	3,192	3,212	2,655	2,680	2,680	2,699
1990	3,642	3,901	3,914	3,840	3,099	3,199	3,212	3,211
1993	3,650	4,054	4,089	4,130	3,317	3,585	3,621	3,670
1994	3,665	4,058	4,100	3,963	3,316	3,603	3,647	3,538
2000	3,942	4,214	4,238	4,097	3,446	3,657	3,683	3,576
Avg. Annual Growth Rate (%) 1985-2000	1.5	1.9	1.9	1.6	1.8	2.	2.1	1.9

	Trade				Finance, Insurance, Real Estate			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	8,269	8,269	8,269	8,269	1,325	1,325	1,325	1,325
1985	9,327	9,534	9,534	9,624	1,444	1,464	1,464	1,479
1990	10,546	11,611	11,670	11,375	1,567	1,633	1,642	1,648
1993	10,455	12,192	12,354	12,558	1,580	1,761	1,787	1,821
1994	10,394	12,162	12,357	11,796	1,577	1,769	1,801	1,711
2000	10,972	12,333	12,448	11,751	1,647	1,810	1,829	1,745
Avg. Annual Growth Rate (%) 1985-2000	1.1	1.7	1.8	1.3	0.9	1.4	1.5	1.1

Table 4.12-5 MESA COUNTY PROJECTED EMPLOYMENT LEVELS BY SECTOR FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (continued)

	Services				Government			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	6,420	6,420	6,420	6,420	5,076	5,076	5,076	5,076
1985	7,036	7,127	7,127	7,190	5,551	5,585	5,585	5,645
1990	7,683	7,977	8,018	8,039	5,949	6,190	6,231	6,260
1993	7,809	8,620	8,733	8,872	5,969	6,634	6,749	6,906
1994	7,791	8,650	8,786	8,384	5,969	6,672	6,810	6,486
2000	8,248	8,981	9,060	8,681	6,175	6,770	6,852	6,551
Avg. Annual Growth Rate (%) 1985-2000	1.1	1.6	1.6	1.3	0.7	1.3	1.4	1.0

	Other				Total			
Year	No Action	Clear Creek	Fruita I	Fruita II	No Action	Clear Creek	Fruita I	Fruita II
1980	3,676	3,676	3,676	3,676	36,592	36,592	36,592	36,592
1985	3,921	4,001	4,001	4,050	40,738	41,680	41,680	42,708
1990	4,195	4,454	4,484	4,494	45,497	48,843	49,425	49,824
1993	4,113	4,831	4,912	5,001	45,359	53,842	55,546	58,731
1994	4,072	4,834	4,932	4,571	45,260	54,145	56,162	52,292
2000	4,107	4,762	4,818	4,474	47,442	54,629	55,721	52,073
Avg. Annual Growth Rate (%) 1985-2000	0.3	1.2	1.2	0.3	1.0	1.8	2.0	1.3

Source: BMML (1982).

4.12.3.2 Population

Population growth and spatial allocation assumptions were developed in conjunction with local officials utilizing the PAS system. Under the No Action alternative, annual growth rates would be approximately one-fifth of the rate realized between 1970 and 1980. Under the various project alternatives, population growth would be twice the rate of the No Action alternative. The population increase attributed to the 100,000-bpd production alternatives would be approximately 28,000 persons during the peak year of construction (1994) and 25,000 during operations. For the 50,000-bpd alternatives, the construction peak would occur in 1993 with a population increase of 23,000, and would stabilize by 2000 with an increase of 12,500 persons.

Most of the project-related growth would occur in the Grand Valley area in Mesa County, and the Battlement Mesa area in Garfield County. Under all alternatives, Mesa County would receive the largest share of the growth. However, because of its large existing population base, the growth rate in the Grand Valley area would remain moderate. With its substantial infrastructure, Battlement Mesa would be the location for the largest share of Garfield County growth.

Clear Creek Mesa and Associated Siting Activities

Projected population levels for Garfield and Mesa Counties (1980-2000) by major alternatives are provided in Tables 4.12-6 and 4.12-7. Figure 4.12-1 graphically displays the incremental population change for the two counties by alternative for selected years. Population growth in Garfield and Mesa Counties due to the project alternatives would begin in 1985 and build fairly rapidly until 1993-1994 (BMML 1982). As construction activities are completed, population in the two counties would stabilize. In 1994, the peak population increase in the two counties under CCM-100 and FI-100 would be approximately 28,000 persons relative to the No Action alternative. Under CCM-50 and FI-50, population increases in the two counties in 1993 would peak at approximately 23,000 persons.

Although the population impacts of CCM-100 would be significant in terms of total numbers relative to growth rates projected under the No Action alternative, annual average growth during the study period would still be significantly lower than the rapid population growth experienced in both Garfield and Mesa counties during the 1970's (see Section 3.12).

As noted in Tables 4.12-6 and 4.12-7, Battlement Mesa would accommodate a substantial population growth under CCM-100. The average annual growth rate between 1985 and 2000 for Battlement Mesa would increase from 11.3 percent (674 to 3,358) for the No Action alternative to 16.4 percent (938 to 9,137) for CCM-100. This reflects the small population base in 1985. Peak population would occur in 1993 at 10,300 persons under CCM-100. Under CCM-50, the population peak would occur in 1993 with 9,332 persons.

Under CCM-100, approximately 11 percent of the total workforce would be expected to reside in Rifle. This is largely because of the existing labor pool and the fact that Rifle is an established community with services and a variety of housing choices. This would result in a peak population increase in 1993 of approximately 2,900 people more than for the No Action alternative. Under CCM-50, peak population would occur in 1993 with 2,704 persons.

Only a small portion of the CCM-100 workforce (5 percent in 1994) would be expected to settle in and around communities in the eastern portions of Garfield County. Given the relatively large population base and geographic area, population increases resulting from CCM-100 and CCM-50 would be relatively small and not likely to exert significant impacts on this area.

In Mesa County, Grand Junction would be the residential location for a substantial portion of the CCM-100 population. Grand Junction is the regional economic center for western Colorado. Furthermore, in the late 1980's, I-70 may well be completed through the De Beque Canyon allowing easier access between the project site and the City. In 1994, the increase in population in Grand Junction due to CCM-100 would be 4,800. Under CCM-50, peak population would occur in 1993, with an increase of 6,800 people over the No Action alternative,

Table 4.12-6 GARFIELD COUNTY PROJECTED POPULATION LEVELS FOR THE NO ACTION, CLEAR CREEK MESA, AND FRUITA I ALTERNATIVES AT 100,000 BPD PRODUCTION AND CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES AT 50,000 BPD PRODUCTION

	Garfield County						Parachute/Battlement Mesa						Rifle					
Year	NA	CCM	FI	FII	CC-50	FI-50	NA	CCM	FI	FII	CC-50	FI-50	NA	CCM	FI	FII	CC-50	FI-50
1980	22,514	22,514	22,514	22,514	—	—	655	655	655	655	—	—	3,405	3,405	3,405	3,405	—	—
1981	27,070	27,070	27,070	27,070	—	—	1,878	1,878	1,878	1,878	—	—	4,656	4,656	4,656	4,656	—	—
1982	29,002	29,002	29,002	29,002	—	—	3,090	3,090	3,090	3,090	—	—	4,610	4,610	4,610	4,610	—	—
1983	24,381	24,381	24,381	24,381	—	—	721	721	721	721	—	—	3,280	3,280	3,280	3,280	—	—
1984	24,200	24,200	24,200	24,200	—	—	647	647	647	647	—	—	3,168	3,168	3,168	3,168	—	—
1985	24,579	25,555	25,555	24,939	26,164	25,695	674	938	938	1,009	1,531	1,233	3,215	3,304	3,304	3,241	3,611	3,500
1986	26,079	30,653	29,790	27,206	—	—	886	2,915	2,508	1,548	—	—	3,590	4,710	4,505	3,915	—	—
1987	29,644	35,479	33,072	30,823	—	—	1,587	4,317	3,211	2,259	—	—	4,955	6,385	5,667	5,309	—	—
1988	31,369	38,500	35,115	33,037	—	—	2,343	5,972	4,091	3,299	—	—	5,550	7,206	6,399	6,061	—	—
1989	32,700	39,743	38,710	34,079	—	—	2,780	6,542	5,917	3,503	—	—	6,075	7,842	7,575	6,563	—	—
1990	32,490	37,936	36,895	33,890	38,505	36,717	2,624	5,645	5,018	3,355	5,876	4,744	5,943	7,507	7,240	6,410	7,447	7,022
1991	33,879	40,881	39,315	35,379	—	—	3,665	7,186	6,299	4,383	—	—	6,102	7,980	7,609	6,644	—	—
1992	34,190	41,418	41,769	35,710	—	—	3,379	8,803	7,038	4,106	—	—	6,303	8,798	8,066	6,851	—	—
1993	33,285	45,401	41,947	34,824	44,100	40,886	3,486	10,309	7,933	4,227	9,332	7,299	6,446	9,351	8,430	7,004	9,150	8,387
1994	31,394	44,403	40,843	33,722	—	—	3,371	10,250	7,826	4,182	—	—	5,643	8,924	7,998	6,533	—	—
1995	31,539	44,255	40,653	33,666	—	—	3,399	10,108	7,680	4,141	—	—	5,671	8,941	7,988	6,444	—	—
1996	31,627	44,464	40,546	33,687	—	—	3,402	10,190	7,579	4,114	—	—	5,696	9,007	8,014	6,471	—	—
1997	31,648	43,570	41,646	33,696	—	—	3,376	10,199	8,098	4,086	—	—	5,714	9,057	8,273	6,496	—	—
1998	31,648	43,958	41,547	33,699	—	—	3,354	9,780	8,011	4,060	—	—	5,732	9,011	8,289	6,518	—	—
1999	31,668	43,149	40,763	33,709	—	—	3,340	9,249	7,576	4,041	—	—	5,750	8,941	8,235	6,541	—	—
2000	31,757	43,040	40,647	33,752	37,264	35,601	3,358	9,137	7,485	4,038	6,545	5,504	5,769	8,951	8,246	6,563	7,307	6,984

Table 4.12-7 MESA COUNTY PROJECTED POPULATION LEVELS FOR THE NO ACTION, CLEAR CREEK MESA, AND FRUITA I ALTERNATIVES AT 100,000 BPD PRODUCTION AND CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES AT 50,000 BPD PRODUCTION

	Mesa County						Grand Junction					
Year	NA	CCM	FI	FII	CC-50	FI-50	NA	CCM	FI	FII	CC-50	FI-50
1980	81,530	81,530	81,530	81,530	—	—	27,077	27,077	27,077	27,077	—	—
1981	86,074	86,074	86,074	86,074	—	—	28,916	28,916	28,916	28,916	—	—
1982	87,315	87,315	87,315	87,315	—	—	29,360	29,360	29,360	29,360	—	—
1983	84,640	84,640	84,640	84,640	—	—	28,007	28,007	28,007	28,007	—	—
1984	85,483	85,483	85,483	85,484	—	—	28,351	28,351	28,351	28,351	—	—
1985	86,498	87,980	87,980	81,528	88,301	88,770	28,836	29,384	29,384	29,891	29,835	30,024
1986	89,864	95,708	96,843	98,867	—	—	30,085	32,203	32,484	33,160	—	—
1987	93,395	100,668	103,688	104,621	—	—	31,301	33,842	34,661	35,052	—	—
1988	93,675	103,274	107,906	108,151	—	—	31,380	34,851	35,946	36,147	—	—
1989	96,310	105,152	106,912	109,553	—	—	32,373	35,257	35,694	36,684	—	—
1990	96,554	104,961	106,743	108,007	103,390	105,178	32,417	35,219	35,660	36,133	36,209	36,928
1991	96,661	105,804	108,133	110,212	—	—	32,406	35,383	35,999	36,790	—	—
1992	97,175	110,499	113,129	115,508	—	—	32,568	36,952	37,616	38,480	—	—
1993	97,758	112,665	116,078	119,328	110,050	113,264	32,761	37,565	38,445	39,528	39,578	40,872
1994	98,248	113,270	116,848	112,315	—	—	32,921	37,768	38,698	37,219	—	—
1995	98,728	113,664	117,183	108,826	—	—	33,077	37,923	38,826	35,912	—	—
1996	99,165	114,099	117,667	109,336	—	—	33,218	38,079	38,993	36,071	—	—
1997	99,559	114,507	117,149	109,796	—	—	33,348	38,227	38,836	36,217	—	—
1998	99,917	114,610	116,579	110,215	—	—	33,456	38,292	38,672	36,337	—	—
1999	100,240	114,584	116,655	110,594	—	—	33,563	38,334	38,738	36,456	—	—
2000	100,536	114,864	116,980	100,945	107,432	109,095	33,657	38,438	38,853	36,563	37,601	37,998

Table 4.12-7 MESA COUNTY PROJECTED POPULATION LEVELS FOR THE NO ACTION, CLEAR CREEK MESA, AND FRUITA I ALTERNATIVES AT 100,000 BPD PRODUCTION AND CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES AT 50,000 BPD PRODUCTION (continued)

	Palisade						Fruita					
Year	NA	CCM	FI	FII	CC-50	FI-50	NA	CCM	FI	FII	CC-50	FI-50
1980	1,474	1,474	1,474	1,474	—	—	2,802	2,802	2,802	2,802	—	—
1981	1,674	1,674	1,674	1,674	—	—	2,982	2,982	2,982	2,982	—	—
1982	1,714	1,714	1,714	1,714	—	—	2,994	2,994	2,994	2,994	—	—
1983	1,393	1,393	1,393	1,393	—	—	3,303	3,303	3,303	3,303	—	—
1984	1,398	1,398	1,398	1,398	—	—	3,302	3,302	3,302	3,302	—	—
1985	1,406	1,489	1,489	1,521	1,565	1,552	3,277	3,396	3,396	3,679	3,450	3,697
1986	1,497	1,935	1,922	1,906	—	—	3,507	3,831	4,371	4,884	—	—
1987	1,666	2,258	2,268	2,222	—	—	3,550	3,952	5,187	5,433	—	—
1988	1,679	2,403	2,419	2,367	—	—	3,445	3,875	5,614	5,529	—	—
1989	1,752	2,424	2,417	2,395	—	—	3,468	3,884	5,148	5,476	—	—
1990	1,739	2,341	2,334	2,300	2,343	2,292	3,463	3,843	5,126	5,124	4,118	5,057
1991	1,717	2,415	2,403	2,376	—	—	3,444	3,875	5,334	5,539	—	—
1992	1,725	2,824	2,679	2,609	—	—	3,466	4,101	6,074	6,537	—	—
1993	1,733	2,989	2,869	2,764	2,819	2,727	3,489	4,221	6,407	7,431	4,667	6,354
1994	1,734	2,998	2,875	2,402	—	—	3,511	4,247	6,499	5,995	—	—
1995	1,738	2,983	2,865	2,247	—	—	3,531	4,257	6,499	5,452	—	—
1996	1,742	2,979	2,863	2,256	—	—	3,551	4,273	6,541	5,489	—	—
1997	1,746	2,977	2,873	2,263	—	—	3,569	4,288	6,288	5,524	—	—
1998	1,749	2,937	2,853	2,270	—	—	3,587	4,283	6,074	5,557	—	—
1999	1,752	2,883	2,810	2,276	—	—	3,604	4,271	6,083	5,588	—	—
2000	1,754	2,876	2,806	2,282	2,325	2,300	3,619	4,281	6,112	5,618	4,289	5,443

Table 4.12-7 MESA COUNTY PROJECTED POPULATION LEVELS FOR THE NO ACTION, CLEAR CREEK MESA, AND FRUITA I ALTERNATIVES AT 100,000 BPD PRODUCTION AND CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES AT 50,000 BPD PRODUCTION (concluded)

	De Beque						Collbran					
Year	NA	CCM	FI	FII	CC-50	FI-50	NA	CCM	FI	FII	CC-50	FI-50
1980	260	260	260	260	—	—	341	341	341	341	—	—
1981	293	293	293	293	—	—	347	347	347	347	—	—
1982	295	295	295	295	—	—	347	347	347	347	—	—
1983	238	238	238	238	—	—	347	347	347	347	—	—
1984	239	239	239	239	—	—	347	347	347	347	—	—
1985	240	240	294	329	440	325	347	347	347	347	361	354
1986	264	609	528	401	—	—	347	347	347	347	—	—
1987	318	898	602	482	—	—	348	366	348	347	—	—
1988	321	1,119	609	535	—	—	348	385	348	348	—	—
1989	330	1,136	616	501	—	—	348	400	348	348	—	—
1990	332	1,019	491	504	1,090	653	348	400	347	348	399	374
1991	333	1,174	609	508	—	—	348	401	347	347	—	—
1992	335	1,599	776	527	—	—	347	402	346	347	—	—
1993	337	1,874	1,011	579	1,700	915	346	418	360	347	438	392
1994	338	1,882	1,002	581	—	—	346	419	360	347	—	—
1995	339	1,845	972	584	—	—	345	419	359	346	—	—
1996	341	1,828	951	588	—	—	345	419	359	345	—	—
1997	342	1,816	991	592	—	—	344	419	358	344	—	—
1998	343	1,742	972	595	—	—	343	419	357	344	—	—
1999	343	1,645	888	598	—	—	342	419	356	343	—	—
2000	344	1,625	868	601	1,014	617	341	419	356	340	403	353

Source: BMML (1982).

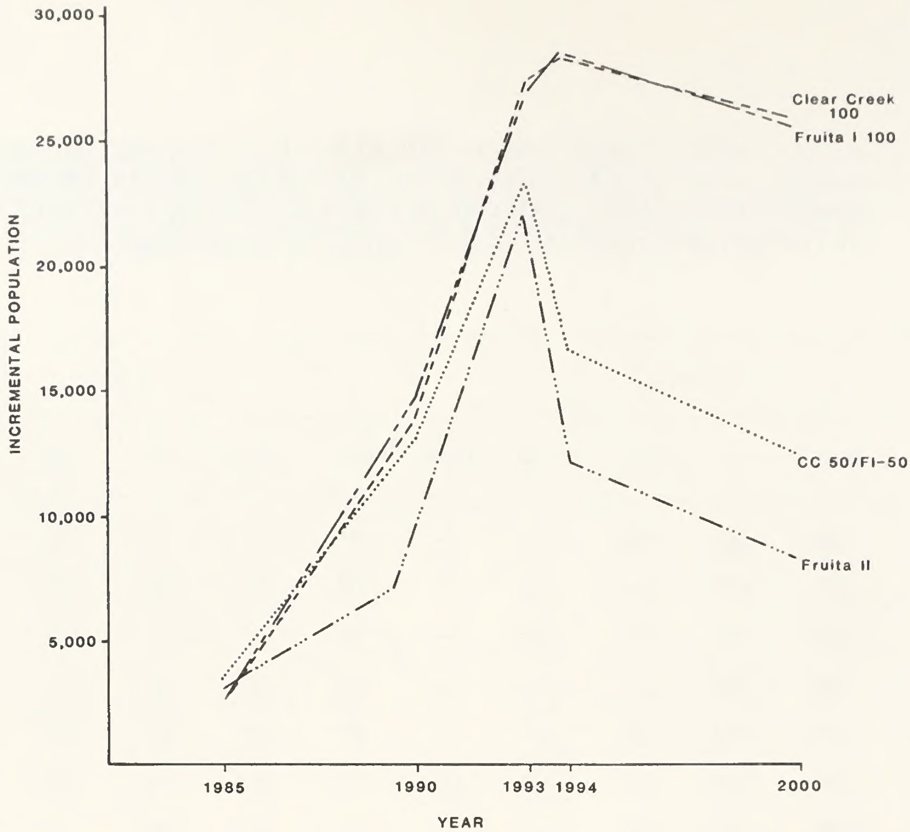


Figure 4.12-1 Comparison of Population Change Resulting from Implementing CCSOP Alternatives

and would decrease by 3,900 in the year 2000. Projected growth in Fruita would be fairly modest, with a maximum increase of about 730 under CCM-100 in 1994. In 1993, under CCM-50, 1,170 additional persons would reside in Fruita over the No Action. Projected population increases in Palisade would be 1,260 (1994) under CCM-100 and 1,086 (1993) under CCM-50. Less than 1 percent of the population increase (73 persons at peak contruction) would be expected to reside in Collbran.

The town of De Beque is the closest municipality to the CCSOP site, and could normally be expected to be the place of residence for many of CCSOP workers. However, the existence of service capacity in Battlement Mesa and the Grand Valley urban vicinity (both within acceptable commuting distance to the site), plus access to commercial services and facilities, entertainment, and schools suggests these areas as residential choices rather than De Beque with its limited infrastructure. The Operator has tentatively planned to encourage its workforce to seek housing either in Battlement Mesa or in the Grand Valley urban vicinity. Therefore, as of 1994, the total CCM-100 workforce projected to be living in De Beque would be only 3.5 percent of the total workforce. This would allow De Beque's local capacities to accommodate new growth (1,882 persons compared to 338 persons anticipated under the No Action), but would not require the creation of a whole new town. Under CCM-50, approximately 1,360 additional persons would reside in De Beque at peak in 1993.

Fruita I

Under FI-100, growth rates in Garfield and Mesa counties would be slightly different than those projected under CCM-100, primarily due to the siting of the upgrading facilities near Fruita. The major difference between the two alternatives would be the result of locating about 25 percent of the workforce in Mesa County rather than Garfield County under FI-100.

Because of Mesa County's substantially larger population base, the population impacts of FI-100 and CCM-100 would be less on a relative basis in Mesa County than in Garfield County. Average annual growth rates between 1985 and 2000 under the No Action alternative would average 1.0 percent in Mesa County. This compares to historical average annual rates of 0.7 percent between 1960 and 1970, and 5.0 percent between 1970 and 1980.

Under FI-100, the average annual growth rate in Mesa County between 1985 and 2000 would be 1.9 percent. Although the population growth resulting from FI-100 would be significant in terms of total numbers of residents, the rate of increase would be substantially lower than in the 1970's.

In Garfield County, population would increase during the years of peak construction activity for FI-100 and CCM-100 and then would level off as the project moved into a lower level of construction activity and the operations phase. During operation, total direct project employment would be approximately 5,125 workers in the two counties, with a total population increase of about 25,500 persons. This compares to a maximum population increase in 1994 during the construction phase of about 28,000 in the two counties, when the total direct workforce would be 9,000 workers. Under FI-50, population would peak in 1993 at approximately 23,000 in the two counties, and decline to 12,400 by 2000.

Under FI-100, peak population in Parachute/Battlement Mesa would occur in 1993 at 7,933, and under FI-50, peak population would occur in 1993 at 7,300. In Rifle, population growth would be slightly less than that expected under CCM-100 (8,430 vs. 9,351, respectively), but would remain the same for the eastern portions of Garfield County. Under FI-50, projected population levels would be only slightly less in Rifle than under FI-100.

In Mesa County, Grand Junction would probably be the residential choice of a large number of workers under FI-100 and FI-50. Projected population levels would be 38,445 for FI-100 and 40,872 for FI-50. As a metropolitan center, Grand Junction could absorb the projected population growth more easily than the more rural parts of the region. Location of the upgrading facilities in the Fruita area would also have a significant impact on the community of Fruita. Projected population in 1993 would be 6,407 under Fruita I and 6,354 under FI-50. Population in Palisade would be 2,869 persons in 1994 under FI-100 and 2,727 under FI-50; in De Beque 1,011 under FI-100 and 915 under FI-50. Less than 1 percent of the additional population would live in Collbran under the FI-100 or FI-50 alternatives.

Fruita II. FII-50 presents different population projections than either CCM-100 or FI-100. Within Garfield County, (1985-2000) population growth would increase from 1.7 percent under the No Action alternative to 2.0 percent under the FII-50. Within Mesa County, the population growth rate between 1985-2000 would increase from 1.0 percent (No Action) to 1.4 percent (FII-50). Under FII-50, the maximum increase in population in Garfield County would be about 2000. For Mesa County, the peak population increase would be about 21,600.

Because most of the FII-50 growth would be located in Mesa County (approximately 94 percent at peak construction in 1993), the increase in population should be absorbed fairly smoothly with appropriate planning and policies. However, under FII-50, the ratio of construction workers to operations workers would be greater than under CCM-100 or FI-100. As a result, significant declines in population would occur after construction is completed. This could create some difficulties in growth management, and highlights the need for planning to ensure that adequate capacities are developed without creating potential over-capacity after construction.

Municipal population projections are again different under FII-50 than under CCM-100 or FI-100. In Garfield County, Battlement Mesa would receive a high proportion of the mining-related workforce (50 percent of the nonlocal construction workforce and 50 percent of the operations workforce). The population growth would be fairly small under FII-50, however; the peak population in any single year would be less than 1,000 new residents and the maximum projected population would be about 4,400. In Rifle, the maximum increase in any one year would be no more than 900. The remaining portions of the county would experience only minor population growth due to indirect impacts of the project.

Mesa County would receive the majority of the population under FII-50. By 1993, the population difference in Grand Junction, for example, would be about 6,800 residents above the No Action alternative. As construction is completed, the population difference would be about 3,000 persons in the year 2,000 over the No Action Alternative.

Because of its close proximity to the Grand Valley site (and local policies concerning growth), Fruita would be expected to serve as the residential location for a significant portion of the FII-50 population. Annual average growth rates between 1985 and 2000 increase from 0.7 percent under No Action to 2.9 percent under FII-50. By 1993, the population difference would be about 4,000 persons under the Fruita II Alternative compared to the No Action alternative. This represents a doubling in population for peak construction years, which would decline to a difference of greater than 50 percent during the operations period. This represents substantial growth, but projected population levels are well below the capacities currently planned by Fruita.

In 1993, about 1,000 more persons would be expected to reside in Palisade due to FII-50, as compared to the No Action alternative. This difference would decline as construction is completed. Approximately 580 persons would reside in De Beque under FII-50. Following current residential patterns in Mesa County, about 95 percent of the population who would choose to live in Mesa County would live in the Grand Valley urban vicinity. A substantial portion of the FII-50-related population (and other alternatives as well) would live in the unincorporated areas of the county. In 1993, approximately 9,600 additional residents would live in the unincorporated areas. Of this total, 1,500 would be assigned to Operator's single-status camp. The annual average growth rate between 1985 and 2000 in unincorporated areas would increase from 1.0 percent under the No Action alternative to 1.3 percent under FII-50.

4.12.3.3 Income

This section describes projected levels of income under the various project alternatives. Under all project alternatives, substantial increases in local income, including total personal income, are projected for both Garfield and Mesa counties. The increase in per capita income would be largely the result of the high salaries projected for oil shale construction and operations workers.

Clear Creek Mesa and Associated Siting Activities

Tables 4.12-8 and 4.12-9 display projections of the levels and components of personal income under the No Action, Clear Creek Mesa, Fruita I and Fruita II alternatives. Substantial increases in local income are projected, particularly in wage (labor) income (BMML 1982). The average annual percentage change in total personal income between 1985 and 2000 would more than double for CCM-100 relative to the No Action alternative. Total personal income in 1994 under CCM-100 would be 54.2 percent higher in Garfield County than under the No Action alternative, and 22.0 percent higher in Mesa County.

While most of this increase in total income would be due to absolute population and employment increases, some increase in personal income per capita is also projected. This increase in per capita income would be the result of the relatively high salaries projected for oil shale construction and operations workers. In 1994, per capita personal income in Garfield County would be $12,277 under CCM-100, relative to the No Action alternative of $11,262. The comparable level for Mesa County would be $9,741 for CCM-100 in 1994, while the No Action alternative is $9,202.

Grand Valley and Associated Siting Activities

Fruita I. Under FI-100 during the peak year of 1994, a 39.2 percent increase in total personal income would be expected over the No Action alternative in Garfield County. In Mesa County, this increase would be 28.2 percent. In 1994, per capita personal income in Garfield County would be $12,052 for FI-100, compared to $11,262 for the No Action alternative. The comparable level for Mesa County is projected to be $9,871 for FI-100, while the No Action is $9,202. Similar levels of personal per capita income would be anticipated under FI-50.

Fruita II. During the peak year of 1993, a 7.9 percent difference in total personal income would be expected between the No Action alternative and FII-50 in Garfield County. A 17.5 percent increase would be anticipated in Mesa County. In terms of per capita income, a 3.2 percent difference would be anticipated in 1993 in Garfield County between FII-50 and the No Action alternative and a 7.1 percent difference would be anticipated between FII-50 and the No Action alternative in Mesa County during the same period.

Table 4.12-8 GARFIELD COUNTY PERSONAL INCOME BY COMPONENT FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (in 1,000 of 1981 dollars)[a]

	Total Labor Income				FICA Payments				Non-Labor Income			
Year	NA	CCM	FI	FII	NA	CCM	FI	FII	NA	CCM	FI	FII
1980	160,998	160,998	160,998	160,998	6,893	6,893	6,893	6,893	66,424	66,424	66,424	66,424
1985	196,208	214,788	214,788	204,405	8,401	9,196	9,196	8,752	73,175	76,230	76,230	74,523
1990	295,494	349,108	336,349	311,179	12,652	14,947	14,401	13,323	91,211	100,926	98,525	93,955
1994	275,699	444,912	398,223	302,859	11,804	19,050	17,050	12,968	89,692	119,299	111,078	94,521
2000	282,884	440,559	410,180	309,043	12,112	18,863	17,562	13,232	94,216	123,473	117,573	99,339
Avg. Annual Growth Rate (%), 1985-2000:												
	2.5	4.9	4.4	2.8	2.5	4.9	4.4	2.8	1.7	3.3	2.9	1.9

	Residency Adjustment				Total Personal Income				Personal Income Per Capita			
Year	NA	CCM	FI	FII	NA	CCM	FI	FII	NA	CCM	FI	FII
1980	2	2	2	—	220,531	220,531	220,531	220,531	9,795	9,795	9,795	9,795
1985	2	2	2	—	260,984	281,824	281,824	270,178	10,618	11,028	11,028	10,833
1990	2	2	2	—	374,055	435,089	420,475	391,813	11,512	11,469	11,396	11,561
1994	2	2	2	—	353,589	545,163	492,253	384,424	11,262	12,277	12,052	11,382
2000	2	2	2	—	364,991	545,171	510,193	395,152	11,493	12,666	12,551	11,707
Average Annual Growth Rate (%), 1985-2000:												
					2.3	4.5	4.0	2.6	0.5	0.9	0.9	0.5

Source: BMML (1982).

[a] NA = No Action
CCM = Proposed Action and Clear Creek alternatives
FI = Fruita I alternatives
FII = Fruita II alternative

4.12.4 Social Impacts

Mesa and Garfield counties have experienced substantial growth and change for many years. Compared to many potential energy development areas of the West, they can be considered dynamic. As such, the two counties have already faced many of the social issues normally associated with more urban areas. This is particularly true for Mesa County. Additionally, most of the proposed growth for CCSOP would occur in the Grand Valley urban area, Battlement Mesa, and the Operator's single-status camp.

Table 4.12-9 MESA COUNTY PERSONAL INCOME BY COMPONENT FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (in 1,000 of 1981 dollars)[a]

	Total Labor Income				FICA Payments				Non-Labor Income			
Year	NA	CCM	FI	FII	NA	CCM	FI	FII	NA	CCM	FI	FII
1980	543,320	543,320	543,320	543,320	27,238	27,238	27,238	27,238	196,335	196,350	196,350	196,335
1985	627,091	646,425	646,425	665,335	31,438	32,407	32,407	33,355	215,274	217,761	217,761	220,194
1990	708,748	771,622	785,153	796,638	35,532	38,684	39,362	39,938	231,739	240,816	242,772	244,432
1994	704,247	886,933	932,883	849,505	35,306	44,465	46,768	42,588	235,188	260,952	267,326	257,108
2000	738,455	888,192	915,382	840,240	37,021	44,528	45,891	42,124	245,310	269,325	273,699	263,894
Avg. Annual Growth Rate (%), 1985-2000:												
	1.1	2.1	2.3	1.6	1.1	2.1	2.3	1.6	0.9	1.4	1.5	1.2

	Residency Adjustment				Total Personal Income				Personal Income Per Capita			
Year	NA	CCM	FI	FII	NA	CCM	FI	FII	NA	CCM	FI	FII
1980	2	2	2	—	712,433	712,433	712,433	712,433	8,738	8,738	8,738	8,738
1985	2	2	2	—	810,929	831,781	831,781	852,175	9,375	9,454	9,458	9,486
1990	2	2	2	—	904,957	973,756	988,565	1,001,134	9,372	9,277	9,261	9,243
1994	2	2	2	—	904,131	1,103,422	1,153,442	1,064,027	9,202	9,741	9,871	9,446
2000	2	2	2	—	946,746	1,112,991	1,143,192	1,062,012	9,416	9,689	9,772	9,572
Average Annual Growth Rate (%), 1985-2000:												
					1.0	2.0	2.2	1.5	0.03	0.2	0.2	0.06

Source: BMML (1982).

[a] NA = No Action
CCM = Proposed Action and Clear Creek alternatives
FI = Fruita I alternatives
FII = Fruita II alternative

Existing social problems within Garfield County focus primarily on:

- Alcohol abuse
- Family problems and child care
- Activities for youth
- Increased demand for mental health services
- Elderly housing

There is little evidence indicating whether these problems occur at rates in excess of population growth, nor has that necessarily been the focus of concern.

Social problems currently facing Mesa County include the following:

- Alcohol and drug abuse
- Requests for assistance such as food stamps
- Family problems and child care
- Elderly housing

Mesa County's Human Service Commission is currently reviewing priorities and has established a list of 18 general issues. The county's human service planner indicated that five general areas seem most critical (BMML 1982). These include housing, transportation, food, planning and coordination of services, and employment. Mental health problems, including a high suicide rate were also mentioned.

Increased mining and construction activities in the two counties, and the subsequent in-migration of large numbers of construction workers under the various project alternatives, could increase the incidence of and kinds of social problems which currently exist, particularly during the construction period. Increases in alcohol and substance abuse, and youth and family-related problems would potentially occur with development of the CCSOP. These problems, often tied to the lifestyles of single construction workers, may be significant under all project alternatives. Positive social benefits may also arise as a consequence of project development. Diversification of the local population with the addition of new people can be expected to have a number of positive impacts — increased availability of goods and services, social amenities, and cultural opportunities.

4.12.4.1 Clear Creek Mesa and Associated Siting Activities

Projected employment and population levels for CCM-100 are provided in Tables 4.12-4 to 4.12-7. As noted, the most critical areas of impact would be Battlement Mesa/Parachute, followed by the Roan Creek area from De Beque north and the Rifle area. Palisade and Fruita would grow at rates similar to their growth rates in the 1970's.

Mesa County would receive the largest share of population growth under any alternative. As an existing urban area, the Grand Valley area could assimilate growth more easily than isolated rural areas. Garfield County would be more heavily impacted by the Clear Creek Mesa alternatives than by the Fruita alternatives. With the in-migration of new workers, increases in school age populations would be steady through 1995. The greatest increase in school age children in Garfield County would occur under CCM-100. Between 1985 and 1995, this age group (5-19), would increase at an average rate of 6.7 percent from 5,528 to 10,581. School systems would be continuing their existing planning efforts, and in some cases, preparing to accommodate major growth (see Section 3.12). Youth services and activities stand out as a primary concern in both counties, especially because of the limited recreation activites now available for this age group.

While the percentage of the elderly would not increase to a great extent as a result of the project, the actual numbers of elderly could increase by approximately 305 people under CCM-100 between 1985 and 1995. The problems of housing, transportation, food, and medical care would, in all probability, increase in severity for this age group. It is quite likely that, for the new population as a whole, the various services under CCM-100 would not be required out of proportion to similar age groups in other settings, but would reflect the rates and amounts of growth that occur.

The loss of the rural lifestyle, which has been fading from much of Garfield County recently, would continue, particularly in the western portions of the County. Cultural, commercial, and social services would reflect the needs and wants of mining and construction work forces as these groups increase in number and proportion. Rural traditions and lifestyles would be less a part of everyday life as the new groups grow larger. Old timers and newcomers may conflict, although the large numbers of newcomers in the rural areas may soon dominate the social make-up of the areas they reside in. Over time, differences between the old and new groups would diminish. The traditional rural structure may become more open to other influences and offer greater diversity, particularly in the more rural areas.

It is assumed that social impacts under CCM-50 would be less than under the CCM-100 and in approximate proportion to the population levels anticipated with lower production.

4.12.4.2 Grand Valley and Associated Siting Activities

Fruita I

Tables 4.12-4 to 4.12-7 identify the major population and employment levels associated with FI-100. Under FI-100, social impacts would be quite similar to those experienced under CCM-100, with some slight variation. Mesa County, particularly in the Grand Valley urban area, would receive the largest share of the population growth, but Garfield County would still be the residential choice of a large number of workers. However, due to the siting of the upgrading facilities near Fruita, growth pressures and the incidence of social problems would be more dispersed and occur in greater frequency in the Grand Valley area than under CCM-100. In Mesa County, for example, the school age population would increase most under FI-100 between 1985 and 1995. This group would increase by 8,304, compared to an increase of 7,359 under CCM-100. In general, however, due to the urban nature of the Grand Valley area, the human service demands created by rapid growth could be much more effectively met than would be possible in more rural areas. As an urban area, the Grand Valley appears well suited to absorb and deal with growth-related social problems.

Social impacts under FI-50 would be less than those experienced under FI-100 and would occur in proportion to the decreased population experienced under the 50,000-bpd alternative.

Fruita II

FII-50 presents different employment and population projections than either CCM-100 or FI-100. First, under FII-50 the majority of social impacts would occur in Mesa County, particularly in the Grand Junction urban vicinity. In 1993, for example, 93 percent of the population growth associated with FII-50 would be located within Mesa County. Some modest growth would be anticipated for the Battlement Mesa/Parachute and Rifle areas; however, these projected rates would be well below those experienced in recent years. Second, the magnitude of the impact would be lower than under CCM-100 or FI-100 because of the reduced scale of FII-50. However, the rapid build-up and decline of the project could lead to severe short-term problems.

While the magnitude of the social impacts could be lower under FII-50, the types of social impacts would be similar to those for the higher production rates. Youth services and activities stand out as a primary concern in both counties, particularly Mesa County. Young families could require public health and social services. A larger number of young, single workers may require increased drug and alcohol counseling, law enforcement, and judicial services. As an urban area, however, Mesa County appears well suited to absorb and deal with growth-related social problems. These problems and causes may, however, be more difficult to identify because of the more complex social and economic structure of Mesa County as compared to Garfield County.

4.12.5 Housing Impacts

Existing housing characteristics in Garfield and Mesa counties were described in Section 3.12. The housing market was characterized as keeping up with demand within certain price ranges. Housing is being built rapidly in unincorporated areas of both counties, but most consistently in Mesa County. Planning and growth management of varying types and with varying requirements is being developed in both counties.

Projected housing needs under the No Action alternative show that the existing housing stock exceeds the housing need until 1986. Both Garfield and Mesa counties' populations are predicted to fluctuate between 1982 and 2000, although most of that fluctuation would occur between 1982 and 1985, when the counties lose population due to outmigration of construction work forces from the Union and Colony projects.

By the year 2000, the population growth under the No Action alternative in both Garfield and Mesa counties would require the addition of about 16,000 units, or a one-third increase from the existing base (see Tables 4.12-10 and 4.12-11). Garfield County would require about 5,150 housing units by 2000; Mesa County would need about 11,000 housing units by the year 2000. The most noticeable effect in Garfield County by the year 2000 would be the increase in dwelling units in the western end of the County (45 percent under the No Action alternative). In Mesa County, by 2000, most of the housing growth would continue current trends, much of it occurring in unincorporated areas of the county.

Under the Clear Creek Mesa alternatives, much of the growth would occur in the Parachute/Battlement Mesa area. This area has anticipated growth, and is capable of providing adequate services. Under the Fruita alternatives, much of the growth would be in the Grand Valley area, where urban levels of services currently exist. Most of the growth, under all alternatives would be directed to existing communities where developable land is available and the housing industry can meet demand. The housing industry in the two-county area is already active and has the capacity to meet project-related demands. The housing mix under all alternatives remains basically unchanged.

The Operator proposes to develop a construction worker housing facility (single-status camp) which would house up to 1,500 construction workers under all alternatives. Under Clear Creek Mesa and Fruita I, this facility would be located in the Clear Creek valley in Garfield County. Under Fruita II, the facility would be located near the upgrading-retort site in Grand Valley.

4.12.5.1 Clear Creek Mesa and Associated Siting Activities

Under the CCM-100 and CCM-50, the Operator would build a 1,500-unit single-status camp in the Clear Creek valley in Garfield County to accommodate temporary construction workers (BMML 1982). The facility would be available for occupancy in 1985 and would probably be built in phases as the need arises. A maximum of approximately 1,500 construction workers would be allocated to the single-status camp (including singles and those married with family absent). This allocation would include about 35 percent of the nonlocal workforce over the construction period, although it would vary somewhat when the workforce is increasing or decreasing.

Under CCM-100, Battlement Mesa is cited as a potential housing location for approximately 7,900-10,300 people by 1993, the peak year of employment. This would accommodate approximately 20-25 percent of the total project workforce. Approximately 51 percent of this housing would be single family, 32 percent multi-family, and 17 percent mobile homes. Battlement Mesa is designed today to serve approximately 25,500 people. Battlement Mesa's land holdings would enable the expansion of up to 54,000 people should the need arise.

The affordability of housing would remain a concern in both counties for low and middle income groups, including seniors. Monitoring would show whether the Operator is compounding the scarcity of housing, particularly mobile home spaces. Local government land use decisions would be a significant factor in this process as would Operator's housing programs.

The faster buildup of the construction workforce, steeper employment peaks, and rapid employment decline under CCM-50 would give the private housing market less lead time to build. The local communities may be more prone to overbuilding facilities.

4.12.5.2 Grand Valley and Associated Siting Activities

Fruita I

Under the Fruita I Alternative, housing impacts would be comparable for the most part to the Clear Creek Mesa alternatives, with certain exceptions. Siting of the upgrading facility near Fruita would decrease the number of people living in Garfield County and slightly increase the number of residents in Mesa County. Hence, the number of total incremental housing units required in Garfield County by the year 2000 under FI-100 would be

Table 4.12-10 GARFIELD COUNTY AND MUNICIPALITIES COMPARISON OF PROJECTED HOUSING NEEDS FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES[a]

	Total Garfield County[b]						
Year	NA	CCM	Cumulative Incremental Change	FI	Cumulative Incremental Change	FII	Cumulative Incremental Change
1983	11,340	11,340	0	11,340	0	11,340	0
1985	11,618	11,618	0	11,618	0	11,618	0
1990	14,632	16,585	1,953	16,180	1,548	15,086	454
1993	16,021	19,233	3,212	18,235	2,214	16,709	688
2000	16,504	21,300	4,796	20,142	3,638	17,641	1,137
Total Change 1983-2000	5,164	9,960	4,796	8,802	3,638	6,301	1,137

	Rifle						
Year	NA	CCM	Cumulative Incremental Change	FI	Cumulative Incremental Change	FII	Cumulative Incremental Change
1983	1,920	1,920	0	1,920	0	1,920	0
1985	1,920	1,920	0	1,920	0	1,920	0
1990	3,095	3,944	849	3,794	699	3,362	267
1993	3,432	4,757	1,325	4,354	922	3,674	242
2000	3,529	5,356	1,827	4,937	1,408	4,029	500
Total Change 1983-2000	1,609	3,436	1,827	3,017	1,408	2,109	500

Table 4.12-10 GARFIELD COUNTY AND MUNICIPALITIES COMPARISON OF PROJECTED HOUSING NEEDS FOR THE NO ACTION, CLEAR CREEK MESA, FRUITA I, AND FRUITA II ALTERNATIVES (concluded)

	Parachute/Battlement Mesa[c]						
Year	NA	CCM	Cumulative Incremental Change	FI	Cumulative Incremental Change	FII	Cumulative Incremental Change
1983	681	681	0	618	0	618	0
1985	681	618	0	681	0	681	0
1990	1,413	2,538	1,125	2,322	909	1,746	333
1993	1,940	3,600	1,660	3,068	1,128	2,308	368
2000	2,040	4,220	2,180	3,579	1,539	2,417	377
Total Change 1983-2000	1,359	3,539	2,180	2,898	1,539	1,736	377

Source: BMML (1982).

[a] NA = No Action
CCM = Proposed Action and Clear Creek alternatives
FI = Fruita I alternatives
FII = Fruita II alternative

[b] The Union and CSOC single status camps are not part of the county or municipal projections.

[c] Battlement Mesa is not an incorporated municipality but a major planned unit development (PUD) in Garfield County. It is planned to accommodate 25,000 - 45,000 people.

3,638, as compared to 4,796 under the CCM-100. The majority of this housing (51 percent) would be single family units. This is similar to both the No Action and Clear Creek Mesa alternatives. In Mesa County, the number of total incremental units required by the year 2000 would be 7,401 under FI-100, as compared to 6,379 under CCM-100. Most of this housing would be single family units (54 percent). The number of housing units would roughly double in Fruita under the FI-100 (1,545) compared to CCM-100 (717). Mesa County has an active existing housing industry capable of meeting or exceeding project-related housing demands.

Under the FI-50 Alternative the faster build-up of the construction workforce, steeper employment peaks, and rapid employment decline would give the private housing market less lead time to build.

Fruita II

Under FII-50, the 1,500 unit single-status camp planned by the Operator would be located near the upgrading-retort site in the Grand Valley. This facility, under FII-50, would house about 52 percent of the nonlocal workforce over the construction period.

The Grand Valley urban vicinity, under FII-50, is cited as the potential housing location for approximately 18,700 additional people by 1993, the peak year of employment. The local housing industry has demonstrated capacity to handle this level of growth. By the year 2000, Mesa County would require 5,319 additional housing units to accommodate new residents. This is less than that required under CCM-100 (6,379) and FI-100 (7,401). The majority of this housing would be single family units (55 percent vs. 13 percent mobile homes and 32 percent multi-family), consistent with the current mix.

Table 4.12-11 COMPARISON OF PROJECTED HOUSING NEEDS, 1983-2000, MESA COUNTY AND MUNICIPALITIES[a]

	No Action	Clear Creek Mesa	Cumulative Incremental Change	Fruita I	Cumulative Incremental Change	Fruita II	Cumulative Incremental Change
Total Mesa County							
1983	34,926	34,926	0	34,926	0	34,926	0
1985	35,962	35,962	0	35,962	0	35,962	0
1990	41,169	44,576	3,407	45,212	4,043	45,658	4,489
1993	42,723	48,197	5,474	49,093	6,370	50,310	7,587
2000	45,817	52,196	6,379	53,218	7,401	51,136	5,319
Total Change 1983-2000	10,891	17,270	6,379	18,292	7,401	16,210	5,319
Grand Junction							
1983	12,267	12,267	0	12,267	0	12,267	0
1985	12,339	12,339	0	12,339	0	12,339	0
1990	14,355	15,579	1,224	15,740	1,385	15,916	1,561
1993	14,925	16,850	1,925	17,043	2,118	17,431	2,506
2000	16,002	18,230	2,228	18,448	2,446	17,431	1,429
Total Change 1983-2000	3,735	5,963	2,228	6,181	2,446	5,164	1,429
Fruita							
1983	1,125	1,125	0	1,125	0	1,125	0
1985	1,167	1,167	0	1,167	0	1,167	0
1990	1,377	1,529	152	2,030	653	1,980	603
1993	1,442	1,675	233	2,391	949	2,645	1,203
2000	1,574	1,842	268	2,670	1,096	2,645	1,071
Total Change 1983-2000	449	717	268	1,545	1,096	1,520	1,071
Palisade							
1983	741	741	0	741	0	741	0
1985	741	741	0	741	0	741	0
1990	805	1,065	260	1,065	260	1,052	247
1993	832	1,254	426	1,242	410	1,230	398
2000	885	1,372	487	1,358	473	1,230	345
Total Change 1983-2000	114	631	487	617	473	489	345
De Beque							
1983	153	153	0	153	0	153	0
1985	153	153	0	153	0	153	0
1990	177	484	307	223	46	265	88
1993	183	662	479	322	139	310	127
2000	193	747	554	354	161	338	145
Total Change 1983-2000	40	594	554	201	161	185	145
Collbran							
1983	164	164	0	164	0	164	0
1985	166	166	0	166	0	166	0
1990	174	198	24	174	0	174	0
1993	177	211	34	183	6	178	1
2000	181	222	41	189	8	182	1
Total Change 1983-2000	17	58	41	25	8	18	1

Source: BMML (1982).

[a] The Union and CSOC single-status camps are not part of the county or municipal projections.

4.12.6 Education

School districts within the region should be able to accommodate the growth anticipated as a result of all project alternatives. Estimated total enrollments would increase most dramatically in Garfield County District No. 16 (Parachute/Battlement Mesa) under the Clear Creek Mesa alternatives and in Mesa County Valley No. 51 (Grand Junction) under the Fruita Alternatives. Increases will be most substantial in the peak construction years 1993-94. Mesa County Valley School District No. 51 is the only school district that may have significant expenditure requirements in all cases.

The two school districts most affected in terms of assessed valuations would be Mesa County Valley School District No. 51 and Mesa County Joint District No. 49. Both of these could have project facilities located within their property tax bases.

4.12.6.1 Clear Creek Mesa and Associated Siting Activities

Garfield County District No. RE-2 (see Figure 3.12-1) includes the communities of Rifle, New Castle, and Silt and has a 1982 enrollment of approximately 2,400 students. Additional anticipated enrollment during the peak construction year, 1993, would be approximately 1,100 new students under CCM-100 compared to 370 new students under No Action (See Table 4.12-12). Due to the excess capacity that has been built in anticipation of the Colony and Union Projects, the District can accommodate the projected CCM-100 enrollment, and may still have excess capacities by the year 2000.

Garfield County Distict No. 16 includes the town of Parachute and the unincorporated community of Battlement Mesa. With an existing (1982) enrollment of 700 students, anticipated additional enrollment would be approximately 1,900 students in 1993-94 for CCM-100. This compares to about 300 additional students under No Action by 1993-94. Since existing capacity is approximately 1000 students, there are no capital costs associated with No Action. Under CCM-100, capital costs would be approximately $9.0 million (1982 dollars) to accommodate peak year enrollment. The District has no outstanding debt. All the new schools have been built with Oil Shale Trust Fund money or provided by Colony and Union, by lease purchase agreement and lease purchase arrangements, thereby setting a precedent.

Mesa County Valley School District No. 51, the largest District in the region, would have a projected peak enrollment in 1996 of approximately 6,800 new students under the CCM-100, compared to a peak enrollment (1997) of 3800 new students under No Action. Mesa County Valley's assessed valuation would be anticipated to increase from $328 million in 1982 to $613 million in the year 2000 under the No Action alternative, and $701 million under CCM-100 (see Table 4.12-13). Estimated total capital costs under No Action would be about $12.2 million, compared to $40.8 million (1982 dollars) under CCM-100. Under No Action, the earliest a bond may have to be issued is in 1988, compared to 1986 under CCM-100. While Mesa County Valley has been managing growth, there may be some difficulty in obtaining authorization to issue bonds to pay for capital improvements as a result of the relatively large mill levy increase that would be necessary to pay back bond principal and interest.

Although it serves a relatively small population base, Mesa County Joint District No. 49 covers a large geographic area encompassing portions of Mesa and Garfield counties and the town of De Beque. Current enrollment is 165 students; capacity exists for an additional 15-25 students. Under No Action, enrollment would actually be stable or even decline; under CCM-100, peak enrollment (1994) may increase to 426 students. In 1982 constant dollars, the Districts' assessed valuation is projected to increase from $20.2 million in 1982 to $86.5 million by the year 2000 under No Action. Since the major CCSOP industrial facilities would be located in the Joint District, the assessed valuation would increase to $1.3 billion under CCM-100. At this time, the District has no outstanding long-term debt. There should be no difficulty issuing future bonds due to growth in the assessed valuation and the reasonableness of the bond redemption mill levy even in the early years of the CCSOP's construction.

Table 4.12-12 ESTIMATED TOTAL ENROLLMENT BY SCHOOL DISTRICT BY ALTERNATIVES (BASED ON SCHOOL-AGE POPULATION)[a]

	Garfield County #RE-2 (Rifle)				Garfield County #16 (Parachute/Battlement Mesa)				Mesa County Joint District #49 (De Beque)			
	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II
1982	2,361	2,361	2,361	2,361	700	700	700	700	165	165	165	165
1985	1,858	1,872	1,872	1,858	260	327	327	343	47	60	60	68
1990	2,583	2,978	2,902	2,701	813	1,472	1,337	986	65	218	101	104
1993	2,729	3,437	3,210	2,864	1,008	2,617	2,059	1,204	66	422	225	121
1994	2,559	3,373	3,142	2,782	986	2,586	2,029	1,205	67	426	223	123
1995	2,548	3,376	3,145	2,752	992	2,534	1,991	1,195	67	419	218	123
1996	2,516	3,379	3,132	2,728	989	2,560	1,975	1,189	67	419	216	124
2000	2,364	3,168	3,006	2,563	903	2,292	1,885	1,086	64	372	199	123

	Plateau Valley #50 (Collbran)				Mesa County Valley #51 (Grand Junction)			
	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II
1982	421	421	421	421	15,269	15,269	15,269	15,269
1985	343	344	344	345	15,607	15,909	15,909	16,245
1990	332	351	338	341	18,213	19,870	20,462	20,720
1993	324	348	334	332	18,670	21,642	22,721	23,514
1994	319	349	334	331	18,816	21,821	22,956	21,972
1995	322	351	333	326	18,925	21,936	23,056	21,255
1996	318	347	331	323	19,017	22,028	23,158	21,331
2000	294	330	313	311	18,428	21,340	22,064	20,631

Source: Mallory (1982).

[a] 90-92 percent of the total enrollment could be expected to be students in the public school system.

Table 4.12-13 PROJECTED ASSESSED VALUATION BY SCHOOL DISTRICT (1,000 OF 1982 DOLLARS)

	Garfield County #RE-2 (Rifle)				Garfield County #16 (Parachute/Battlement Mesa)				Mesa County Joint District #49 (De Beque)			
	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II
1982	33,342	33,342	33,342	33,342	5,928	5,928	5,928	5,928	20,179	20,179	20,179	20,179
1985	49,352	49,352	49,352	49,352	122,959	122,959	122,959	122,959	23,597	25,781	23,597	23,597
1990	65,430	76,147	70,618	69,339	421,180	434,778	426,591	426,092	42,182	315,097	228,995	81,815
1993	73,323	86,897	84,154	77,814	798,826	815,324	811,254	804,206	55,714	582,928	402,849	82,752
1994	74,859	91,261	87,083	79,479	891,936	911,412	906,812	897,441	61,440	708,980	496,127	190,906
1995	77,404	97,886	92,271	83,587	940,783	966,668	958,388	946,537	68,014	824,267	583,073	328,748
1996	79,734	100,301	94,530	85,292	1,002,739	1,029,591	1,021,108	1,008,930	75,512	930,477	667,442	335,540
2000	82,290	108,101	102,444	89,070	963,672	996,199	986,531	969,348	86,510	1,311,435	1,023,298	346,306

	Plateau Valley #50 (Collbran)				Mesa County Valley #51 (Grand Junction)			
	No Action	CCM	Fruita I	Fruita II	No Action	CCM	Fruita I	Fruita II
1982	10,499	10,499	10,499	10,499	328,272	328,272	328,272	328,272
1985	15,523	15,523	15,523	15,407	401,541	401,541	403,725	401,557
1990	18,518	19,603	19,965	19,932	577,552	624,531	726,921	782,986
1993	20,901	22,068	22,282	22,397	597,489	648,407	837,969	886,458
1994	21,739	23,323	23,504	23,718	600,540	670,563	891,467	961,841
1995	22,588	24,396	24,692	24,971	603,111	681,623	935,798	1,013,096
1996	23,536	25,377	25,689	25,772	604,999	685,867	962,181	1,010,507
2000	26,000	28,022	28,351	27,743	612,692	701,011	1,003,478	995,725

Source: BMML (1982).

Plateau Valley School District No. 50, serving the communities of Collbran, Mesa, Plateau City, and Molina had a 1982 enrollment of 421 students. Under No Action, enrollment is actually projected to decline by nearly 50 students between 1985 and 2000, and decline by 14 students under CCM-100. No capital improvements were projected as a result of declining enrollments. With a projected declining enrollment, the District should be able to manage with existing facilities for several years.

Capacities which are being planned for would be more than adequate for the smaller population growth anticipated under CCM-50. The two school districts most affected would be Mesa County School District No. 51 and Mesa County Joint District No. 49. Both of these would have project facilities within their tax bases. District No. 49's tax base would show a smaller increase under CCM-50. The District should be able to accommodate the growth without difficulty.

4.12.6.2 Grand Valley and Associated Siting Activities

Fruita I

Within Garfield County District No. RE2, anticipated additional enrollment in 1993 is approximately 850 new students for FI-100. Projected assessed valuation in the year 2000 would be $102 million under the FI-100, $6 million less than under CCM-100, and $20 million more than under No Action. Garfield County No. RE-2 would not benefit from any large-scale project's assessed value falling within its tax base under any alternative. The District can, however, accommodate peak enrollments under FI-100 and may have excess capacity by the year 2000.

Garfield County No. 16 may anticipate of 560 fewer students under FI-100 than under CCM-100 (1993). Under FI-100, capital costs were estimated to be $3.5 million, or $5.5 million less than under CCM-100. This compares to no capital costs associated with No Action.

Mesa County Valley District No. 51 could anticipate a peak enrollment (1996) of 7,900 additional students under FI-100 (as compared to 6,759 under CCM-100; 3,750 under No Action). The Districts' assessed valuation would increase to approximately $1.0 billion under FI-100, as compared to $701 million under CCM-100. The CCSOP's direct assessed valuation under FI-100 for the upgrading facilities would be the major difference between the two alternatives. Estimated total capital costs under No Action would be about $12.2 million compared to $51.7 million under FI-100. Under FI-100, the earliest a bond may have to be issued is in 1986.

Mesa County Joint District No. 49 may anticipate 70 additional students in 1993-94 under the FI-100. The assessed valuation is projected to increase to $1.0 billion under FI-100 (compared to $1.3 billion under CCM-100 and $86.5 million under No Action). Capital costs would be an estimated $0.4 million to accommodate peak enrollment (compared to $2.4 million under CCM-100).

As under CCM-100, enrollment under FI-100 for the period 1985-2000 would decline in Plateau Valley School District No. 50. No capital improvements were projected. The District's assessed valuation would be essentially the same for the year 2000 under both FI-100 ($28.3 million) and CCM-100 ($28.0 million).

Under the lower production rate (FI-50), District No. 51 would be most affected as there would be less assessed valuation from both project facilities and development associated with population growth. This, combined with the capacity of existing facilities and anticipated growth, may make it difficult for the District to increase the mill levy to accommodate growth and also maintain the desired level of service.

Fruita II

Within Garfield County District No. RE2, anticipated additional enrollment for 1993 is 500 students under FII-50. Since the actual maximum capacity of 1,100 students in the District would not be exceeded, capital costs were not estimated. Projected assessed valuation is $82.3 million in the year 2000 under the No Action alternative, compared to $89.1 million under FII-50.

Garfield County No. 16 has an estimated additional capacity for approximately 1,000 students. Under the No Action peak in 1991, approximately 350 new students would enroll compared to about 500 new students under FII-50. The District would be able to accommodate the new students. Since actual capacity would not be exceeded, capital costs were not estimated. District No. 16's assessed valuation would increase from $5.9 million in 1982 to approximately $964 million in 2000 under No Action (due to Union Oil Shale) and $969 million under FII-50.

Mesa County Valley District No. 51 may anticipate peak enrollment in 1993 of about 8,250 new students under FII-50 compared to 3,800 new students under the No Action. Assessed valuation would increase from $328 million in 1982 to $613 million by 2000 under No Action and $996 million under FII-50. Estimated incremental capital costs under No Action would be about $12.2 million, compared to $54.2 million under FII-50. Under No Action, a bond may need to be issued in 1988, compared to 1985 under FII-50.

Mesa County Joint District No. 49 may experience a decline in enrollment, even under FII-50. Actual capacity would not be exceeded, under either No Action or FII-50; hence, no capital costs were estimated. The District's assessed valuation would increase from $20.2 million in 1982 to $86.5 million in 2000 under No Action compared to $346.3 million under FII-50.

Plateau Valley School District No. 50's enrollment, as in all the alternatives, would be expected to decline (by about 35 students) under FII-50. Consequently, no capital improvements were projected. The District's assessed valuation is anticipated to increase from $10.5 million in 1982 to $26.0 million by the year 2000 under No Action compared to $27.7 million under FII-50.

4.12.7 Facilities, Services, and Fiscal Impacts

This section provides an analysis of the hypothetical projections of tax base, facility capacities, capital requirements, and fiscal balances developed for the project alternatives (see Table 4.12-14 for the fiscal balance summary). The projections are the output of FISPLAN, a computer model (developed by BMML in 1982) which predicts facility capacity requirements and fiscal effects for local governments. Based on these outputs, conclusions were made regarding the potential effects of the alternative scenarios and, in particular, the incremental project alternative impacts. Extensive local review of the output was undertaken. Major assumptions governing the projections are described in Appendix B-4.

In summary, the areas of Garfield and Mesa counties which would be affected by development of the project alternatives are already in a state of transition brought about by growth and development. Planning efforts, capital impovement programs, and construction and renovation of facilities have been instituted. These efforts are primarily to correct existing deficiencies and provide capacities to accommodate recent and anticipated growth. An additional project, even of the CCSOP's magnitude, would not create major thresholds.

The financial effects of the projected growth on local governments would be positive for the counties because they would benefit from direct increases in their tax base. Garfield County would benefit the most with CCM-100, while Mesa County would benefit the most from FI-100 and FII-50. Because the location of the mine is fixed, Garfield County would receive a substantial property tax base under all alternatives. One aspect of the lower production alternatives would be the rapid build-up of the population associated with construction activity followed by a decrease to operating levels. This would put pressure on facilities and create service demands for a peak population which may result in overbuilding of capacity. Mesa County may have some initial problems dealing with the lead time for financing its capital program but its expanding revenue capability would overcome any initial deficits.

Most municipalities would have financial problems stemming from large capital expenditures which have already been planned, mostly to correct existing deficiencies. Potential shortfalls would be related to capital for which funding was not identified, and for induced operations and maintenance costs associated with the new facilities. For the purpose of this EIS, however, it was assumed that there would be no adjustments in revenue and rate structures, or any long-term financing of capital improvements.

Table 4.12-14 FISCAL BALANCES - CUMULATIVE BALANCE IN THE YEAR 2000 (100's OF 1982 DOLLARS)

Jurisdiction	No Action	Clear Creek Mesa	Clear Creek Mesa Increment	Fruita I	Fruita I Increment	Fruita II	Fruita II Increment
Garfield County:							
General Fund	192,941	348,339	155,398	302,325	109,384	228,390	35,449
Rifle:							
General Fund	(6,294)	(8,282)	(1,988)	(7,089)	(795)	(5,627)	667
Water Fund	(457)	(704)	(1,935)	(4,355)	(1,242)	(3,491)	(378)
Sewer Fund	410	723	313	615	205	508	98
Parachute:							
General Fund	(2,290)	(3,168)	(878)	(3,142)	(852)	(2,763)	(473)
Water Fund	(457)	(704)	(247)	(635)	(178)	(851)	394
Sewer Fund	586	843	257	816	230	666	80
Mesa County:							
General Fund	1,100	24,340	23,240	66,815	65,715	86,625	85,525
Grand Junction:							
General Fund	(71,800)	(70,700)	(1,100)	(71,800)	(000)	(56,200)	(15,600)
Water Fund	(4,178)	(5,442)	(1,264)	(5,155)	(977)	(4,540)	(362)
City/County Sanitation	400	383	(17)	383	(17)	390	(10)
Fruita:							
General Fund	(1,610)	(441)	1,169	(1,676)	(66)	(1,366)	244
Water Fund	(8,266)	(8,239)	27	(8,738)	472	(8,580)	(314)
Sewer Fund	(2,652)	(2,631)	21	(2,569)	83	(2,573)	79
Palisade:							
General Fund	(140)	(236)	(96)	456	316	773	773
Utility Fund	(9,670)	(6,383)	3,287	(6,315)	3,355	(7,156)	2,514
De Beque:							
General Fund	(387)	(4,047)	(3,630)	(1,471)	(1,084)	(336)	51
Utility Fund	(613)	(2,739)	(2,126)	(1,323)	(710)	(893)	(280)
Collbran:							
General Fund	(3,082)	(2,634)	448	(2,436)	646	(2,018)	1,064
Water Fund	(1,289)	(1,337)	(48)	(1,288)	1	(1,289)	0
Sewer Fund	(3,008)	(3,008)	0	(3,008)	0	(3,008)	0
Ute Water District:							
Water Fund	(99,704)	(89,547)	10,130	(87,838)	11,866	(90,072)	9,632

Source: BMML (1982).

4.12.7.1 Clear Creek Mesa and Associated Siting Activities

Garfield County

Garfield County's economy has expanded considerably in the service, mining, and construction sectors and would be expected to continue this trend under No Action and CCM-100. Population impacts would be greater under CCM-100 than under all other project alternatives. The county's tax base would grow to 9.7 times its 1982 level ($125 million) under No Action and 20.1 times as much under CCM-100 by the year 2000. Garfield County plans $6.6 million in needed capital improvements over the period 1982-2000, most of which are slated for 1982 and 1983 regardless of growth expected with the CCSOP project. Capital expenditures projected for CCM-100 total $7.7 million, or $1.1 million more than No Action.

With large increases in property tax revenues, and significant increases in other sources, the county would begin to accumulate a surplus balance starting in 1986. By 2000, fiscal surpluses would amount to $193 million under No Action and $348 million under CCM-100. The issue of incorporation for Battlement Mesa may become a concern as the population grows and increased levels of public services and facilities are requested. As a county subdivision, it benefits from the large property tax base generated by CCM-100.

The City of Rifle would experience its greatest net population growth over the study period (1980-2000) under CCM-100, reaching a total of 8,951, compared to 5,769 for the No Action alternative in 2000. In 1993, Rifle would have nearly 3,000 additional people with CCM-100 compared to the No Action alternative (9,351 vs. 6,446). Assessed valuation would grow from about $12.2 million in 1982 to $43.9 million in 2000 under the No Action alternative, compared to $72.7 million with CCM-100. Rifle's capital improvements program for 1983 is anticipated to be $5.45 million (1982 dollars). If all the planned capital improvements are made (city hall, parks and recreation, water and sewer, and streets) there would be very few additional capital requirements under CCM-100 (or any) alternative.

Parachute's assessed valuation in the year 2000 is projected at $12.2 million for No Action and $19.4 for CCM-100. Parachute has planned $1.7 million in municipal improvements (approximately half of which are grant-funded) which are needed regardless of future growth. In spite of the increase in the tax base and other revenues, the current tax and rate structures are not adequate to meet the incremental general fund costs. Year 2000 shortfalls are estimated at $2.3 million for the No Action alternative and $3.2 million for CCM-100. Parachute's water fund would accumulate shortfalls due to unfunded capital and additional operations and maintenance (O&M) costs which the existing rate structure would be unable to accommodate. The sewer fee structure is meeting system needs. Under CCM-100 (and any other alternative), Parachute may have the greatest difficulty of any community funding expansion. The major industrial area located at the entrance to the Parachute Creek valley could, however, encompass Union's ancillary facilities and increase the tax base.

Battlement Mesa is provided services and facilities by means of special districts within Garfield County. Because it is an unincorporated county subdivision and because of its designed capacity, Battlement Mesa can accommodate substantial growth. Existing water and sewer systems would provide ample capacity for peak projected growth. The Grand Valley Rural Fire Protection District is experiencing rapid growth and may be required to provide more specialized equipment and higher levels of services. The district tax base contains the Union Project, so it has adequate financial capabilities. Battlement Mesa and Parachute are included in the Grand River Hospital District, which has applied to open a clinic to provide emergency/outpatient service in the area. In addition, Battlement Mesa Inc. had planned to contract for a private medical facility in that area.

Under CCM-50, the increase in the tax base in Garfield County would be smaller than under CCM-100 because of the reduction in the number and value of facilities and reduced production. The effects of the lower production level on municipal tax bases would be related to the increase in population only, as no project facilities are within municipal property tax bases (i.e., municipal tax base increases would be lower under CCM-50 in proportion to lower population growth). However, the faster buildup of employment may bring new assessed valuation on line sooner than under CCM-100.

CCM-50 would result in a county cumulative general fund surplus, but this will be smaller than that created under CCM-100. Because CCM-50 would create lower long-term population growth than CCM-100, municipal general fund deficits would be expected to be larger than under the CCM-100, but smaller than under No Action.

Mesa County

Under CCM-100, Mesa County would have sufficient financial resources to accommodate growth-related needs and appears to have the capabilities to appropriately manage growth. Assessed valuation would increase from $341 million to $662 million under No Action by the year 2000, and to $764 million under CCM-100. Mesa County has planned a $56 million capital improvements program over the next three years. Of that, $38 million would be financed with bonds to be repaid from Capital Improvement Fund revenues raised by an allocation of county sales taxes. Increases in revenue derived from property tax, use tax, sales tax, and severance tax may assist the county to overcome shortfalls initially created by unfunded capital expenditures. Fiscal balances in the year 2000 would be positive with CCM-100 generating $23 million more than the No Action Alternative ($1.1 million vs. $24.3 million).

The City of Grand Junction would grow from a 1983 population level of 28,007 persons to 38,438 in 2000 under CCM-100. Assessed valuation would also increase from $128.4 million (1982) to $277.4 million (2000) under CCM-100 compared to $226.7 million under No Action. The city has a major capital improvement program planned (about $45 million). Planned plus projected capital needs would lead to annual and cumulative shortfalls. These shortfalls would be increased by the excess of annual induced O&M costs ($71.8 million for the No Action; $70.7 million for CCM-100) over the annual revenues in the year 2000. The 1.3 million gallon water treatment plant expansion has not been funded. This cost, together with additional projected capital and induced O&M, would lead to Water Fund shortfalls of $4.2 million under No Action and $5.4 million under CCM-100. The Sanitation Fund has a rate structure adequate to cover current and projected annual O&M, plus debt retirement costs. By the year 2000, there would be a $400,000 surplus in the Sanitation Fund.

The Town of Fruita would grow to 4,281 people in the year 2,000 under CCM-100, 662 more people than under No Action. Fruita's assessed valuation would increase from $8 million to $14.7 million by the year 2000 under No Action and to $18.2 million under CCM-100. The town has planned extensive capital improvements, mostly funded by recently approved bond proceeds, which will generate additional debt service as well as new O&M. New growth will be essential to retire the bonds. In the year 2000, a $1.6 million cumulative deficit would exist under No Action, compared to $0.4 million under CCM-100; a result of more incremental revenues generated. Growth would alleviate rather than aggrevate Fruita's fiscal problems.

Palisade's population in the year 2000 is projected to reach 2,876 under CCM-100. It would not be as directly affected as other jurisdictions by the project due to a limited desire for growth and the services offered. Assessed valuation would increase from a 1982 level of $4.1 million to $7.1 million under No Action compared to $14.6 million for CCM-100. Planned water and sewer capital expenditures total $4.5 million of which $2.5 million is unfunded. Unfunded capital, new O&M, and additional debt payments create large annual and cumulative shortfalls in the utility fund which would be lessened under CCM-100. By 2000, utility shortfalls of $9.7 million and $6.3 million would be anticipated for No Action and CCM-100, respectively.

The Ute Water Conservancy District, projected to serve 41,000 people under No Action in the year 2000 and 45,500 people under CCM-100, plans $47 million in capital imprcvements over 5 years. Ute's plans would provide more than enough capacity (estimated at 168,000 people) for all the project alternatives. Other water districts in the Grand Valley would also adequately meet anticipated growth. The numerous sanitation districts also appear adequately equipped to meet future demand. The Persigo regional treatment system will serve most of the Grand Valley entities in the 201 area, and will provide capacity for up to 150,000 people. Increased growth may place new demands on the several fire districts in the area. Private medical services in the area are adequately meeting current needs and with plans for expansion will continue to meet growth-related needs.

Relative to its current small population (300), De Beque would experience considerable growth under CCM-100 (1,882 people in 1994). Assessed valuation would increase to $1.2 million in the year 2000 under No Action (compared to $542,000 in 1982) and $7.9 million under CCM-100. De Beque's capital improvements would total about $1.6 million, including a new town hall and street improvements. These improvements are necessary to bring town facilities up to standard, and would not be induced by projected growth. Although most of the planned capital improvements may be grant-funded, additional projected capital needs would be $638,000 more for CCM-100 than for No Action. De Beque's general fund would accumulate a shortfall of $387,000 under No Action by the year 2000 and $4.0 million under CCM-100. Its Utility Fund would have an increased shortfall of 2.1 million dollars under CCM-100.

By the year 2000, the town of Collbran's tax base would double to about $1.5 million under CCM-100. The town provides limited municipal services to its residents.

Mesa Water and Sanitation District is the only district in the De Beque/Collbran vicinity. It is anticipated that it will take over the Mesa Water Works Company. Sufficient water and sewer treatment capacity exists to meet future growth, though fire flow in the area is inadequate. The Plateau Valley Hospital District is expected to continue to meet short-term health care needs.

Under CCM-50, since no project facilities would be located in Mesa County, the difference in the county tax base increase between the levels of production would be related to the difference in the size of the population, (i.e., larger than No Action, but smaller than CCM-100). The effects on municipal tax bases of reducing the level of production would also be related to population levels.

4.12.7.2 Grand Valley and Associated Siting Activities

Fruita I

Garfield County. Garfield County should have sufficient resources for all its governmental activities under FI-100. Garfield County's population would rise from 29,002 in 1982 to a peak of 41,947 in 1993 under FI-100, or nearly 3,500 people less than under CCM-100. The average annual rate of population increase during the period of most rapid growth (1984-1993) would be 6.3 percent. Garfield County's tax base would exhibit tremendous growth under both No Action and CCM-100. FI-100 results in a year 2000 assessed valuation of $2.2 billion (compared to $1.21 billion for No Action and $2.51 billion for CCM-100). The county plans $6.6 million in needed capital improvements regardless of expected CCSOP-related growth. Planned and projected capital requirements would amount to $7.3 million under FI-100, a $0.7 million increase over No Action. By 2000, the fiscal surplus in the county would be $302 million for FI-100; or $109 million over No Action.

Generally, impacts on the City of Rifle and the special districts around Rifle under FI-100 are similar to those experienced under CCM-100. The city of Rifle would experience almost as much net population growth under FI-100 as under CCM-100 (8,246 and 8,951, respectively) in the year 2000. The year 2000 assessed valuation is projected to reach $71.5 million under FI-100, slightly less than under CCM-100 ($72.7). Rifle has planned capital improvements totalling $5.45 million. Under FI-100, projected incremental capital costs would be only $210,000 more than for No Action. Planned expenditures would provide sufficient capacities to accommodate growth.

As in the case of Rifle, impacts on the community of Parachute due to FI-100 would not be significantly different than those experienced under CCM-100. Population levels, which would peak in 1989, would be virtually identical for CCM-100 (1,966) and FI-100 (1,960). Assessed valuations by the year 2000 would be $19.4 million (CCM-100) and $18.5 million (FI-100). Parachute's capital improvements program totals about $1.7 million. For FI-100, additional needs would bring the total estimated capital costs to $2.4 million (compared to $2.5 million for CCM-100). General fund expenditures by the year 2000 would not be radically different for FI-100 than for CCM-100, both showing a substantial shortfall.

Under FI-100, impacts on the new community of Battlememt Mesa would be virtually identical to that experienced under CCM-100. Planned services and facilities would provide ample capacity for peak projected growth.

Impacts in Garfield County under FI-50 would be similar to those anticipated under CCM-50. A smaller increase in the tax base in Garfield County would also occur under FI-50, but the difference would be less marked since fewer of the facilities would be located in the county under this alternative.

Mesa County. FI-100 would produce a greater population impact in Mesa County than the CCM-100 due to the location of the upgrading facilities near Fruita. Under FI-100, the population peak of 117,667 would occur in 1996. FI-100 would result in a population increase 17 percent higher in the year 2000 than No Action (100,536). Mesa County's assessed valuation would approach $1.1 billion by 2000 under FI-100, compared to $662 million under No Action. Projected fiscal balances in the year 2000 under No Action would be $1.1 million for No Action and $66.8 million for FI-100. It appears that Mesa County would have sufficient resources to manage anticipated growth under FI-100. FI-100 would provide a balance between population and the tax base for Mesa County, and would still provide substantial surpluses for Garfield County.

Grand Junction's peak population under FI-100 would occur in 1996 at 38,993, nearly comparable to CCM-100 (38,079). The real growth in assessed valuation would increase under FI-100, amounting to about $282.4 million by 2000, 2.2 times as great as the 1982 assessed valuation of $128.4 million. The city tax base would grow with this alternative (as with all other project alternatives) but not to the extent experienced by the county.

Grand Junction has planned capital improvements programs totaling about $45 million. Along with projected additional needs, the total capital amount for the 1982-2000 period for No Action would be about $53 million. Under FI-100, this would increase to $59 million. Thus, the peak project increment would be about $6 million greater than with the No Action alternative. In addition to the capital costs, the induced O&M for the new facilities would be an estimated $5.3-5.9 million annually.

The current revenue structure would not be adequate to support annual costs, including induced O&M, on top of an unfunded capital program. The resulting cumulative year 2000 shortfall would be about the same level for No Action and FI-100 ($71.8 million) and only slightly less for CCM-100 ($70.7 million). A water fund shortfall of $5.2 million would exist in 1982; under the sanitation fund, a positive surplus of $400,000 would occur. These shortfalls would occur primarily due to the large amount planned for capital expenditures for which funding has not yet been identified. Most of these plans are intended to meet existing needs and not projected growth; yet, the unfunded expenditures contribute to shortfalls which are predicted throughout the year 2000.

The current population of the town of Fruita, about 3,000, would grow to about 3,600 in the year 2000 under No Action. With the upgrading facilities located nearby, the FI-100 would create the largest impact on town population. The peak population would occur in 1996 at 6,541, and in 2000 the total would be 6,112. The net population impact (year 2000) would be 2,500 for FI-100. The year 2000 assessed valuation would be expected to double under FI-100 ($29 million) compared to $14.7 million for No Action. Extensive capital improvements have been planned with or without the CCSOP. Growth would have to occur to retire the bonds. In the year 2000, a $1.7 million shortfall could occur under FI-100 compared to $1.6 million under No Action and $0.4 million under the CCM-100.

Impacts on the community of Palisade would be essentially the same under FI-100 and CCM-100. Only slight differences would occur in 1994 peak population (2,875 and 2,998, respectively) and year 2000 assessed valuation ($14.4 and $14.6 million, respectively). FI-100 would double the tax base projected for No Action ($7.1 million). The General Fund cumulative balances in the year 2000 would be positive for FI-100 ($456,000), compared to a shortfall of $236,000 for CCM-100 and $140,0000 for No Action. The reason the most favorable balance would occur under FI-100 is that the severance tax would be considerably higher than for CCM-100 (due to more workers directly employed by the CCSOP) while annual expenditures would be slightly lower.

Special districts within the Grand Valley area would be impacted under FI-100 in a manner similar to that experienced under the CCM-100. Only slight differences would occur, particularly with the Ute Water District. Under FI-100, the population of the District would reach 47,996 in 1986, or about 7,000 more than under No Action. The assessed valuation of the District (year 2000) would be $417 million under FI-100 compared to $347 million for No Action. Projected cumulative shortfalls would be expected in the year 2000. These would total $99.7 million for No Action, $89.5 million for CCM-100, and $87.8 million for FI-100.

Impacts associated with FI-100 would be significantly less in the town of De Beque than under CCM-100. De Beque would experience a peak population of 1,011 under FI-100, more than 800 people less than under CCM-100. The assessed valuation (year 2000) would climb to $3.2 million for FI-100, $4.7 million less than under CCM-100. By the year 2000, the accumulated shortfall for No Action would be $387,000 compared to $1.5 million for FI-100 and $4.0 million for CCM-100. This shortfall would result from unfunded capital plus higher incremental expenditures projected for FI-100 relative to the incremental revenues, which would not exhibit much increase over No Action.

The Town of Collbran would not be expected to grow beyond its current population under FI-100. The tax base would be expected to rise to $1.1 million in the year 2000 under FI-100, compared to $1.0 million for No Action. The cumulative general fund shortfall (year 2000) would be smaller for FI-100 ($2.4 million) and CCM-100 ($2.6 million) since expenditures would not be much higher than for the No Action alternative ($3.1 million). Also, more revenues would be generated by growth in the property and sales tax bases and severance tax.

Special districts in the De Beque and Collbran areas under FI-100 would experience essentially the same level of impacts as those associated with CCM-100.

Under FI-50, the tax base increase in Mesa County would be smaller in relation to the population because of the decrease in the number and value of facilities to be built in the county. The effects of the lowered production level on municipal tax bases would be similar to those experienced under other 50,000 bpd alternatives, since no project facilities would be located within municipal tax bases.

Fruita II

Garfield County. With an increased tax base and other revenue increments from the CCSOP, Garfield County should have few problems meeting incremental needs under FII-50. Population would increase by 4,750 from 1982-2000 under FII-50, an increase of 2,000 people more than No Action. By the year 2000, the assessed valuation of the County would be $1.5 billion under FII-50; an increase of $300 million more than under No Action.

A capital improvement program of about $6.2 million is planned by the County to meet existing needs. Few additional requirements would be attributable to project-related growth. The total for No Action over the period 1982-2000 would be $6.6 million (including the $6.2 million); for FII-50 this would amount to $6.7 million. Thus, only $400,000-$500,000 may be attributed to growth.

Under FII-50, the City of Rifle could have a 1993 peak population of about 7,000 people. Rifle's tax base would expand considerably more than its population, reaching $52.6 million by 2000 under FII-50, $8.7 million more than under No Action. Rifle's planned $5.5 million capital improvement program can meet existing needs and provide ample capacity for growth. General fund shortfalls however, would start in 1983, with cumulative shortfalls in the year 2000 of $5.6 million under FII-50 and $6.3 million under No Action. The Water Fund would experience shortfalls of $3.5 million under FII-50 (compared to $3.1 for No Action); the projected sewer fund revenues (year 2000) show a positive balance for No Action ($410,000) and FII-50 ($508,000). Special districts in the Rifle area, with expansion of the tax base, appear adequate to meet future demand.

The town of Parachute's population under FII-50 would fluctuate and then peak in 1989 at 1,808, compared to 1,694 under No Action. Parachute's assessed valuation would be expected to reach $14.2 million by the year 2000 under FII-50, compared to $12.2 million under No Action. Growth in the property tax base would far exceed the 1982 level of $685,000, and would be 3-4 times the level reached in 1984 ($4.2 million). The critical aspect would be the lag inherent in getting new property on the tax rolls. While the population peak would occur in 1989, the assessed valuation would not peak until 1991.

Parachute plans to spend about $1.7 million in 1982 and 1983 on municipal improvements. Additional capital costs projected for FII-50 would generate about $515,000 in excess of the planned capital program. Annual shortfalls due to new O&M costs, plus unfunded capital needs, would result in accumulated year 2000 shortfalls of $2.8 million for FII-50 ($2.3 million for No Action). The water fund shows projected year 2000 shortfalls; the sewer fund shows positive balances in 2000.

The community of Battlement Mesa would certainly attract new residents under FII-50. In Battlement Mesa, in some instances, capacity has been built which far exceeds the anticipated population. Financial support for system operations may become an issue if sufficient growth does not materialize.

Mesa County. Under FII-50, Mesa County would experience a rapid population build-up due to construction activity, peaking in 1993 at 119,328, from the 1982 level of 87,315. In 1993, the incremental difference due to

FII-50 would be 21,570 more than for the No Action alternative. The Mesa County assessed valuation would experience a great deal more growth due to FII-50 than for No Action. From the 1982 level of $341 million, the year 2000 FII-50 level would reach $1.06 billion (compared with $662 million for No Action), an increase of $400 million. The county would, therefore, have ample resources to deal with growth. The county has a $56 million capital improvements program. In addition, capital requirements projected with FII-50 would total about $5 million more. Because of its incremental revenue capacity, the county would experience a cumulative year 2000 fiscal balance of $86.6 million for FII-50, compared to $1.1 million for No Action.

The City of Grand Junction's population would increase rapidly with FII-50 construction activity, reaching a 1993 peak of 39,528, a difference of 6,767 more than with No Action. By the year 2000, the population would have dropped off by 3,000 due to a smaller operations work force. The city tax base would exhibit considerable growth, though not to the extent experienced by the county. The year 2000 FII-50 level ($267 million) would be double the 1982 level, and $40 million higher than for No Action. In spite of tax base increases and other additional revenues, Grand Junction would experience annual and cumulative general fund shortfalls resulting from unfunded capital needs and new O&M. Year 2000 shortfalls would accumulate to $71.8 million for No Action and $56.2 million for FII-50. The FII-50 shortfall would be lower because there are more incremental revenues available. Cumulative shortfalls of $4.2-4.5 million would occur for the Water Fund in the year 2000 for No Action and FII-50. The sanitation fund would have a year 2000 surplus of about $400,000 for FII-50 and the No Action.

The City of Fruita would be substantially affected by FII-50, with its peak 1993 population reaching 7,431, double the No Action projected population. The year 2000 tax base for FII-50 ($29.6 million) would be 3.7 times the 1982 level, and double the amount for No Action ($14.7 million). Fruita has planned major capital improvements to meet existing needs and accommodate growth. Little additional capital would be required over No Action. The FII-50 increment would be about $600,000. The general fund would experience shortfalls from new annual O&M related to capital improvements, with accumulated shortfalls of $1.4 and 1.6 million for FII-50 and No Action, respectively. Extensive water system improvements are planned; in addition, FII-50 needs are estimated at $400,000. With the unfunded portion of these capital expenditures, plus debt payments and induced O&M, resulting year 2000 cumulative shortfalls in the water fund of $8.3 and $8.6 million would occur for No Action and FII-50. The sewer fund would also experience cumulative deficits of about $2.6 million for both No Action and FII-50 due to unfunded capital and induced O&M.

Palisade's population would increase from 1,714 in 1982 to a peak of 2,764 in 1993 under FII-50, 60 percent more than for No Action. Growth in the tax base would be experienced with FII-50, expanding from $4.1 million in 1982 to $12.8 million in the year 2000, an increment of $5.8 million more than with No Action. The cumulative year 2000 General Fund balance for FII-50 would be about $773,000, compared to a cumulative shortfall of $140,000 for No Action. In the year 2000, a shortfall of $7.2 million (FII-50) is projected for the Utility Fund, (compared to $9.7 million for No Action).

Under FII-50, the 1993 peak population of the Ute Water Conservancy District would be 41 percent higher than in 1982, compared to a 14 percent increase under No Action. Ute's planned capital improvements would provide sufficient capacity for the projected growth. No incremental costs are projected under FII-50. Annual shortfalls would be initially created by the capital expenditures for which debt service was not assumed. However, after the improvements are made, there would be recurring shortfalls associated with new annual O&M costs induced by the improvements. Year 2000 accumulated shortfalls of $99.7 and $90.1 million would occur with No Action and FII-50 alternatives, respectively. The same conclusions about the effects of growth on the special districts in the Grand Valley area associated with CCM-100 and FI-100 also apply to FII-50.

The Town of De Beque would be expected to reach a population of 344 people with No Action. The population would nearly double with FII-50 reaching 601 at its peak in the year 2000. With FII-50, the tax base would reach $3 million in the year 2000, an increment of $1.8 million more than with No Action. De Beque's general fund has shortfalls stemming from unfunded capital, but otherwise can almost cover its current annual expenditures. The year 2000 would balances would have shortfalls of $387,000 and $336,000 for No Action and FII-50, respectively. With additional capital plus induced O&M costs, sizable shortfalls in De Beque's utility systems would be accumulated by the year 2000 ($613,000 for No Action; $893,000 for FII-50).

No growth is projected for the town of Collbran under FII-50. With the planned capital improvements program (for which funding has not been identified) plus incremental costs associated with induced O&M, cumulative shortfalls would occur in all the town's funds. By the year 2000, a cumulative shortfall of $2 million is projected under FII-50, compared to $3 million under No Action.

Potential growth effects on the De Beque area special districts from FII-50 would be essentially the same as those identified for CCM-100 and FI-100.

4.12.8 Conclusions for the Study Region: Mesa and Garfield Counties

- Because CCSOP demand for construction and operations workers would exceed local availability, significant in-migration into the two counties would occur. The resultant population increase during the peak construction years (1994-97) of the 100,000-bpd alternatives would be approximately 28,000. The post-construction population increase under those alternatives would be approximately 25,500 (in the year 2000). The peak population increase under the 50,000-bpd alternatives would be approximately 24,000, slightly less than with the 100,000 bpd alternatives. However, population levels would decline rapidly under these alternatives, to about 12,500 more than under No Action.

- A critical element in the analysis is the Operator's intention to encourage employee location in the Grand Valley and Battlement Mesa areas, where adequate physical capacities exist, developable land is available, and the housing industry is ready to meet demand. This allocation would result in Mesa County receiving the greater portion of population growth under all alternatives, and Battlement Mesa accommodating the largest part of Garfield County's growth. The Town of De Beque would potentially grow overall to several times its current size, but would receive a relatively small portion overall of population growth.

- The areas of Garfield and Mesa counties which would be affected by development of all major project configurations are in a state of transition brought about by growth and development (BMML 1982). Planning efforts, capital improvement programs, construction and renovation of facilities, and such measures as the Mesa County sales tax have been instituted. These efforts have been devised to remedy existing deficiencies and to provide capacities to accommodate expected growth. The impacts of a project of the CCSOP's magnitude have been anticipated and can be physically accommodated.

- The financial effects of the CCSOP would be significant and positive for the counties because they would benefit from increases in their property tax bases (see Tables 2.4-2 and 2.4-3, Section 2.4). Garfield County would benefit most with CCM-100, but would also show substantial surpluses under the other alternatives. Mesa County benefits most under FI-100 and FII-50. Mesa county may have some initial problems dealing with the lead time for financing its capital programs, but its expanding revenue capability should overcome initial shortfalls. The most favorable balance of population to tax base would occur under FI-100.

- Most of the municipalities would have financial problems stemming from large capital expenditures (which have already been planned). Fiscal shortfalls would be related to capital expenditures for which funding was not identified, and for induced operation and maintenance costs associated with new facilities. However, this analysis assumed no adjustments in revenue and rate structures or long-term financing. It is probable that such adjustments would occur because municipal budgets must, by law, be balanced. In general, the fiscal condition of Grand Valley municipalities (with the exception of Grand Junction) would improve under all major project configurations while that of Rifle, Parachute, and DeBeque would worsen.

- The CCSOP would greatly expand employment opportunities, particularly in the construction and mining sectors. The economies of Mesa and Garfield counties would become increasingly dependent on and vulnerable to fluctuations in the energy fuels industry. Under CCM-100, 1993 construction employment would amount to 22 percent of total Garfield County employment. Mining employment in Garfield County in 2000 would make up 25 percent of all employment. The high wage rates associated with the project would increase local income and may work toward higher wages in other sectors. Other sectors, especially agriculture, may have difficulty competing for labor.

- Development under all project configurations would increase growth pressures, the incidence of social problems, and the demand for social and human services in both counties. Population and economic growth would work toward the continuing decline of western Garfield County's rural lifestyle, but would also bring with it greater social and cultural diversity.

- The Operator's single-status camp would reduce the need for temporary housing during the construction phase. The area's housing industry should be able to meet the demand for permanent housing, although the accelerated schedule of the 50,000 bpd production rate alternatives may make this difficult.

4.13 Energy and Transportation

4.13.1 Net Energy Analysis

4.13.1.1 General Energy Impacts

Impacts to the energy balance of the region would be positive because of the production of shale oil. Although construction of the mine and plant would result in a net loss of energy during the short term, shale oil production during operations would increase energy availability for consumers in the United States. The net gain of energy during operations would outweigh the consumptive loss during construction. The amount of energy produced at the 100,000-bpd and 50,000-bpd rates represents approximately 2.0 and 1.0 percent of the oil imported into the United States during 1981.

4.13.1.2 Methodology

The methodology used in the net energy analysis is set forth in *Energy Analysis Handbook for Oil Shale Development* (BLM 1982i). The methodology attempts to quantify the energy used to produce energy. The methodology employs "trajectories" broken into modules for each production scenario and rate. Each direct and indirect energy input was traced back to resources in the ground, forming the parameters of the study. The analysis does not include an energy assessment of unrecovered resources. Energy input includes operational, transportation, materials, and infrastructure energies.

4.13.1.3 Impacts to the Clear Creek and Grand Valley Areas

Table 4.13-1 indicates the energy requirements needed to produce 100,000 bpd of shale oil. The table shows that the Proposed Action would have a net energy gain of 1.58×10^{14} Btu and the energy output to input ratio is 3.4:1. The CC-100 and FI-100 alternatives have output to input ratios of 3.5:1 and 3.0:1, respectively. It should be noted that for every configuration, the major energy input to produce shale oil is electricity.

The net energy analysis for the 100,000-bpd rate indicates that the Fruita 1 alternative has the least desirable energy ratio. This difference is attributable to the energy expended to transport raw shale oil from Clear Creek mesa to the upgrading modules, and (potentially) back again for transport to market. The amount of energy expended in pumping of raw and upgrade shale oil increases the amount of energy consumed.

Electrical generation requirements for the project configurations producing 100,000 bpd would be the same, as indicated on Table 4.13-1. Some minor differences occur due to variations in project configuration details (e.g., pipeline lengths). Projections by the Colorado Public Utilities Commission indicate that by 1991, Colorado will be a net importer of electricity. At this time it appears that the existing or projected power supply in the project area would be sufficient for the project's power requirements.

Table 4.13-1 SUMMARY OF ENERGY BALANCE, 100,000-BPD PRODUCTION RATE[a]

Energy Type	Project Configuration		
	Proposed Action	Clear Creek	Fruita 1
Total Direct Energy	2.84×10^{13} Btu[b]	2.83×10^{13} Btu	3.99×10^{13} Btu
Materials Energy	1.26×10^{13} Btu	1.12×10^{13} Btu	1.44×10^{13} Btu
Direct Electrical	354 Mw[c]	354 Mw	354 Mw
Energy Produced	2.23×10^{14} Btu	2.23×10^{14} Btu	2.23×10^{14} Btu
Energy Consumed[d]	6.48×10^{13} Btu	6.33×10^{13} Btu	7.48×10^{13} Btu
Ratio of Energy Production/Consumption	3.4:1	3.5:1	3.0:1

[a] All values reported on an annual basis except for Direct Electrical which is reported as a daily requirement.
[b] Btu = British thermal unit
[c] Mw = Megawatt (1,000,000 watts)
[d] Includes operations, transportation, materials, and infrastructure energy

On-site electrical generation and other sources of project-related energy production are anticipated for utilization. These methods, if implemented, would decrease the demand for outside power resources.

Table 4.13-2 indicates the energy requirements needed to produce 50,000 bpd of shale oil. The table shows that the PA-50 alternative would have a net energy gain of 9.07×10^{13} Btu and an energy output to input ratio of 4.2:1. The energy ratios for the other project configurations vary from 4.4:1 to 3.3:1. These variations are attributable to differences in transport of water, oil, or raw shale.

The energy ratios for the 50,000-bpd production rate appear to be more favorable than the 100,000-bpd rate. This is because the all underground operation would extract a higher grade shale oil; hence the per unit (e.g., ton of shale oil) energy expenditure would be less. Note that the 50,000 bpd production rate would have a much shorter operational life than the 100,000-bpd rate; therefore, the total amount of shale oil produced would be much less under the 50,000-bpd scenarios.

4.13.1.4 Transportation Alternatives

The differing transportation alternatives were considered in the net energy analyses. In cases where differences occurred (e.g., pipeline lengths), the alternative considered in detail was the most energy consumptive alternative. The figures presented, therefore, represent the greatest possible energy consumption that could occur under any alternative.

4.13.1.5 Hazardous Waste Disposal

Impacts on the net energy analysis due to solid and hazardous waste disposal would not be significant and alternative methods of disposal would not affect energy ratios.

4.13.1.6 Secondary Impacts

The potential secondary impacts of the proposed project would be additional energy consumption because of secondary population growth. These impacts were considered in the net energy analyses presented previously.

Table 4.13-2 SUMMARY OF ENERGY BALANCE, 50,000-BPD PRODUCTION RATE[a]

	Project Configuration			
Energy Type	Proposed Action	Clear Creek	Fruita I	Fruita II
Total Direct Energy	1.14×10^{13} Btu[b]	1.13×10^{13} Btu	1.71×10^{13} Btu	1.45×10^{13} Btu
Materials Energy	5.44×10^{12} Btu	4.04×10^{12} Btu	4.96×10^{12} Btu	9.79×10^{12} Btu
Direct Electrical	149 Mw[c]	149 Mw	149 Mw	149 Mw
Energy Produced	1.19×10^{14} Btu	1.19×10^{14} Btu	1.19×10^{14} Btu	1.19×10^{14} Btu
Energy Consumed[d]	2.83×10^{11} Btu	2.68×10^{11} Btu	3.36×10^{11} Btu	3.58×10^{11} Btu
Ratio of Energy Production/Consumption	4.2:1	4.4:1	3.5:1	3.3:1

[a] All values reported on an annual basis except for Direct Electrical which is reported as a daily requirement.
[a] Btu = British thermal unit
[b] Mw = Megawatt (1,000,000 watts)
[c] Includes operations, transportation, materials, and infrastructure energy

4.13.2 Transportation Impacts

4.13.2.1 General Impacts

Generally, transportation impacts would be most significant as they affect motor vehicles and associated road use. Construction and operational employees, as well as secondary population growth, would add vehicles to the present state and county road system. Airports and railroads would also experience increased use.

The analysis of impacts to transportation was performed using a technique developed by the BLM (1982j). Data utilized in the calculations were obtained from the Colorado Department of Highways and from the socioeconomic impact assessment (Section 4.12). In all instances the traffic volume figures have been rounded to the nearest 50 vehicles.

The traffic impacts of all project configurations at the 100,000-bpd and 50,000-bpd production rates are shown in Tables 4.13-2 through 4.13-11. These tables address the road segments outlined in Section 3.13, the Roan Creek road, and 16 Road. Traffic projections for road segments A-H are based on data from the Colorado Department of Highways and projected population figures. Projections for the Roan Creek road and 16 Road are based on calculations of relative increases in population.

14.13.2.2 Clear Creek Mesa and Associated Siting Activities

The effect of the PA-100 and CC-100 alternatives would not significantly impact Interstate Highway 70 (road segments A-E). This is determined by the Peak Hourly Traffic/Capacity at Level of Service "C" (PHT/CAP) ratios shown on Table 4.13-2. In all instances, the ratios are consistently below 1.0; hence the level of service would be maintained (see Section 3.13.3). Road segments F-H do indicate some change in level of service around the year 2010 and into 2070. The ratios shown on Table 4.13-2 indicate a potential level of service change.

The effect of the PA-100 and CC-100 alternatives on the Roan Creek road is significant. As Table 4.13-3 indicates, the Average Daily Traffic (ADT) figures increase significantly over the present ADT values. The existing road is substandard for the anticipated traffic demand and would have to be upgraded to accommodate the increase of traffic. A new connection to I-70, bypassing De Beque, could be needed to handle the traffic volume and type of traffic anticipated.

No impact is anticipated for 16 Road due to the PA-100 or CC-100 alternatives. The increase in traffic shown is from general population increase, not from the CCSOP.

The effect of the PA-100 or CC-100 alternatives would be less than at a 100,000-bpd production rate (Tables 4.13-4 and 4.13-5). As with the higher production rate, no significant impact would be expected on I-70 (segments A-E) and similar, but less significant, impacts would be expected on road segments F-H. The Roan Creek road would also experience fewer impacts, as indicated on Table 4.13-4.

Table 4.13-3 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, PROPOSED ACTION AND CLEAR CREEK 100,000 BPD CONFIGURATIONS

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.43
1995[e]	A	29.6	5,700	650	3,400	.19
	B	19.4	11,400	1,400	3,500	.40
	C	17.0	12,450	1,700	3,450	.49
	D	8.9	12,350	1,700	3,450	.49
	E	42.4	13,950	1,950	3,500	.56
	F	15.1	5,700	750	950	.79
	G	4.3	41,000	4,550	2,000	2.28
	H	8.4	10,350	1,250	1,400	.89
2010	A	29.6	7,800	900	3,400	.26
	B	19.4	14,900	1,850	3,500	.53
	C	17.0	16,700	2,300	3,450	.67
	D	8.9	16,550	2,300	3,450	.67
	E	42.4	18,750	2,600	3,500	.74
	F	15.1	7,600	1,000	950	1.05
	G	4.3	50,200	5,550	2,000	2.78
	H	8.4	13,500	1,650	1,400	1.18
2070	A	29.6	16,400	1,900	3,400	.56
	B	19.4	24,450	3,100	3,500	.89
	C	17.0	28,100	3,250	3,450	.94
	D	8.9	30,100	3,400	3,450	.99
	E	42.4	31,550	3,450	3,500	.99
	F	15.1	15,500	2,000	950	2.11
	G	4.3	74,900	8,300	2,000	4.15
	H	8.4	21,900	2,650	1,400	1.89

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "C"
[d] PHT/CAP Ratio - see text for explanation
[e] Peak year of employment

Table 4.13-4 TRAFFIC PROJECTIONS FOR ROAN CREEK AND 16 ROAD, PROPOSED ACTION AND CLEAR CREEK 100,000 BPD CONFIGURATIONS

	ADT - Roan Creek Road[a,b]		ADT - 16 Road	
Year	PA	CC	PA	CC
1980	50	50	50	50
1995[c]	1,200	1,200	50	50
2010	1,050	1,050	100	100
2070	1,050	1,050	100	100

[a] ADT = Average Daily Traffic
[b] PA = Proposed Action Configuration
CC = Clear Creek Configuration
[c] Peak year of employment

Airports

Increases to air traffic for the Walker Field airport would likely be similar to those in the recent past (Section 3.13.3). While the CCSOP would contribute to the overall increase in air traffic, the impact would not be significant because recent airport expansion would accommodate expected increases.

Railroads

Assuming that the shale oil would be transported via pipeline and that the present rail system would be below capacity (Section 3.13), there should be no significant impacts to the present rail systems from the CCSOP. Similarly, considering the low level of railroad traffic, impacts on at-grade crossings would be insignificant.

A railyard and terminal located near De Beque would handle the necessary project-specific rail traffic. During construction, the main activity would be handling incoming construction material. After shale oil production begins, the main emphasis would be on handling materials and products related to project operation.

Pipelines

Current pipeline-use projections indicate that existing pipeline systems would not be utilized to capacity for transport of shale oil. For the CCSOP, a new shale oil transport line would hto be constructed to transport the shale oil to pipelines that would connect to refineries. Potential pipeline routes are described in Chapter 2.0. Existing natural gas pipelines would be utilized for providing natural gas supply but should not be seriously impacted.

4.13.2.3 Grand Valley and Associated Siting Activities

Tables 4.13-2 to 4.13-6 show that the FI-100 alternative would have approximately the same impact to the I-70 road segments (A-E) as would the PA-100 and CC-100 alternatives.

The impacts of FI-100 on the Roan Creek road and 16 Road would differ from the previously described configurations. Since a portion of the workforce traffic would shift to the Fruita area, there would be less impact on the Roan Creek road and more impact on 16 Road (Table 4.13-7). The substandard conditions described previously for the Roan Creek road also apply to the FI-100 alternative. Similarly, the present condition of 16 Road is substandard for the anticipated traffic demand. Upgrading of this road would be necessary to accomodate the expected traffic.

Table 4.13-5 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, CLEAR CREEK AND PROPOSED ACTION CONFIGURATIONS, 50,000 BPD

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.43
1993[e]	A	29.6	4,050	450	3,400	.13
	B	19.4	5,850	750	3,500	.21
	C	17.0	6,150	850	3,450	.25
	D	8.9	7,150	1,000	3,450	.29
	E	42.4	8,100	1,150	3,500	.33
	F	15.1	4,200	550	950	.58
	G	4.3	23,800	2,650	2,000	1.33
	H	8.4	5,400	700	1,400	.50
2010	A	29.6	3,850	450	3,400	.13
	B	19.4	5,550	700	3,500	.20
	C	17.0	5,850	800	3,450	.23
	D	8.9	5,800	800	3,450	.23
	E	42.4	6,350	900	3,500	.26
	F	15.1	7,150	1,000	950	1.05
	G	4.3	22,600	2,500	2,000	1.25
	H	8.4	5,150	650	1,400	.46

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "c"
[d] PHT/CAP - see text for explanation.
[e] Peak year of employment

Table 4.13-6 TRAFFIC PROJECTIONS FOR ROAN CREEK ROAD AND 16 ROAD, PROPOSED ACTION AND CLEAR CREEK CONFIGURATIONS, 50,000 BPD

	ADT - Roan Creek Road[a,b]		ADT - 16 Road	
Year	PA	CC	PA	CC
1980	50	50	50	50
1993	1,150	1,150	50	50
2000	1,000	1,000	100	100

[a] ADT = Average Daily Traffic
[b] PA = Proposed Action Configuration
CC = Clear Creek Configuration

Table 4.13-7 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, FRUITA I ALTERNATIVE, 100,000 BPD

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.43
1993[e]	A	29.6	5,950	650	3,400	.19
	B	19.4	11,000	1,400	3,500	.40
	C	17.0	12,000	1,650	3,450	.48
	D	8.9	11,950	1,650	3,450	.48
	E	42.4	13,450	1,900	3,500	.52
	F	15.1	5,950	750	950	.79
	G	4.3	39,600	4,400	2,000	2.20
	H	8.4	10,000	1,250	1,400	.89
2010	A	29.6	8,150	950	3,400	.28
	B	19.4	14,400	1,800	3,500	.51
	C	17.0	16,150	2,250	3,450	.65
	D	8.9	16,000	2,250	3,450	.65
	E	42.4	18,100	2,550	3,500	.73
	F	15.1	7,950	1,050	950	1.11
	G	4.3	48,500	2,550	2,000	1.28
	H	8.4	13,050	1,600	1,400	1.14
2020	A	29.6	17,050	1,950	3,400	.57
	B	19.4	25,250	3,200	3,500	.91
	C	17.0	29,400	3,400	3,450	.98
	D	8.9	29,650	3,350	3,450	.97
	E	42.4	29,700	3,250	3,500	.93
	F	15.1	16,150	2,110	950	2.22
	G	4.3	84,350	9,350	2,000	4.67
	H	8.4	25,200	3,050	1,400	2.18

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "c"
[d] PHT/CAP Ratio - see text for explanation.
[e] Peak year of employment

Table 4.13-8 TRAFFIC PROJECTIONS FOR ROAN CREEK ROAD AND 16 ROAD, FRUITA I ALTERNATIVE, 100,000 BPD

Year	ADT[a] - Roan Creek Road	ADT - 16 Road
1980	50	50
1995	900	50
2010	800	100
2070	800	100

[a] ADT = Average Daily Traffic

The impacts of the FI-50 and FII-50 alternatives would be less than at a 100,000-bpd production rate. As with the higher production rate, no significant impact would be expected on I-70 (Segments A-E) from either the FI-50 or FII-50 alternatives. Similar, but fewer, impacts would be expected on road segments F-H. It should be noted that the volume of traffic would increase on road segments F-H for the FII-50 alternative due to the shift of population to the Fruita area.

Impacts to the Roan Creek road and 16 Road for FI-50 and FII-50 are similar, but less than from the FI-100 bpd rate. Again, both of these roads are presently substandard to handle the anticipated traffic needs for either the FI-50 or FII-50 alternatives. Upgrading would be necessary to handle the increased traffic.

Impacts to airports, railroads, and pipelines would be similar to those described previously for the Proposed Action.

4.13.2.4 Transportation Alternatives

The differing transportation alternatives were considered in both the energy and transportation analyses.

Table 4.13-9 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, FRUITA I CONFIGURATION, 50,000 BPD

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.43
1993[e]	A	29.6	4,150	450	3,400	.13
	B	19.4	6,050	750	3,500	.21
	C	17.0	6,300	850	3,450	.25
	D	8.9	6,650	900	3,450	.26
	E	42.4	7,500	1,050	3,500	.30
	F	15.1	4,350	600	950	.63
	G	4.3	24,500	2,700	2,000	1.35
	H	8.4	5,550	700	1,400	.50
2010	A	29.6	3,900	450	3,400	.13
	B	19.4	5,650	700	3,500	.20
	C	17.0	5,900	800	3,450	.23
	D	8.9	6,050	850	3,450	.25
	E	42.4	6,850	950	3,500	.27
	F	15.1	4,050	550	950	.58
	G	4.3	22,950	2,550	2,000	1.28
	H	8.4	5,200	650	1,400	.46

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "c"
[d] PHT/CAP Ratio - see text for explanation.
[e] Peak year of employment

Table 4.13-10 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, FRUITA II CONFIGURATION, 50,000 BPD

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.43
1993[e]	A	29.6	4,400	500	3,400	.15
	B	19.4	6,350	800	3,500	.23
	C	17.0	6,650	900	3,450	.26
	D	8.9	5,650	800	3,450	.23
	E	42.4	6,400	900	3,500	.26
	F	15.1	4,600	600	950	.63
	G	4.3	25,800	2,850	2,000	1.43
	H	8.4	5,850	750	1,400	.54
2010	A	29.6	3,950	450	3,400	.13
	B	19.4	5,750	750	3,500	.21
	C	17.0	6,000	800	3,450	.23
	D	8.9	5,750	800	3,450	.23
	E	42.4	6,500	900	3,500	.26
	F	15.1	4,150	550	950	.58
	G	4.3	23,350	2,600	2,000	1.30
	H	8.4	5,300	650	1,400	.46

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "c"
[d] PHT/CAP Ratio - see text for explanation.
[e] Peak year of employment

Table 4.13-11 TRAFFIC PROJECTIONS FOR ROAN CREEK ROAD AND 16 ROAD FRUITA I, FRUITA II CONFIGURATIONS, 50,000 BPD

	ADT - Roan Creek Road[a,b]		ADT - 16 Road	
Year	FI	FII	FI	FII
1980	50	50	50	50
1993[c]	850	750	300	350
2000	800	650	250	300

[a] ADT = Average Daily Traffic
[b] FI = Fruita I Configuration
FII = Fruita II Configuration
[c] Peak year of employment

4.13.2.5 Solid and Hazardous Waste Disposal

Disposal of solid and hazardous waste by any of the methods proposed would not have a significant impact on the transportation systems of the area.

4.13.2.6 Secondary Impacts

The potential secondary impacts to transportation due to any of the project configurations at either production rate would come from induced population growth. These secondary transportation effects due to population increases were considered in the transportation impact analysis. As discussed above, most of the road segments analyzed would be able to handle the increased traffic without further improvements. Due to more road use, deterioration of road surface would likely occur more rapidly with project development. Road maintenance would need to be increased to alleviate these problems. A similar situation would occur for increased railroad traffic.

4.14 Cumulative Impacts

4.14.1 Introduction

Cumulative environmental impacts are those which result from the incremental impacts of an action added to other past, present, and reasonably foreseeable future actions, regardless of who is resposible for such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ 1978: 1508.7). As discussed in Section 1.6, this EIS addresses cumulative impacts of projects in the region of the CCSOP that (1) currently exist, (2) are currently being constructed, or (3) have a substantial commitment of resources at this time ($100 million dollars or more as of September 1982). These projects have been considered in the cumulative analysis of each discipline, as applicable. Figure 4.14-1 shows these projects.

The cumulative impacts for the CCSOP have been addressed for all disciplines in the same order as in Chapters 3.0 and 4.0.

4.14.2 Air Quality and Meteorology

Cumulative air quality impacts would result from the proposed CCSOP and other sources in the region. Issues include compliance with Prevention of Significant Deterioration (PSD) increments for sulfur dioxide (SO_2) and total suspended particulates (TSP), Colorado Category I increments for SO_2, National Ambient Air Quality Standards (NAAQS), and State of Colorado Ambient Air Quality Standards for SO_2, TSP, nitrogen oxides (NO_x), and carbon monoxide (CO). Additional information is available in the *Draft Supplemental EIS on the Prototype Oil Shale Leasing Program* and the appropriate amendments (BLM 1982b, BLM 1982k, BLM 1983a).

Background concentrations of CO, lead, NO_2, hydrocarbons, ozone, SO_2, TSP, and T_{15} (respirable particles less than 15 microns in diameter) are usually near or below the measurable limits (BLM 1982b). Exceptions are short-term concentrations of TSP (probably related to windblown fugitive dust), and ozone, possibly related to long-range transport from urban areas and/or to photochemical reactions with natural hydrocarbons.

To determine the contribution of additional industrial developments to air quality impacts in the region, pollutant concentrations were estimated by BLM (1982b) using the Topographic Air Pollution Analysis System (TAPAS). This system, comprised of several air quality computer models, predicts the resulting ground level concentrations by taking into account topography, ground cover, and meteorology as well as industrial plant emission characteristics (Dietrich et al. 1982).

Figure 4.14-1 shows the region modeled, new emission sources, and sensitive receptor locations. Table 4.14-1 lists the emission totals for sources located in Figure 4.14-1. Due to the general, preliminary nature of many of the sources shown on this figure, specific development details are lacking. Therefore, air pollutant impacts were modeled conservatively and generically. A worst-case analysis was performed.

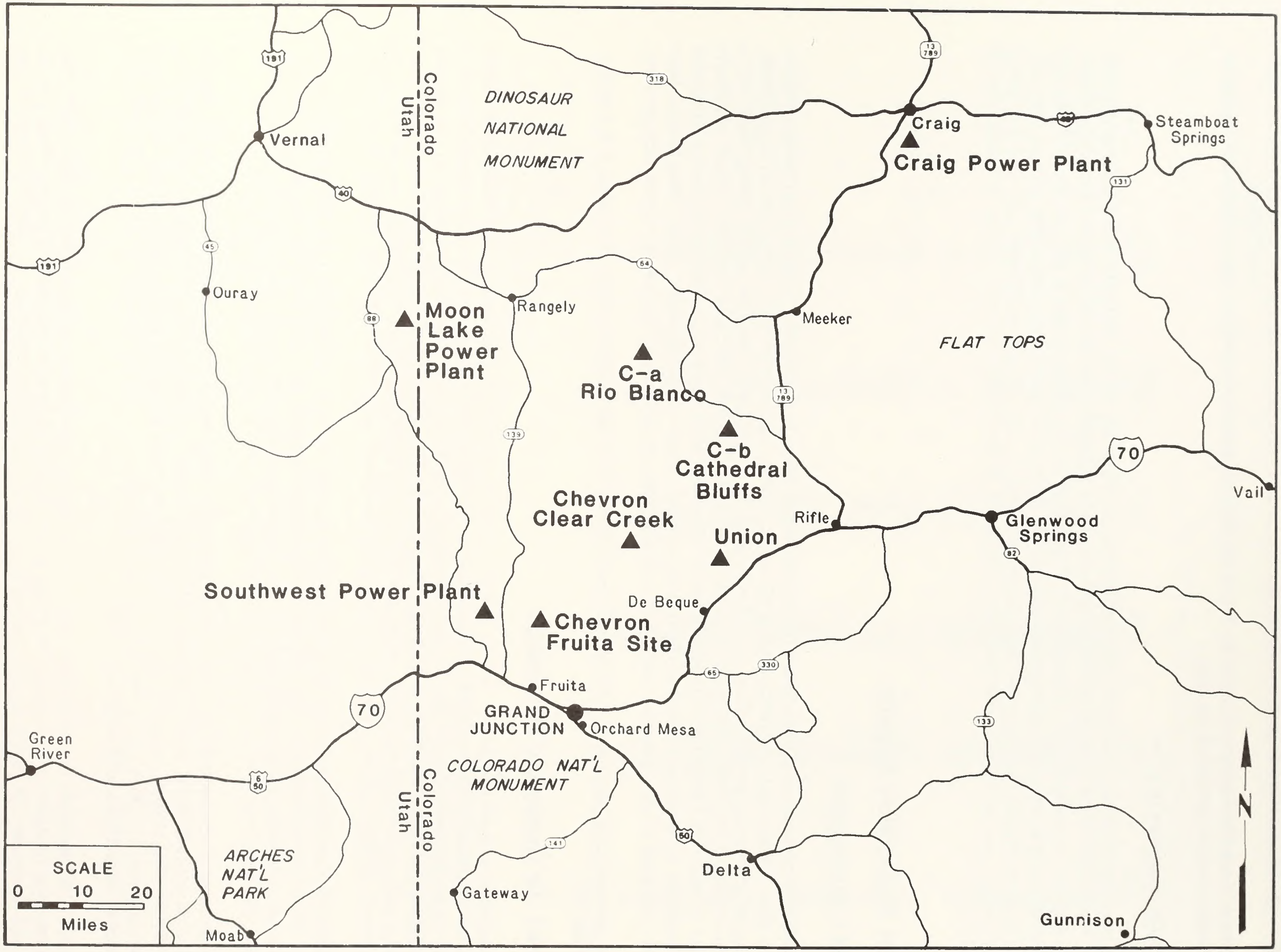


Figure 4.14-1 New Projects Assumed for Cumulative Impact Analysis

Table 4.14-1 TOTAL EMISSION ASSUMPTIONS FOR MODELED POINT SOURCES (g/sec)[a]

Source	1993 Low[b]			1993 High[b]			2003 Low[b]			2003 High[b]		
	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x
Colorado Synfuel												
Cathedral Bluffs	0	0	0	19	42	172	19	42	172	67	153	621
Chevron-retort-	0	0	0	77	51	516	77	51	516	154	101	1,031
upgrade	0	0	0	8	22	92	8	22	92	16	44	183
Colony	34	40	220	34	40	220	34	40	220	34	40	220
Mobil	0	0	0	0	0	0	0	0	0	50	66	194
Rio Blanco	0	0	0	39	14	117	39	14	117	78	28	233
Superior-Pacific	0	0	0	0	0	0	0	0	0	10	44	22
Union	10	13	39	50	66	194	50	66	194	90	120	350
Colorado Power Plants												
Craig	90	371	742	90	371	742	90	371	742	90	371	742
Hayden	23	348	245	23	348	245	23	348	245	23	348	245
Southwest	15	131	291	15	131	291	15	131	291	15	131	291
Utah Synfuel												
Enercor-Rainbow	4	3	3	4	3	3	4	3	3	4	3	3
Paraho-Ute	0	0	0	6	12	32	6	12	32	27	50	134
Syntana	0	0	0	11	11	62	11	11	62	36	36	206
Western	6	3	3	6	3	3	6	3	3	6	3	3
White River	8	6	34	27	19	115	27	19	115	55	38	230
Utah Power Plant												
Moonlake	31	53	281	31	53	281	31	53	281	31	53	281

Source: Dietrich et al. (1982b).

[a] Modeled emissions for varying stack heights appear in the supplemental impact analysis technical report (Dietrich et al. 1982b).
[b] High and low scenarios relate to the production rates as defined in Draft EIS for the Prototype Oil Shale Leasing Program and appropriate amendments (BLM 1982b, 1982k, and 1983a).

Table 4.14-2 summarizes the ranges of maximum 24-hour predicted concentrations at various receptor areas for TSP, SO_2, and NO_x from new sources in 2003. The upper range assumes a 24-hour meteorologically persistent condition while the lower range assumes less conservative 11-hour meteorological conditions. PSD Class I incremental SO_2 standards would be consumed in the Mt. Zirkel Wilderness Area while only the high range would consume the Class I PSD increment for TSP. The high range for Category I SO_2 increment would be consumed in Dinosaur National Monument. The PSD Class II areas of Roan Cliffs and the Grand Hogback would exceed the TSP increment for the low and high ranges, and consume the SO_2 increment in the high range.

Cumulative secondary impacts due to population growth would affect air quality. Corresponding emission rates were estimated using the percent contribution (Table 4.14-3) of direct and indirect emission rates related to oil shale development (PEDCO 1982). Percent contributions of the production years of 1990 and 2000 were applied to the individual source emission rates that are presented in Table 4.14-1. The results are compiled in Table 4.14-4.

Due to the preliminary nature of the emission rates and worst-case senarios, air pollutant concentration estimates were modeled using conservative calculations developed by Turner (1970). The assumptions developed for this worst-case analysis are:

- The direct distance between sources and receptors are calculated without terrain considerations.

- The 24-hour wind direction persists at 4 meters/second and is under stable conditions.
- All emissions are ground level releases with no effective height.
- The plume centerline concentrations are calculated.
- No particulate deposition occurs.

The resulting values indicate a relative potential impact to air quality, especially total suspended particulates. As shown in Table 4.14-3, particulates directly attributable to oil shale development make a small contribution (less than 20 percent of the total) to the total air quality emissions. The increased secondary emissions of TSP from additional vehicles on unpaved roads and wood fires would contribute over 80 percent to the overall emissions. Gaseous emissions of SO_2 and NO_x from residential heating and combustion engines, however, would have only a slight adverse effect when compared to the various oil shale point sources, and in most cases remain below all applicable federal standards.

Table 4.14-2 MAXIMUM 24 HOUR PREDICTED POLLUTANT CONCENTRATION RANGES (micrograms/cubic meter), 2003 HIGH LEVEL SCENARIO[a]

Sensitive Areas	TSP	SO_2	NO_x
Class I Areas			
Flat Tops Wilderness	6-13[b]	5-12[b]	23-55
Mt. Zirkel Wilderness	0-1	6-15[b]	4-11
Category I Areas			
Dinosaur National Monument	2-5	2-6[b]	12-28
Class II Areas			
Roan Cliffs	143-343[c]	45-109[c]	(313)-(752)[d]
Grand Hogback	52-124[c]	40-95[c]	(145)-(347)
PSD Increments			
Class I Increments	10	5	-
Class II Increments	37	91	-

Source: Dietrich et al. (1982b).

[a] High level scenario as defined in Draft EIS for the Prototype Oil Shale Leasing Program and appropriate amendments (BLM 1982a, 1982k, and 1983a).
[b] Value violates Class II PSD increments.
[c] Value violates Class I PSD increments.
[d] Parenthetic values compare 24 hr concentrations to annual Ambient Air Quality Standards for NO_2.

4.14.3 Noise

No cumulative noise impacts are expected in the region, except for possible increases in noise due to vehicle and rail transport and increased populations.

Table 4.14-3 PERCENT CONTRIBUTION OF DIRECT AND INDIRECT EMISSIONS RELATED TO OIL SHALE DEVELOPMENT

	Percent Contribution	
	Direct	Indirect
Total Suspended Particulates		
1990	15.1	84.9
2000	19.4	80.6
Sulfur Dioxide		
1990	96.3	3.7
2000	96.7	3.3
Oxides of Nitrogen		
1990	92.4	7.6
2000	94.4	5.6

Source: Pedco (1982).

Table 4.14-4 TOTAL EMISSION ASSUMPTIONS FOR SECONDARY POINT SOURCES (g/sec)[a]

	1993 Low			1993 High			2003 Low			2003 High		
Source	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO^x	TSP	SO_2	NO^x
Colorado Synfuel												
Cathedral Bluffs	0	0	0	107	2	14	79	1	10	278	5	37
Chevron-retort-	0	0	0	433	2	42	320	2	31	640	3	61
upgrade	0	0	0	45	1	8	33	1	5	66	1	11
Colony	191	2	18	191	2	18	141	1	13	141	1	13
Mobil	0	0	0	0	0	0	0	0	0	208	2	10
Rio Blanco	0	0	0	219	1	10	162	0	7	324	1	12
Superior-Pacific	0	0	0	0	0	0	0	0	0	42	1	1
Union	56	0	3	281	3	16	208	2	12	374	4	21
Colorado Power Plants												
Craig	506	14	61	506	14	61	374	13	44	374	13	44
Hayden	129	13	20	129	13	20	96	12	15	96	12	15
Southwest	85	5	24	85	5	24	85	5	24	85	5	24
Utah Synfuel												
Enercor-Rainbow	22	0	0	22	0	0	17	0	0	17	0	0
Paraho-Ute	0	0	0	34	0	3	25	0	2	112	2	8
Syntana	0	0	0	62	0	5	46	0	4	150	1	12
Western	34	0	0	34	0	0	25	0	0	25	0	0
White River	45	0	3	152	1	9	112	1	7	229	1	14
Utah Power Plant												
Moonlake	174	2	23	174	2	23	129	2	17	129	2	17

[a] High and low scenarios relate to the production rates as presented in the Draft EIS for the Prototype Oil Shale Leasing Program and appropriate amendmens (BLM 1982a, 1982k, 1983a).

4.14.4 Water Resources

Surface Water

The cumulative impact of withdrawal of large quantities of water from the Colorado River system for development activities can be expected to result in stream flow depletion for the Colorado River, especially during low flow periods. The CCSOP by itself is projected to have an ultimate water withdrawal of approximately 25,000 acre-feet from the Colorado River. When taken in conjunction with the other withdrawals for the GCC Roan Creek reservoir, the Colorado River stream flow depletion at De Beque would amount to 10.0 percent of the mean annual flow if the maximum amounts of water are withdrawn. Salinity of the Colorado River would increase to some extent for average flow conditions due to this water withdrawal. The cumulative impacts on water quantity and quality due to water withdrawals by this and other projects from the Colorado River would affect present and future water users.

Similarly, cumulative water withdrawals would impact the available share of water consumption for Colorado. Based on the 1979 depletions in Colorado of 1,785,000 acre-feet, the remaining water available for Colorado (according to the Upper Colorado River Compact of 1948) would be 1,191,000 acre-feet. Water withdrawal for the CCSOP is projected to constitute an additional 2.1 percent of the available share of consumption for Colorado. Under appropriate economic conditions, other oil shale development could be expected to increase considerably, and demand substantially more water from the Upper Colorado River system. As much as 955,000 acre-feet of water has already been committed to future use in Colorado through various planned and authorized water projects (BLM 1975).

Ground Water

Cumulative impacts to ground water are not expected to be significant. Owing to the hydraulic isolation of the CCSOP and other oil shale properties, significant cumulative impacts are not anticipated. Potentially important regional aquifers above and below the oil shale zone were not encountered on Clear Creek mesa nor at the alternative Grand Valley site. Proposed and alternative pipeline corridors should not affect these water-bearing bedrock units.

Localized cumulative impacts may occur should additional oil shale development occur immediately adjacent to the Clear Creek site. Such impacts are grouped as (1) water quality related, and (2) water quantity (dewatering) related.

As discussed in Section 4.4.2, some increases in total dissolved solids (TDS) may occur as a result of mining and spent shale disposal. Given that mining and disposal would not directly disturb important regional aquifers (Upper and Lower Parachute Creek Aqiufers, and alluvial system systems), impacts to regional water quality should be negligible.

Dewatering impacts to regional bedrock aquifers are not expected. Locally, the proposed well field system to pump water from Clear Creek alluvium would reduce water levels in this aquifer. A decrease in the saturated thickness of the alluvial aquifer may result in water level decreases in the range of 7 to 20 feet. This decline could be accelerated if additional withdrawal occurs to support any adjacent oil shale development.

4.14.5 Topography, Geology, and Paleontology

Topography

Cumulative impacts to topography in the region would occur from construction activities, infrastructure development, and associated land use changes. Compared to the topographic features of the entire area (Figure 4.14-1), any changes to the topography due to the projects under consideration would be minimal, hence the impact insignificant. In the case of CCSOP mining operations, proper reclamation techniques would further reduce any impact to the region's topography.

Geology

Cumulative geologic impacts associated with development of the CCSOP and other projects in the area would consist of both increased energy consumption and production. The development of shale oil as an energy source would result in a permanent loss of this energy resource but would provide energy to the region and nation. For project development and related infrastructure development, additional energy sources (coal, oil, and gas), as well as construction-related minerals (sand and gravel, building stones, and clay) would be required and permanently committed to the various projects.

Paleontology

Cumulative impacts to paleontological resources within the region would include improving access to remote areas and potential exposure of fossil bearing strata during construction and operational activities. Cumulative impacts to paleontological resources are not predicted at this time.

4.14.6 Soils

The cumulative impacts of development on the soil resources of the region would be most significant (in terms of productivity lost) when considering prime farmland soils. It is estimated that some prime farmland acreage would be lost, mostly as a result of secondary development activities. Additionally, wind and water erosion during the construction of housing and community facilities may result until proper stabilization has occurred. Losses to soil productivity would occur due to project construction and operational activities for each of the alternatives considered. In some instances (e.g., surface mining), such productivity loss would be large in terms of acreage, but take place on relatively unproductive (i.e., rangeland) soils. Additionally, the productivity loss on these soils would be temporary and would be restored upon reclamation. In other instances (e.g., residential development) lost acreage would be much smaller but the loss would be permanent.

Acid rain would affect soil properties such as pH, electrical conductivity, and sodium content. The actual impact upon these soils, which typically have a pH in excess of 7.4 (except at some of the higher elevations of the project area), is expected to be minimal because of the buffering capacity.

Potential cumulative wind erosion impacts on adjacent undisturbed land up to 100 yards away from disturbed areas would be minimal compared to the total acreages of cropland or rangeland that exist in the Piceance Basin.

4.14.7 Aquatic Ecology

The most significant cumulative impacts to aquatic resources are likely to be those associated with water consumption due to intake diversions and secondary growth. Depending on operation of the GCC diversion and the Loma diversion, reductions below minimum flows needed for protection of endangered species, as suggested by Miller et al. (1982), are possible. When diversions proposed for other oil shale projects, power plants, and domestic water supplies are considered, flows below recommended flows become likely.

Additional pressures and resulting impacts on the recreational fisheries resources can also be expected due to the increased population. However, the CCSOP only accounts for about 50 percent of population growth in the region which is expected over the life of the project (Section 4.12). Thus, the magnitude of these secondary impacts described in Section 4.7 will be considerably greater than would be the case if only the CCSOP were considered.

4.14.8 Terrestrial Ecology

Vegetation

The cumulative impacts on the vegetation types of the region are insignificant except for agricultural lands along the Colorado River and its tributaries. Agricultural productivity would be affected due to off-site developments that would be concentrated along the major transportation routes which, in this area, are agricultural valley bottoms. Long-term and residual impacts may be anticipated with respect to the roles that vegetation plays in regional ecosystem productivity and carrying capacity for livestock and wildlife, ecosystem structure, and processes such as soil development.

Cumulative impacts to threatened and endangered plants are not expected to be significant on a regional basis. A study of these impacts, including a field data acquisition effort, is presently in progress under the direction of the Colorado Department of Natural Resources.

Wildlife

Cumulative effects of development in this area may reduce regional carrying capacity for most wildlife; however, wildlife species composition may not change significantly within direct areas of impact. Widespread displacement of wildlife to adjacent, less impacted areas of their range and modification of their movements and seasonal patterns of habitat use are likely. Big game abundance may be reduced in response to increased levels of human activity, including operational noise, off-road vehicle use, poaching, and harrassment on winter ranges and during critical periods such as fawning and calving. Increased regional demand for hunting and other wildlife recreation opportunities would result in increased hunting pressure and harvest. Consequently, the demand for specific types of wildlife-related recreation may not be met.

Cumulative impacts to endangered wildlife species are not expected to be significant on a regional basis. Although the potential for mitigation through siting and activity buffer zones exists, the practicality and potential effectiveness of these measures are difficult to assess over the life of the CCSOP, during which time a significant amount of energy and related project development is planned.

Prairie dog towns which could support black-footed ferrets could be directly and indirectly affected by industrial and community development. Also, bald eagle use of riparian habitats along the Colorado River may be reduced in response to significantly increased levels of human activity and harrassment. Compression of the present winter range of this species from Parachute to Fruita may result in a decline in the number of bald eagles in the region.

Finally, loss of peregrine falcon hunting habitat and potential nest sites may restrict the potential success of future reintroduction efforts in this area. As concentrated oil shale development occurs in the vicinity, increased levels of human disturbance, habitat loss, and operational noise may preclude the peregrine falcon from this area.

4.14.9 Visual Resources

Cumulative effects of development in the region would result in alteration of the visual setting of the region. Construction of several large-scale energy resource, mineral, and industrial development projects would alter the existing landscape and pose sharp contrasts within the rural character of the region. The aesthetic experience of visitors and residents in the region would be permanently altered.

4.14.10 Cultural Resources

Cumulative impacts to the cultural resources within the region from increased natural resource development may be significant. Impacts resulting from physical construction of energy, mineral, and industrial development can be mitigated according to provisions of 36 CFR 800. Problems arise, however, as a result of increased populations in the area in conjunction with improved access to previously undisturbed remote areas. Increased vandalism and unauthorized collecting associated with recreational activity and other pursuits may occur. The potential exists for inadvertent destruction of unknown sites which have not previously been recorded, as well as purposeful destruction of known sites.

4.14.11 Land Use, Recreation, and Wilderness

Changes in regional land use patterns, recreation, and wilderness use would result due to the cumulative effects of several large-scale projects. Populations relocating to the area would demand that new housing and community services and facilities be developed, creating changes in current land use patterns. Increased numbers of people would create increased demands for recreational and wilderness opportunities. Developed recreational sites would receive additional use, possibly overloading capacities, or stimulating expansion.

Perhaps the most significant cumulative effect, however, would be changes in current land use patterns, particularly in areas along valley floors. The region in and adjacent to impacted communities would begin to exhibit characteristics of urbanization; that is, increased population densities, greater numbers of residential and commercial structures, and increased traffic. Urban functions would encroach upon what is now predominantly rural, open space and irrigated and nonirrigated cropland. However, most growth would continue to occur in or near existing urban areas, primarily because of infrastructure requirements.

4.14.12 Socioeconomics

Constructing and operating several natural resource and energy-related projects within the region would create a number of cumulative social and economic impacts. It is anticipated that, with enhanced development, population levels in the region would increase dramatically by the year 2000. Growth associated with industrial development would bring with it opportunities and potential problems.

Employment opportunities within the region would increase due to constructing and operating several projects simultaneously. Significant increases in the nonlocal population base would occur. The region's economic structure would inevitably become more dependent on mining and construction activities. Total personal income would grow significantly, primarily because of high annual earnings projected for energy-related workers, accompanied by increased local spending and economic activity. Increased competition for workers among economic sectors, particularly agriculture, would take place as a consequence of increased development.

Social impacts within the region would occur at rates equivalent to increases in populations. The kinds of problems occurring would most likely be those commensurate with the lifestyles of single-status construction personnel. Rural areas of the region would be more directly impacted than urban centers. The loss of rural lifestyles, which has been occurring for over a decade, would also continue. Increased population and congestion would confront area residents over the next several decades. However, social diversity would be enhanced with the new project.

The service and capacity thresholds for many communities have already been reached, and several of these communities have carried out planning processes, explored financing options, scheduled or built facilities, or instituted new programs to meet service demands. The addition of new populations beyond those resulting from the CCSOP would accelerate this changing situation and create a number of demands on both existing and planned structures. This would be particularly evident in the case of water and sewer systems, and local school systems. However, a number of communities' services facilities have been designed to accommodate population levels that would be associated with several projects of the magnitude of the CCSOP (i.e., Ute Water Conservation District and Battlement Mesa Inc.).

The housing construction industry should be able to meet increased housing demand brought about by several simultaneous projects. The industry may require incentives to build speculative housing because of uncertainties created by previous energy industry delays and shutdowns within the region. The affordability of housing would remain a regional concern for low and middle income groups, including seniors.

Financial effects of projected growth on local governments would probably be most positive for the counties which would benefit from direct increases in their tax bases from the projects. Smaller municipalities, who have not expanded for growth, could possibly have financial difficulties stemming from capital expenditures which have already been planned, mostly to correct existing deficiencies.

4.14.13 Energy and Transportation

Energy

The cumulative impacts on the area's energy balance would result from increased consumption and increased production. The net effect of most reasonably forseeable future actions (e.g., oil shale projects) would be a net increase in the amount of energy available to the region and to the nation. The cumulative impacts of energy consumption would potentially require expansion of existing energy production and distribution facilities. The net impact would be positive since these additional production and distribution capabilities would improve the opportunities for growth within the region.

Transportation

The cumulative effects of assumed projects would add additional pressures to existing transportation systems and potentially result in more traffic congestion, accidents, and road repair costs. Road, railroad, air traffic, and pipeline improvements would be necessary to accommodate increased transport requirements. The cumulative effects of road and rail traffic would increase maintenance time and costs on these systems. However, a beneficial positive effect would occur due to the expansion of the transportation facilities. Once expanded, these facilities would be available for other uses following project closures.

4.15 Unavoidable Adverse Impacts

Implementation of the CCSOP would create a number of unavoidable adverse impacts, as would any proposed development of this magnitude.

The following items include the unavoidable adverse impacts identified during analysis of the project.

- Degradation of air quality
- Increased noise levels
- Alteration of stream drainage channels from their existing physical configurations and flow conditions
- Loss of up to 25,000 acre-feet of water in the Colorado River
- Loss of oil shale deposits
- Alteration of natural geologic, topographic, and ground water conditions
- Loss of soil material and a decrease in soil productivity
- Losses in established plant cover
- Loss of terrestrial and aquatic habitat for wildlife and fish
- Loss of wildlife and fish
- Adverse impacts to several candidate threatened or endangered plant species
- Loss of two relatively large populations (greater than 100 individuals each) of the Uinta Basin hookless cactus in an area of approximately 200 acres
- Reduction of regional carrying capacity for deer and elk
- Loss of recreational opportunites as a result of lowered deer and elk densities in the region

- Alteration of scenic (visual) conditions in the area, either through degradation of air quality or construction of project facilities
- Potential loss or destruction of undiscovered archaeological or paleontological (fossil) resources
- Changes in rural lifestyles in the area
- Increase in unauthorized occupancy and use of public and private lands
- Potential losses of prime farmland due to secondary population growth
- Increased use and possible degradation of area recreation and wilderness resources
- $6-10 billion investment
- Energy use in the development and operation of the project
- Increased use of area roads and railroads with possibilities for more traffic accidents involving humans and wildlife accompanied by increased noise, dust, and related impacts

4.16 Irreversible and Irretrievable Commitments of Resources

The CCSOP would involve irreversible and irretrievable commitments of various resources that are either consumed, committed, or lost during the life of the project. Use of many resources is required in the extraction and refinement of raw materials in a manner that meets the proponent's financial and the public's consumptive needs. The irreversible and irretrievable commitments of this project would include the following.

- Air quality degradation, which may never be remedied and restored to its present state
- Ground and surface water impacts which may never be reversed or corrected, or returned to their present state
- Mining of 275,000 tons per day of raw oil shale for the 90-year project life
- Permanent topsoil losses due to erosion
- Loss of established plant cover for corridors, plant sites, and related facilities
- Wildlife losses, in terms of habitat and individuals
- Degradation of scenic quality
- Loss of archaeological, historical, and paleontological resources due to accidental disturbance or mitigation activities so that the resources can never be recovered, remedied, or restored to their present state
- Loss of approximately 640 acres of prime farmland

A number of the irreversible and irretrievable commitments indicated above would be minimized or mitigated as a result of regulatory agency authority described in Chapter 1.0. Likewise, the Operator has made and will make further commitments to minimize these irreversible and irretrievable losses which are not governed by specific agency authority. Section 4.18 presents these committed and uncommitted mitigation measures.

4.17 Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

According to BLM policy (BLM 1981d: IV, p. 45; BLM 1982b: Appendix, p.4) the local short-term impacts of the project (i.e., current impacts through major construction activities) would cover the 17-year period from 1982 to 1999. Short-term uses of man's environment by the CCSOP would occur during this period. Long-term project impacts would occur over about 100 years (90-year project life plus 10 years), or until 2082.

The major short-term and long-term considerations are as follows.

- Short-term
  - Effects on air quality and local climate
  - Alteration of existing surface and ground water conditions
  - Effects on wildlife, vegetation, and soils in the project vicinity
  - Loss of fish and wildlife
  - Visual and noise impacts
  - Cultural resources (archaeological, paleontological, historical) impacts due to construction, operation, and secondary growth
  - Changes in land use patterns
  - Losses of small acreages of prime farmland
  - Increased uses of area lands, and recreation and wilderness opportunities
  - Socioeconomic impacts, local and regional
  - Project uses of energy and transportation facilities
- Long-term
  - Productive use of oil shale deposits
  - Revegetation of approximately 22,650 acres following project closure
  - Increased population, with the accompanying urban amenities
  - Economic growth (both primary and secondary) locally, regionally, and nationally
  - Production of 100,000 bpd of shale oil for the 90-year project life
  - Associated national security/energy independence

The short- and long-term impacts presented above and the reactions and values they elicit in various individuals, groups, organizations and agencies were compared and weighed by BLM in selecting the agency preferred alternative. The BLM considered the possible positive and negative attributes of each impact, taking into consideration various points of view.

4.18 Mitigation

Mitigation is defined as avoiding, minimizing, compensating, rectifying, reducing, or eliminating an adverse environmental impact (BLM 1981d). The mitigation measures presented in this section are actions that could reduce or eliminate the impacts identified in Sections 4.2 through 4.13.

Two types of mitigation measures are presented: (1) committed — resulting from procedures outlined in the Operator's Proposed Action or the requirements of state, federal, or local laws and regulations regarding project development and (2) uncommitted — suggested measures to be considered by the applicant, or by regulatory agencies in their permitting processes. The latter measures are proposed in consideration of economic, technical, and political feasibility.

Regarding committed mitigation required by regulatory agencies, the BLM can require and enforce mitigation measures only on BLM-administered land (not on private land), except in cases where a federal law provides specific authority. Measures may also be required and enforced by BLM if the measure is designed to mitigate an impact that could affect BLM-administered land. Authority for other federal requirements is given under various laws and regulations.

All mitigation measures presented in Appendix C-1 are given as they pertain to impacts for various environmental disciplines (e.g., ground water, wildlife). Starred (*) activities in Appendix C-1 are those to which the Operator is committed. Mitigation for each of these activity areas is identified as applicable to construction, operation, or reclamation. Socioeconomic mitigation is presented in Appendix C-2 by subject area (e.g., housing).

4.18.1 Discipline-Specific Mitigation Measures

The following statements summarize recommended mitigation in each discipline as applicable to the CCSOP alternatives.

Air Quality and Meteorology

No specific mitigation is proposed, aside from regulatory requirements and proposed project development activities.

Noise

Mitigation for primary and secondary noise impacts is generally included with the Proposed Action.

Water Resources

The primary overall impact to ground and surface waters would be contamination in the form of TDS, TSS, and nonhazardous wastes by surface runoff or ground water flowing through disturbed areas, or by pipeline or other toxic spill material entering stream courses. The mitigation of such impacts would include: (1) proper routing of all surface flows around disturbed areas, (2) sedimentation ponds at points downstream of all disturbance areas to reduce TDS and TSS, (3) contingency plans for handling all accidental spills, (4) use of sediment control measures where appropriate, and (5) prevention of spent shale leachate from entering surface and ground water systems.

Topography

Most topographic impacts would be associated with changes at the mine site, facilities sites, reservoir sites, and project corridors from construction through reclamation of the project. In general, measures to reduce these impacts would include (1) avoidance; (2) proper engineering design of open pit slopes, spent shale piles, reservoir embankments, cut and fill slopes, landfills and other features; and (3) adherence to a reclamation plan that requires proper contouring.

Geology

Geologic impacts would result from disruption of site stratigraphy and extraction of the shale oil resource. Landslides, slumping, and/or other mass-wasting processes could occur from cut/fill activities at the mine site, facilities sites, reservoirs, spent shale disposal areas, and transport corridors. Mitigation measures to reduce these impacts would include: (1) avoidance of areas on stratigraphic units exhibiting instability; (2) proper engineering evaluation including geotechnical assessments of the geologic setting prior to construction; (3) design of proper drainage systems to minimize slope surcharging (overloading) by ponds or undercutting by running water; and (4) reclamation of temporary and (where appropriate) permanent features, to minimize potential for man-induced instability.

Paleontology

Impacts to Paleontological resources would result from disruption of fossil-bearing strata during construction of project facilities, reservoirs, disposal areas and transportation networks, and from the actual mining of the oil shale. Surface mining of oil shale would create the highest potential for impact. Additional impacts may be experienced locally during associated infrastructure development.

In general, measures to reduce these impacts would include (1) avoidance of known fossil collection sites and (2) survey of suspected fossil-bearing strata during construction, operation, and reclamation of the project. Fossil finds encountered during the course of the project would be brought to the attention of the proper federal and state agencies.

Soils

Impacts to soils would occur as erosion losses, losses of prime farmland, changes in soil profile characteristics, and losses of soil cover and productivity. Mitigation of incremental erosion losses would largely be accomplished through the reclamation described in Section 2.3. Erosional impacts not specifically mitigated in this plan would include: (1) erosion of the reclaimed spent shale pile interbench slopes, and (2) streambank or hillside erosion by pipelines, roads, or other types of disturbance. Mitigation measures applicable to these impacts would include retention of an on-site reclamation specialist who could monitor development activities and suggest mitigation such as (1) reducing slope of reclaimed interbench sideslopes, (2) revegetation, and (3) application of wind and water erosion control measures (asphalt emulsifiers, netting, contour furrows, and pitting). Compensation would probably be the least costly method of mitigating prime farmland losses. Stockpiling and replacement of available cover soil would reduce changes to soil profile characteristics; however, duration of burial should be minimized during operational phases.

Aquatic Ecology

Construction practices which would minimize sedimentation and disturbance of riparian vegetation were assumed during impact assessment. However, construction impacts could be further mitigated if stream crossings and other activities potentially impacting surface waters were conducted at times of the year least critical to biological activity. Avoidance of fish spawning periods would be especially desirable.

The BLM may require changing the route of the Rangely B pipeline in order to protect a population of Colorado River cutthroat trout.

Impacts associated with stream depletion could be mitigated by minimizing water withdrawals during low flow periods, and by providing for minimum releases from reservoirs proposed for Roan Creek and Big Salt Wash. Minimum releases should be established on the basis of a stream flow model developed for the purpose of protecting aquatic biota, such as that developed by the Instream Flow Group of the Fish and Wildlife Service (Horton and Cochnauer 1980).

Direct impacts to aquatic biota at the De Beque water diversion could be substantially reduced by design modifications. Reduction of intake velocity to less than 1 foot per second would substantially reduce losses of larger organisms (EPA 1976b). Elimination of the weir would reduce attraction of fish to the intake site.

Addition of travelling screens modified for fish transport to the diversion design would also reduce losses. The feasibility of unconventional diversion designs making use of infiltration dikes (Schrader and Ketschke 1978) or wedge wire screens (Smith and Ferguson 1979) should also be considered.

Planning for improbable yet serious impacts, such as spills associated with vehicle accidents and pipeline breaks, would likely reduce the magnitude of the impacts. Specific spill cleanup plans, storage of cleanup equipment and supplies on site, personnel training programs, and pipeline construction with frequent check valves to limit the size of a spill are examples of such planning.

Impacts to aquatic biota could, in part, be off set by compensatory development of aquatic habitat. Construction and operation of water storage reservoirs in a manner which would allow development of a viable aquatic community offers considerable opportunity in this regard. Habitat improvement projects, stocking programs, and other procedures could also be undertaken in nearby, unaffected water bodies.

Terrestrial Ecology

Vegetation. Impacts to vegetation from construction and operation activities would include permanent loss of threatened and endangered plant species populations and habitat, loss of riparian habitats and wetland, and loss of rangeland and cropland productivity. Impacts to candidate or listed threatened or endangered plant populations and their habitats could be partially avoided by routing project facilities around them. Since the primary cumulative impact to rare cacti would be the collection of specimens for commercial horticultural purposes, direct impacts to these plants could be compensated for by the restriction of access to undisturbed populations on CCSOP controlled land. Transplanting, artificial propogation, and re-establishment of habitat for threatened and endangered plants would be relatively costly mitigation measures which are uncertain of success. Direct impacts to wetlands could be effectively mitigated by avoidance of disturbances in riparian areas. Since irrigated croplands are much more productive of forage than surrounding areas, avoidance of these areas would significantly reduce impacts or productivity. Revegetation employing native plant species would mitigate the loss of stable and productive plant communities.

Wildlife. The quality of wildlife habitats in affected areas would be reduced as a result of surface disturbance and vegetation removal. Siting options for major facilities and within corridors should be exercised to the fullest extent feasible to maintain sensitive wildlife habitats and other important areas of wildlife use, including movement corridors. Riparian, wetland, and aquatic habitats could be maintained or enhanced through use of siting options. Activity buffer zones could be established for bald eagle roost sites, sage grouse leks, and raptor nest sites to minimize disturbance during critical periods. Initial construction could also be timed to avoid critical nesting (raptors and sage grouse) and concentration (bald eagle and big game) periods. Construction on big game winter range could be avoided during December-April, and during May-July on spring ranges.

Effective wildlife mitigation features could be incorporated into the project design including electrocution-proof transmission lines, fencing of highways, and use of underpasses and one-way deer gates where existing deer movement corridors transect proposi]ed roads. Road kill losses could also be minimized through use of mass transportation of workers and strict control of vehicle speeds.

During the construction and operational phases of the project, off-site habitat enhancement measures including chaining, brush beating, clear cutting and selective thinning of forest stands, nitrogen fertilization, and adjustment of grazing pressures could be undertaken to mitigate lost big game carrying capacity. The value of affected areas following project closure and subsequent reclamation would depend on restoration of existing patterns of topographic and vegetational diversity, habitat interspersion, and sources of free water.

The above suggested mitigation measures for wildlife impacts are extensive and may be costly. The level of detail is based in part on recent meetings concerning the U.S. Fish and Wildlife Service Coordination Act report and BLM Biological Assessment.

Visual Resources

Facilities and corridors would alter the character of the local landscape by introducing form, line, color, and texture. Form impacts can be reduced in some areas through design and siting, but for the most part cannot be mitigated. Reclamation of disturbed areas would reduce and, in some cases, eliminate color impacts, but only for corridors with pipelines. Line impacts within corridors could be reduced by constructing corridors to complement existing landscape line; if reclamation is successful, little or no line impact would remain. Mitigation of texture impacts would depend on the success of reclamation efforts.

Cultural Resources

Cultural resource mitigation would involve implementation of cultural resources surveys, as necessary, in advance of construction activities. The BLM will consult with the Colorado State Historic Preservation Officer, and the Advisory Council on Historic Preservation concerning possible mitigation measures for sites eligible for the National Register of Historic Places. Types of mitigation would include excavation and analysis, avoidance of disturbance, and recording through photographs, drawings, or collection prior to disturbance.

Socioeconomics

Several mitigation measures have been assumed as part of the social and economic analysis, including the 1,500 person single-status camp and the Operator's plan to encourage employee location in areas that can best accommodate growth. These measures could substantially reduce the problem of temporary housing for construction personnel. Other impacts that could be reduced or ameliorated by mitigation are fiscal shortfalls prior to the onset of project-related revenues, and potential increases in demand for human and social services.

The Operator's general approach to mitigation of social and economic impacts of the CCSOP is described below. More specific cooperative actions which the Operator would take in mitigating social and economic impacts are described in Appendix C-2. The actual selection and implementation of specific mitigation programs would be based upon negotiations with local officials at the time of project development.

- The Operator believes that government has the responsibility to provide public services and facilities to both new and existing residents. The Operator recognizes that its project-related growth could aggravate the problems of providing these services and facilities in a timely fashion. The Operator proposes to work cooperatively with government officials to help ensure that financing would be available to meet these needs.

- The Operator believes that growth resulting from the CCSOP would generate adequate revenues to pay its own way; the Operator proposes to work with affected local governments to identify policies which would enable this to happen.

- The Operator proposes to encourage employees to locate in communities with current or planned infrastructure capacity to absorb new growth. This could require various types of incentive programs to ensure the timely availability of housing in certain communities. This would allow growth to occur in the areas with the best capacity to absorb growth without exceeding the capacity threshold of their public facilities.

- Emphasis would be placed on balancing population growth with the tax base. Those areas with a substantial sales or property tax base would be best equipped to respond to growth. As appropriate, the Operator proposes to work cooperatively with government officials to ensure that adequate financing would be available at the front end to provide necessary services and facilities.

- A key factor considered in determining the spatial allocation has been the desire by the Operator to minimize the number of affected communities. The Operator can thereby target its mitigation efforts and develop more comprehensive effective strategies rather than diluting its efforts over numerous communities. The Grand Valley area and Battlement Mesa Planned Unit Development have been identified as areas where the Operator's growth and mitigation efforts would be concentrated.

- The Operator is aware that some infusion of capital into local financial institutions could be needed so that private capital construction such as housing and commercial development could occur. Similarly, in order to achieve its spatial allocation goals, the Operator would use incentives both for the housing industry and for employees.

- The Operator proposes to emphasize quality in all aspects of its mitigation efforts. In particular, through incentives offered to private developers, quality in design of housing and residential development would be stressed, so that desirable and enjoyable living environments are created for new and established residents alike.

- Another characteristic of the Operator's mitigation efforts would be to place emphasis on providing technical assistance to local governments to increase their capability to manage growth. The Operator proposes to work with local governments and entities to identify impacts attributable to the CCSOP and possible solutions.

- The analysis of the socioeconomic study resulted in estimates of potential impacts. However, in order to ensure that the impacts reflect actual conditions, the Operator proposes to develop a monitoring program in conjunction with local governments and agencies.

- The Operator proposes to provide regular employment estimates and updated scheduling information. The Operator would also provide information to new employees concerning the availability of housing and public services.

- The Operator recognizes that the delays and uncertainties associated with the shale industry could make it more difficult to use traditional financing mechanisms, such as bonding, for public facilities. These could also inhibit the private sector from building housing on a speculative basis. The Operator recognizes this problem, and would make the necessary commitments or guarantees to ensure that adequate facilities and services would be in place in time to serve the new population.

- The Operator proposes to continue its cooperation with the Cumulative Impacts Task Force (CITF), the Colorado Joint Review Process (CJRP), and local government agencies.

Land Use, Recreation, and Wilderness

These impacts would result primarily from increased population in the project and vicinity. Proper planning, use of regulatory controls such as zoning, and restriction of access to recreation and wilderness areas may be required to minimize degradation from overuse. The BLM may require the Rangely B pipeline route to be changed to protect a population of Colorado River cutthroat trout. The BLM is currently enforcing a "no-surface occupany" stipulation on a portion of the proposed pipeline route.

Energy

Mitigation for energy impacts differs somewhat from the mitigation for other strictly environmental discipline sources. Power requirements of the project must be met to allow for project development. Mitigation of any impacts to the present energy network may be accomplished by cogeneration, construction of additional power generating sources (e.g., Colorado-Ute Southwest Plant), or expansion of existing services utilizing power from other areas. Any of these options must meet both engineering and regulatory criteria for construction.

Transportation

Mitigation measures to reduce impacts to the transportation network would include road construction and improvements, land use planning, implementation of a mass transit system, and shift scheduling. Road improvements would include work on the Roan Creek Road and other roads as necessary. Road improvement plans could be developed in cooperation with government entities. Planning efforts could be implemented (with local government) to accomodate necessary railroad facilities and transhipment activities on land owned by the Operator. Additionally, if a bypass around De Beque to connect to I-70 becomes necessary, planning efforts could be undertaken in conjunction with De Beque authorities. A bus system or alternative mass transportation system could reduce the effects of the workforce on roadways. The system could have pickup points in both counties. Varying shift schedules could also minimize conflicts with other traffic using the regional transportation system.

4.18.2 Reclamation Potential

One of the most significant impacts of the CCSOP would be surface disturbance due to mining and associated facilities; therefore, reclamation would be an extremely important mitigation measure.

A relative assessment of the reclamation potential was performed on the siting alternatives and major project configurations. This assessment also facilitates comparison of reclamation potential among various components of the alternative packages (e.g., the La Sal pipeline route compared to other applicable pipeline routes). Factors assessed were available topsoil, slope, plant community response to disturbance, and precipitation. Qualitative estimates of reclamation potential were made and are summarized in Table 4.18-1. The type and duration of disturbances associated with each alternative and major project configuration are also identified.

Despite a shorter growing season, the areas at higher elevations in the project vicinity have greater potential for reclamation than those at lower elevations, primarily because of greater amounts of precipitation, lower potential evapotranspiration, and generally greater volumes of topsoiling material. Average topsoil replacement depths (available topsoil volumes respread over disturbed areas) at these higher elevations are of adequate thickness (15-25 inches) and approximately equal. Plant communities at these elevations having the highest revegetation potential include woodlands, grasslands, and plateau shrublands (Terwilliger et al. 1974).

Based on considerations of available topsoil, slope, plant community response to disturbance, and annual precipitation, the CC-50 and CC-100 alternative configurations would have the greatest reclamation potential. This is due to the fact that the majority of project features under these configurations occur in higher precipitation zones and areas with greater volumes of available topsoil, thus contributing to higher reclaimability. Likewise, the PA-50 and PA-100 project configurations would have good potential reclaimability.

Many of the project components of FI-50, FI-100, and FII-50 would be located in lower precipitation zones and have relatively less available topsoil for use during reclamation. Therefore, reclamation potential of these configurations would be fair to poor. The FII-50 alternative configuration would have the lowest reclamation potential of all configurations. FI-50 and FI-100 would have fair reclamation potential.

Table 4.18-1 SUMMARY OF RECLAMATION POTENTIAL

Siting Alternative	Disturbance Types[a]	Duration (S,L,R)[b]	Reclamation Potential (−3 to +3)[c]	Reclamation Proposed Yes or No
Open Pit Mine	1	L	0.9	Yes
Mesa Valley Fill Spent Shale Disposal	1	L	1.1	Yes
Clear Creek Plant Site	1	L	0.9	Yes
Grand Valley Plant Site	1	L	−0.8	Yes
Upper Dry Fork Reservoir	3	R	0.2	No[d]
Lower Dry Fork Reservoir	3	R	0.0	No[d]
Lower Conn Creek Reservoir	3	R	0.4	No[d]
Upper Conn Creek Reservoir	3	R	0.5	No[d]
Parachute Creek Reservoir	3.	R	0.4	No[d]
Big Salt Wash Reservoir	3	R	−0.3	No[d]
Roan Creek Corridor	1,2	S,L,R	−0.2	Yes
Big Salt Wash Corridor	1,2	S,L,R	−0.2	Yes
Douglas Pass Road Corridor	1,2	S,L,R	−0.4	Yes
Dorchester Coal Railroad Route	1	R	−0.4	No
Straight Line Tunnel Route	1,2	R	0.0	No[d]
Roan Creek Tunnel Route	1,2	R	−0.2	No[d]
Rangely Corridor A	2	S	0.6	Yes
Rangely Corridor B	2	S	0.6	Yes
La Sal Corridor	2	S	0.6	Yes
Grand Valley SOPS Corridor	2	S	UA	Yes
Clear Creek Mesa SOPS Corridor	1	S	0.8	Yes
Buck Gulch Corridor	2	S	0.2	Yes
Parachute Creek Pipeline	2	S	−0.1	Yes
Rail Road Spur at De Beque	1,3	R	−0.2	No[d]
Spent Shale Disposal Areas				
Stove/Buniger Canyon	1,3	R	−0.6	Yes
Garvey Canyon	1,3	R	−0.6	Yes
Dry Gulch	1,3	R	−0.8	Yes
Munger Creek	1,3	R	−0.6	Yes

[a] Soil Removal = Type 1
Soil Disturbance = Type 2
Inundation = Type 3

[b] S = short term; L = long term; R - Residual

[c] Relative estimates; although numerical ratings coincide with impact analysis matrices, evaluation procedures are not the same. Sum and mean of values presented in "Reclamation Potential (−3 to +3)" column for each configuration.

[d] Only revegetation of cut and/or fill slopes.

5.0

Consultation and Coordination

5.0 CONSULTATION AND COORDINATION

The CCSOP is undergoing regulatory coordination and public review through the Colorado Joint Review Process (CJRP). The Bureau of Land Management, Colorado Department of Natural Resources, and Mesa and Garfield counties serve as members on the CJRP Coordination Team. Other local, state, and federal agencies with regulatory and review authority over project activities participate to ensure coordination of their respective responsibilities. The CJRP serves as a forum for exchange, discussion, and dissemination of information. CJRP participants have been actively involved in project scoping and have been continuously appraised of project developments (see Section 1.1.2 for further discussion of the CJRP).

In addition, CJRP participants have reviewed the Preliminary Draft EIS on the CCSOP. This Draft EIS reflects comments submitted by the participants. Government agencies or entities involved in the review of the CCSOP and production of this EIS are listed below by jurisdiction.

Federal Agencies

Bureau of Land Management
- Colorado State Office
- Meeker Office (incorporating Craig Office comments)
- Moab (Utah) Office

National Park Service
- Denver
- Fruita

Environmental Protection Agency
- Denver

Fish and Wildlife Service
- Denver
- Grand Junction

Army Corps of Engineers
- Sacramento (California) Office

State Agencies

State of Utah

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

Rio Blanco County
- Impact Coordinator

Delta County
- Impact Office

Mesa County
- County Planner
- County Administrator

Towns and Communities

Grand Junction
- City Manager

Rifle
- Mayor's Office

Fruita
- City Manager

New Castle
- Planning Department

Glenwood Springs
- City Planner

Parachute
- Town Manager

Palisade
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Silt
- Town Planner

De Beque
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6.0

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6.0 LIST OF PREPARERS

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Responsibilities - Graphic displays and layout

Jackie S. Miller

Word Processor Operator

Qualifications - 5 years as word processor/typist

Responsibilities - Word processing

Other CDM Personnel Contributing to EIS

Jerry Proffitt - Ground Water Hydrology

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Kelly White - Land Use

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7.0

Glossary of Terms

7.0 GLOSSARY OF TERMS

AIR SHEDS Areas in which weak dispersion conditions result from the effects of obstructions (such as elevated topographic features) on the normal wind flow pattern.

ALLUVIAL SOIL A soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recently deposited materials.

ALLUVIUM Clay, silt, sand, gravel, or other rock materials transported by flowing water and deposited in comparatively recent geologic time as sorted or semisorted sediment in riverbeds, estuaries, and floodplains, on lakes, shores, and in fans at the base of mountain slopes and estuaries.

AMBIENT AIR QUALITY In the presence of commercial shale oil operations, may be described by the sum of background air contaminant concentrations (in the absence of other pollutant emitting sources) plus the concentration estimated to result from plant operations.

ANIMAL UNIT MONTH The amount of forage that a cow and a calf (six months of age and under) would consume in one month. This unit is used to calculate carrying capacity and serves as a basis for grazing fees.

ANOXIC Of or relating to a deficiency of oxygen reaching body tissues.

ANTICLINE An arch of stratified rock in which the layers bend downward in opposite directions from the crest.

AQUIFER A water-bearing stratum of permeable rock, sand, or gravel.

ARTESIAN Refers to ground water under sufficient hydrostatic pressure to rise above the aquifer containing it.

AVIFAUNA The birds of a region.

BACKGROUND CONCENTRATION A pollutant level which could be expected in an area in the absence of any sources related to human activity.

BAGHOUSE A stationary source pollution control system designed to filter particulates at over 99 percent efficiency.

BASELINE The existing information from which estimates, projections, etc., are based to analyze environmental impact.

BEDROCK The solid rock underlying unconsolidated surface materials.

BIOTA The animal and plant life of a region.

CAIRN A mound of stones erected as a landmark or memorial.

CALCINE To heat (as inorganic materials) to a high temperature but without fusing in order to drive off volatile matter or to effect changes (as oxidation or pulverization).

CARRYING CAPACITY The maximum number of animals an area can support without inducing damage to vegetation or related resources. Carrying capacity may vary from year to year on the same area due to fluctuating forage production.

CHARACTERISTIC LANDSCAPE The established landscape within an area being viewed. This does not necessarily mean a naturalistic character. It could refer to a farming community, an urban landscape, a primarily natural environment, or other landscape which has an identifiable character.

CLIMATE The average course or condition of the weather at a specific location over a period of years (usually several decades).

COLLUVIUM Loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits.

COLORADO JOINT REVIEW PROCESS (CJRP) A process to coordinate regulatory reviews and enhance public participation regarding major energy and mineral developments in Colorado.

CRITERIA POLLUTANT A substance for which the EPA has promulated an air quality standard; includes sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, total suspended particulates, and lead.

CRITICAL WINTER RANGE That area where all individuals of the species of interest are located at the point in time when distribution is most restricted over an average five winters out of ten.

CULTURAL MODIFICATION Any man-caused change in the land or water form or vegetation or the addition of a structure which creates a visual contrast in the basic elements (form, line, color, texture) of the naturalistic character of a landscape.

CUMULATIVE IMPACT TASK FORCE (CITF) A cooperative venture of state and local governments and industry to develop tools to assess potential social and economic impacts from major developments in northwestern Colorado.

DEMOGRAPHIC Of or relating to the statistical study of human populations, with reference to size, density, distribution, and vital statistics.

DISPERSION POTENTIAL The ability of the atmosphere to dilute or disperse air pollutants.

ENDANGERED SPECIES Any species which is in danger of extinction throughout all or a significant portion of its range.

ENDEMIC Naturally occurring in a specific locality or region; distribution is usually limited.

EVAPOTRANSPIRATION Loss of water from the soil both by evaporation and by transpiration from the plants growing thereon.

EYRIE The nest of a bird of prey (raptor).

FAUNA The animals or animal life of a region.

FEEDSTOCK Raw material supplied to a machine or processing plant.

FLOODPLAIN Level land that may be submerged by floodwaters.

FLORA The plant life of a region.

FORMATION The primary unit of stratigraphic mapping or description. Formations may be combined into groups or subdivided into memLers.

HABITAT The place or type of site where a plant or animal species lives and feeds.

HYDROCARBONS Any one of a very large class of chemical compounds composed primarily of carbon and hydrogen. The largest single source of hydrocarbons today is petroleum crude oil.

HYDROSTATIC PRESSURE The pressure exerted by the water at any given point in a body of water at rest.

INDIGENOUS Growing or living naturally in a particular region or environment.

INFRASTRUCTURE The foundation underlying a nation's, region's, or community's economy or social structure.

INTERTIE An interconnection permitting passage of a commodity, such as natural gas, between two or more systems.

JOINT FREQUENCY DISTRIBUTION Set of meteorological data describing the concurrent frequencies of occurrence of defined wind directions, wind speed classes, and atmospheric stabilities.

KEROGEN The organic, oil-yielding material present in oil shales. Kerogen is not a definite compound but a complex mixture varying from one shale to another.

LEACH To pass out or through by percolation.

LEK An area where grouse carry on display and courtship behavior during the breeding season.

LITHIC SITES Sites which are characterized by or related to man's production of stone tools.

LOAM A soil consisting of a friable mixture of varying proportions of clay, silt, and sand.

MEMBER A division of a geologic formation differentiated by separate or distinct rock characteristics.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) Federal standards which establish the absolute national limits for pollutant concentrations.

NONATTAINMENT AREA A designated area where a stated pollutant is not in compliance with the National Ambient Air Quality Standards (NAAQS).

NONPOINT SOURCE A pollutant source originating over an area, rather than from a single point.

PASSERINE Of or relating to the largest order of birds (Passeriformes) which consists chiefly of perching songbirds.

PETROGLYPH A carving or inscription on rock.

pH A measure of acidity or alkalinity. A pH of 7 is considered neutral, less than 7 is acid, and greater than 7 is basic (alkaline).

PHYSIOGRAPHIC PROVINCE An extensive portion of the landscape normally encompassing many hundred of square miles, which portrays similar qualities of soil, rock, slope, and vegetation of the same geomorphic origin.

PIEZOMETRIC SURFACE The surface to which the water from a given aquifer will rise by hydrostatic pressure.

POINT SOURCE A pollutant source whose origin of emissions can be approximated by a single point.

POLLUTANT Any gaseous, chemical or organic waste that contaminates air, soil, or water.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD) The management concept of establishing more stringent pollution increment levels in areas with clean air. PSD increments limit the amount of additional sulfur dioxide and total suspended particulate concentrations. Geographic areas are divided into three classes - each allows different increments of TSP and SO_2 concentration increases.

Class I - minimal additional deterioration in air quality (certain national wilderness areas).
Class II - moderate additional deterioration in air quality (most lands).
Class III - greater deterioration for planned maximum growth (industrial areas).

PRIME FARMLAND Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air, are not excessively erodible or saturated with water for a long period of time, and either do not flood frequently or are protected from flooding. Prime farmlands are determined by criteria established by the U.S. Soil Conservation Service.

RAPTOR A bird of prey; includes owls, hawks, eagles, and falcons.

RESIDUAL IMPACTS Those impacts remaining following project shutdown, decommissioning, and abandonment.

RETORT A vessel used for solid to liquid distillation of oil shale by applying direct or indirect heat.

RIPARIAN Related to or living or located on the bank of a natural watercourse or water body; usually in reference to plants which grow in association with a high water table.

RIPRAP A foundation or sustaining wall of stones thrown together without order, as on an embankment slope to prevent erosion.

ROOKERY A breeding ground or nesting area for birds, particularly herons.

SALINE SOIL A soil containing soluble salts in a concentration that impairs growth of plants.

SCENIC QUALITY The degree of harmony, contrast, and variety within a landscape.

SCENIC QUALITY CLASS The value (A, B, or C) assigned a scenic quality rating unit by applying scenic quality evaluation key factors, which indicate the relative visual importance of the unit to the other units within the physiographic region in which it is located.

SECONDARY IMPACTS The effects caused by something which, itself, is a result of something else. Secondary impacts may be caused by growth in population trade, and service activities which result from a primary source of growth, such as mining.

SODIC Of, relating to, or containing sodium.

SOIL HORIZON A layer of soil, approximately parallel to the soil surface, with characteristics differentiating it from adjacent layers.

SOIL PROFILE A vertical section which includes all the soil horizons, the organic surface layers, and the parent material or other layers beneath the soil.

SPAWN To produce or deposit eggs, usually of fish.

SPECIES A category of biological classification comprising organisms or populations potentially capable of interbreeding.

STABILITY CLASS A classification scheme of seven classes ranging from unstable (A) to extremely stable (G) to describe the vertical mixing characteristics of the atmosphere. Unstable conditions correspond to good atmospheric mixing where extremely stable conditions correspond to poor vertical mixing.

STRATIGRAPHY Geology that deals with the origin, composition, distribution, and succession of strata.

SYNOPTIC Relating to atmospheric or weather conditions that exist over a broad area.

SYNTHETIC CRUDE OIL (Syncrude) A substance produced by adding hydrogen to crude shale oil, comparable with the best grades of conventional crude oil.

THREATENED SPECIES Any species which is likely to become an endangered species within the foreseeable future.

TOPOGRAPHY The configuration of a surface including its relief and the position of its natural features.

TOPSOIL The surface layer of soil, usually rich in organic matter and considered suitable as plant growth media.

TOTAL SUSPENDED PARTICULATES (TSP) The portion of total particulates in the atmosphere consisting of minute particles which remain suspended for long periods of time.

UNIQUE FARMLAND Land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yield of a specific crop, when treated and managed according to acceptable farming methods.

VISITOR DAY One or more persons on an area of land or water for the purpose of engaging in a recreational activity for a period or periods of time aggregating 12 hours.

VISUAL RESOURCE MANAGEMENT (VRM) The planning, design, and implementation of management objectives to provide acceptable levels of visual impacts for all BLM resource management activities.

VISUAL RESOURCE MANAGEMENT CLASS The degree of visual change that is acceptable within the characteristic landscape. It is based upon the physical and sociological characteristics of any given homogeneous area and serves as a management objective.

1. Class I. This class provides primarily for natural ecological changes; however, it does not preclude very limited management activity. Any contrast created within the characteristic environment must not attract attention. It is applied to wilderness areas, some natural areas, wild portions of the wild and scenic rivers, and other similar situations where management activities are to be restricted.

2. Class II. Changes in any of the basic elements (form, line, color, texture) caused by a management activity should not be evident in the characteristic landscape. A contrast may be seen but should not attract attention.

3. Class III. Contrasts to the basic elements (form, line, color, texture) caused by a management activity may be evident and begin to attract attention in the characteristic landscape. However, the changes should remain subordinate to the existing characteristic landscape.

4. Class IV. Contrasts may attract attention and be a dominant feature of the landscape in terms of scale; however, the change should repeat the basic elements (form, line, color, texture) inherent in the characteristic landscape.

WICKIUP A tepee-shaped hut or shelter, usually grass or brush-covered, used by the nomadic Indians of the western United States.

WIND ROSE A graphical display of wind speed and wind direction frequencies at a meteorological station. The bar graphs extend into the direction from which the wind blows. These directions are the sixteen compass point directions.

WINTER RANGE That area where all individuals of the species of interest are located in over an average five winters out of ten during the period 15 December to 15 March.

XERIC Characterized by, relating to, or requiring only a small amount of moisture.

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8.0 REFERENCES

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Appendices

APPENDICES

APPENDIX A

ALTERNATIVES ELIMINATED FROM DETAILED STUDY

The listing of alternatives in this appendix are those that the BLM has chosen not to analyze in this EIS. The alternatives are described, and major reasons for elimination are displayed.

Appendix A, outline for alternatives that have been eliminated from detailed study.

A. Resource Properties
   1. Parachute Creek

B. Site for Major Facilities
   1. Feed Prep
      a. Adjacent to Mine
   2. Retort
      a. Skinner Ridge
      b. No Name/Mud Springs
   3. Upgrade
      a. Skinner Ridge
      b. No Name/Mud Springs

C. Alternate Sites & Corridors
   1. Primary Water Sources
      a. Ruedi Reservoir
      b. Other
   2. Primary Water System
      a. Loma System
         1. Route D
         2. Route E
      b. Loma System - Reservoir
         1. Ruby Lee
   3. Access Road to Clear Creek
      a. Big Salt - East Gulch
      b. Douglas Pass
      c. Piceance Creek - East Fawn
      d. Piceance Creek - Dry Gulch
      e. Piceance Creek - Hunter Creek
   4. Access Road to Fruita
      a. Douglas Pass - Route A
      b. Douglas Pass - Route C
   5. Intertie Pipelines - Fruita to Clear Creek
      a. Deer Creek
      b. Douglas Pass
   6. Product Transport Corridors
      a. LaSal - Route II
   7. Rail Transport to Fruita
      a. Route A
      b. Route D
   8. Shale Transport System - Fruita
      a. Railroad
         1. Carr Creek Route
         2. Kimball Creek Route
      b. Conveyor

D. Mine Technology
   1. Mining Methods
      a. All Underground
      b. All Open Pit
   2. Mine Access
      a. Vertical Shafts
      b. Adit Shafts
   3. Underground Mining Methods
      a. Chamber & Pillar
      b. Sublevel Stoping
      c. Sublevel Caving
      d. Block Caving

E. Process Technology
   1. Retorting
      a. Lurgi LR
      b. Parahoe DH
      c. Union B I-H
      d. Tosco II
      e. Superior
      f. In-Situ
   2. Upgrading
      a. Delayed Coking-Hydrotreating
      b. No upgrading

F. Spent Shale Disposal - Clear Creek
   1. Clear Creek Mesa
      a. North/South Clear Creek
      b. Clear Creek Deep Canyon
      c. Northeast Corner
      d. Underground
   2. Drainage Control
      a. Willow Creek Open Channel
   3. Reclamation
      a. Revegetation Without Topsoil

G. Power Sources
   1. Offsite Power
   2. Chevron Build Own Plant

A. RESOURCE PROPERTY SELECTION FOR MINE LOCATION

Introduction:

Chevron owns two properties in Western Colorado comprising a total of about 48,000 acres. Each property contains substantial oil shale reserves and Chevron plans to eventually develop both reserves. However, due to the economic, technologic and government risks of developing oil shale in general, Chevron believes it prudent to develop one property at a time.

1. PARACHUTE CREEK PROPERTY

Description:

The Parachute Creek property is located approximately 9 miles north of the town of Parachute on the western edge of Parachute Creek covering an area of approximately 15,000 acres.

Engineering, Economic and Technological Considerations:

The following considerations make the Parachute Creek property less favorable than the Clear Creek property for oil shale development at this time:

o Surface Ownership and Access

While Chevron owns the minerals in Parachute Creek, it neither owns nor controls a substantial portion of the surface over these deposits. From an economic and technical standpoint, the most appropriate location for a retort plant site serving the Parachute property is on surface property presently owned by others. In addition, the most desirable surface access route to this property is over land owned by others.

The potential for delays in acquiring surface control for access and major facilities is such that property development would need to be delayed until the needed surface rights could be acquired. This would be difficult within the existing time frame.

In comparison, surface access to the Parachute reserves is limited due to surface land ownership patterns.

o Ease of Expansion to 100,000 BPD.

It is the desire of Chevron management to establish an operation on one of the two properties that would produce 100,000 BPD at the earliest practical date and to expand beyond that rate to completely utilize all mineral reserves.

Each of the properties has approximately the same total mineral reserves, and has about the same potential for development of an underground mine at 50,000 BPD for approximately 25 years.

Due to limited high-grade underground reserves, expansion beyond the 50,000 BPD is best accomplished by surface mining methods. Substantial overburden depths on the Parachute Creek property make it less suitable for surface mining than the Clear Creek property and, therefore, less appropriate for expansion beyond 100,000 BPD.

B. PROPOSED AND ALTERNATIVE SITES FOR MAJOR FACILITIES - FEED PREPARATION, RETORT, AND UPGRADE FACILITIES

1. FEED PREPARATION SITE SELECTION

Introduction:

A feed preparation plant is required to reduce the ore from the six-inch minus size resulting from primary crushing which occurs in the mine, to the 1/4-inch minus size required for retort feed. Because the retorting operation is a continuous process, a continuous delivery of properly sized feed to each operating retort is necessary. The feed preparation plant would be located with the retorts.

a. Adjacent to Mine

Description:

The feed preparation plant would be located adjacent to the primary crushing plants near the mines.

Engineering, Economic and Technological Considerations:

Location of the feed preparation plant adjacent to the mines would result in duplication of equipment required to ensure continuous feed to retorts.

Operation of a remote feed preparation plant may require additional storage facilities at the retort plant to provide the required response to retort operations. Additional storage, duplicate equipment, emergency power, or all three may be required to maintain a continuous feed of ore to the retorts.

As the open pit mine moves, the feed preparation plant would become an isolated unit incurring all the disadvantages of being located neither with the mine nor with the retorts. To avoid this problem, the feed preparation plant would have to be relocated several times through the life of the project - a costly and disruptive operation.

All conveyors must be covered and dust must be collected dry to minimize the amount of surface moisture on the feed delivered to the retorts and maintain high retort efficiency. Dry handling of the 1/4-inch minus ore for the full distance from the mine to the retort would increase dust emissions and increase costs for covered conveyors and dust collection equipment. This is more costly and requires significantly more electric power than simply suppressing the dust by water sprays on the 6-inch minus primary ore.

2. RETORT SITE SELECTION

Introduction:

The commercial retort system consists of eleven major process sections with a nominal design capacity of 100,000 BPD. The retorts are the most capital intensive of all facilities in the Clear Creek Project.

Construction and operation costs are highly sensitive to the location of these facilities. A key factor in retort site selection was minimizing raw shale transportation distances from the mines to the retorts, thus minimizing costs. This means that retort sites must be located within a reasonable distance from the mine and feed preparation facility. Because little flexibility exists in siting the retorts at remote locations, no remote sites were examined for the retorts only. One remote site was examined for the feed preparation, retort and upgrading plant complex.

a. Skinner Ridge

Description:

The Skinner Ridge plant site is located on the northerly slope of Skinner Ridge, south of Clear Creek in the southwest corner of the main property block. This site would abut the property line.

Engineering, Economic and Technological Considerations:

Extensive engineered fills and special foundations would be required to develop sufficient plant area at this site. Acquisition of additional property at the southern end of the property would be required to eliminate that problem.

This site is approximately 2-1/2 miles further from the mining and final retorted shale operations than the Clear Creek mesa site. Oil Shale and retorted shale would have to be transported across the Clear Creek mesa valley at the cost of an extensive belt conveyor system, the consumption of additional electric power and the generation of larger quantities of fugitive dust emissions. Therefore, the operational costs of transporting raw and retorted shale for this alternative would be substantially greater than the proposed location.

b. No Name/Mud Springs

Description:

This plant site is located on the ridge between No Name and Mud Springs Creeks in the southeastern portion of the main property block.

Engineering, Economic and Technological Considerations:

Extensive excavation and engineered fill would be required to develop the 500 acre site at this location. It is near the center of mining and final retorted shale disposal operations but is remote from the planned initial disposal site. Therefore, the operational costs of transporting raw and retorted shale for this alternative would be greater than those of the preferred alternative. Selection of this site would require an alternate initial disposal plan to avoid extensive cots, power consumption and fugitive dust emissions resulting from transporting the retorted shale several miles to the initial disposal site on the Clear Creek Mesa Valley.

3. UPGRADING FACILITY SITE SELECTION

Introduction:

One of the major costs in the Clear Creek Project is construction and operation of the upgrading plants.

The commercial upgrading plant consists of four modules each containing five major sections which are utilized to remove impurities such as metals, sulfur, and ammonia. Upgraded raw shale oil or synthetic crude is a product that is acceptable for normal crude oil refining.

Operational efficiency, ease of maintenance and socioeconomic considerations are key factors affecting the siting of this facility. Operational costs are sensitive to location.

a. Skinner Ridge

Description:

The Skinner Ridge plant site is located on the northerly slope of Skinner Ridge, south of Clear Creek in the southwest corner of the main property block. This site would abut the property line.

Engineering, Economic and Technological Considerations:

Extensive engineered fills and special foundations would be required to develop sufficient plant area at this site. Acquisition of additional property at the south would be required to eliminate that problem.

This site is approximately 2-1/2 miles further from the mining and final retorted shale operations than the Clear Creek mesa site. Raw shale oil would have to be transported across the Clear Creek mesa valley by a costly extensive pipeline system that consumes additional electric power. Therefore, the operational costs of transporting raw shale oil for this alternative would be greater than the proposed location.

b. No Name/Mud Springs

Description:

This plant site is located on the ridge between No Name and Mud Springs Creeks in the southeastern portion of the main property block.

Engineering, Economic and Technological Considerations:

Extensive excavation and engineered fill would be required to develop a plant site at this location. It is near the center of mining and final retorted shale disposal operations but is remote from the planned initial disposal site. Therefore, the operational costs of transporting raw shale oil would be greater for this alternative. All of the disadvantages associated with the proposed Clear Creek site are also applicable here. As a result, there are no significant advantages to developing the upgrading plant at this location considering the proposed project configuration and size.

C. SITES AND CORRIDORS FOR INFRASTRUCTURE FACILITIES

1. PRIMARY WATER SOURCES

Introduction:

As its primary source of water for commercial shale oil operations, CSOC plans to withdraw water from the Colorado River near DeBeque and Loma.

a. Ruedi Reservoir

Description:

Ruedi Reservoir is a Federally owned project which is operated by the U.S.B.R. and located on the Fryingpan River, a tributary of the Roaring Fork River between Glenwood Springs and Aspen, Colorado. A limited amount of water from that facility will be marketed through contracts negotiated and administered by the U.S.B.R.

Engineering, Economic and Technological Considerations:

Water would be released from Ruedi Reservoir and carried in the Fryingpan, Roaring Fork and Colorado rivers to CSOC's diversion structures in the Colorado River near DeBeque and Loma. From the Colorado River the water would be pumped to the project site. This source of water appears to be attractive because it would apparently be available, on demand, 365 days per year and would thus reduce the amount of reservoir storage required to regulate other supplies. CSOC's success in consummating a water purchase agreement would depend on the rates charged for Ruedi water and the U.S.B.R.'s flexibility in making deliveries.

b. Other Sources

Description:

Although the major sources of water identified to date are those described in the previous sub-sections, other sources have been or are being considered. These are:

- o Groundwater in other valleys adjacent to Clear Creek and Roan Creek.
- o Groundwater and surface water occurring on CSOC's Parachute Creek property.
- o Groundwater and surface water occurring in the northern portions of the Piceance Basin.
- o Irrigation water presently used in the Clear Creek/Roan Creek Basin, the Parachute Creek Basin and the Colorado River Basin.
- o Other existing or planned reservoirs.

Engineering, Economic and Technological Considerations:

The engineering, economic and technological considerations for these sources are similar to the considerations for the major sources previously described.

2. PRIMARY WATER SYSTEMS

Introduction:

In order to meet increasing water demands as the project develops, CSOC proposes a phased water development program. Alternative systems and/or alternative system components for diverting, storing and delivering water are being considered.

a. Loma System

Introduction:

The proposed Loma System would divert water from the Colorado River near Loma and, through a system of pipelines, pump stations and reservoirs, subsequently deliver that water to the Clear Creek Project site and the upgrading plant north of Fruita (if this site is selected).

(1) Diversion/Route D

Description:

Diversion D would be located on the Colorado River near the mouth of Horsethief Canyon and approximately 3 miles southwest of the town of Mack. Because of limited space, the intake structure would probably be located in the river channel with access by way of a bridge.

The pipeline north from Diversion D would follow a northeasterly course to East Salt Creek or Big Salt Wash. The route would continue up the East Salt Creek or Big Salt Wash valleys to their respective origins and then follow ridgelines to the Clear Creek Plant site. A connection to the upgrading plant north of Fruita would be provided if necessary.

Engineering, Economic and Technological Considerations:

Because of limited space, an adequate sediment excluding device probably could not be installed at this intake. A sediment deflector could be incorporated into the pier to eliminate much of the courser material but it would be ineffective for most suspended material. Due to the remoteness of this site, access and obtaining a power supply would be more difficult than at sites A, B, C and F.

(2) Diversion/Route E

Description:

Diversion E would be located approximately one mile upstream from Diversion D. This facility would consist of an inlet conduit connected to a pump station and surge stand system.

The pipeline route from Diversion E would follow approximately the same course as Route D.

Engineering, Economic and Technological Considerations:

The disadvantages of this site are poor river hydraulics, remoteness for access and power supply, and an inlet channel that would require periodic sediment removal.

b. Loma System - Reservoir Sites

In order to assure that a continuous supply of water is available from the Loma System a storage facility may be required to provide water during periods when diversions from the river are not legally possible or are inadequate to satisfy CSOC's requirements.

Water would be stored in the reservoir during those times when excess water would be available (excess to immediate project needs) under the Loma water right. Subsequently, water would be withdrawn from the reservoir, as required, to meet project demands.

(1) Ruby Lee Reservoir Site

Description:

Ruby Lee Reservoir is a small existing agricultural reservoir in the Big Salt Wash basin immediately south of the Garfield/Mesa county line. For use in regulating the Loma supply, Ruby Lee Reservoir would have to be enlarged to the capacity desired. The dam structure and appurtenances would be similar to those previously described for Big Salt Wash Reservoir and Roan Creek Reservoir.

Engineering, Economic and Technological Considerations:

This site is less attractive than the Big Salt Wash Site because of the lack of sufficient topographic relief to provide a significant increase in storage volume. Because the valley is wide at this location, an extremely long dam with a large volume embankment would probably be required which would be more costly.

3. ACCESS ROADS TO CLEAR CREEK PROPERTY SITE

Introduction:

A two- to four-lane paved access road must be constructed from Interstate I-70 and a nearby railhead to the plant site on the Clear Creek property.

A project of this size and cost must maintain at least primary and secondary access routes in the event of an unforeseen road closure. Therefore, two routes are identified in this section that should be considered together as one access system.

a. Big Salt Wash, East Gulch to Clear Creek Route

Description:

The route would leave the Big Salt Wash Canyon and follow Deer Creek and East Gulch south to gain access to the ridge top where it would traverse the ridge north until it joined the original route at the head of Big Salt Wash. The approximate total route length for this alternative is 64 miles. This route would avoid grades in excess of 7 percent.

Engineering, Economic and Technological Considerations:

While this route would maintain a desirable maximum grade of 6 percent, it would add 11 miles to the length of the road thereby increasing construction costs.

Because of the additional road length, worker commute time and length of haul for construction materials would be substantial. Since much of the road follows the high elevation ridges, substantial winter maintenance would be required.

Finally, added worker commute time, haul length, and winter maintenance, will result in comparatively higher operational costs than the other alternatives.

b. Douglas Pass to Clear Creek Routes

Description:

Two routes are considered for this road access. They are numbered 1 and 2 for the purpose of this discussion.

Route 1 - This access road route begins at the top of Douglas Pass on the Douglas Pass highway and ascends the ridge east of the highway at an 8 percent grade. The route continues along the ridge between Pike Ridge and Calf Point and then turns northeast to a point near the headwaters of Left Fork Lake Creek. At this point the route turns east then northeast to the headwaters of Cathedral Creek. The route then turns east then southeast and would ascend along the ridge between West Willow Creek and Clear Creek at a 2% grade to the Clear Creek plant site. This route is approximately 29 miles long from Douglas Pass to the Clear Creek site and approximately 57 miles from Highway 50.

Route 2- This access road route begins where East Salt Creek meets with Douglas Pass highway. From this point the route heads east then northeast along East Salt Creek on a 2% grade to a point near the bottom of Corral Canyon. The route turns north and ascends Corral Canyon to the top of Long Point on an 8% grade. Continuing north along Long Point, the route then turns northeast to a point near the headwaters of Left Fork Lake Creek. At this point the route turns east then northeast to the headwaters of Cathedral Creek. The route turns east then southeast and would descend the ridge between West Willow Creek and Clear Creek at a 2% grade to the Clear Creek plant site. This route is approximately 33 miles long from the Douglas Pass road and approximately 53 miles from Highway 50.

Engineering, Economic and Technological Considerations:

Preliminary study results indicate that these routes are impractical due to the additional distance and unstable geologic conditions on the Douglas Pass Road.

c. Piceance Creek Road to Clear Creek Property (East Fawn Creek)

Description:

This route commences on Piceance Creek Road, Rio Blanco County Road #5, and proceeds southwest along Black Sulfur Creek on Rio Blanco County Road #26 to the intersection with Fawn Creek, Rio Blanco County Road #29. It then proceeds up Fawn Creek to East Fawn Creek to the Rio Blanco/Garfield County line near the head of Mud Springs Creek. It then proceeds west along this ridge skirting the heads of East Willow Creek and West Willow Creek to intersect with the road, Big Salt Wash to Clear Creek Route, as it proceeds down the ridge between Clear Creek and Willow Creek to the plant site.

The length of this route from Rifle is approximately 65.1 miles. A two-to-four lane paved road would be constructed from the Piceance Creek road to the Clear Creek Property.

Engineering, Economic and Technological Considerations:

Of the several routes between the plant site and Piceance Creek Road, this route is the shortest and appears to be geologically stable with few springs to cause drainage and slide problems. Road design can generally follow contours minimizing extensive earthwork, although numerous slide draws are crossed which would require small drainage structures. It has the disadvantage of being virtually on the edge of the open pit mine and may require relocation when the open pit is well advanced into the project. Twenty-four (24) miles of new construction and upgrading of minimal standard county roads is required from the Piceance Creek Road to the Clear Creek plant site.

The distance between the Piceance Creek Road and the nearest railhead at Rifle is 41 miles. Total distance from Rifle to the Clear Creek Property using this route is 65 miles from the railhead. This is a significant distance to move construction materials, construction crews and operating personnel.

Because of road length, worker commute time and length of haul for construction materials would be substantial. Since much of the road follows the high elevation ridges, there would probably be a large amount of winter maintenance required. As a result, associated operational costs would be high compared to other alternatives.

d. Piceance Creek Road to Clear Creek Property (Dry Gulch)

Description:

This route commences at the Piceance Creek Road, Rio Blanco County Road #5 and follows Black Sulfur Creek, Rio Blanco County Road #26 to Fawn Creek Rio Blanco Road #29, thence south on Rio Blanco County Road #87 up Dry Gulch and then east and south along Rio Blanco County Road #69 up onto a ridge between Dry Gulch and Hunter Creek. From this point the road proceeds southeasterly along the ridge top to the intersection with the Fawn Creek route near the head of Mud Springs Creek and thence to the plant site.

The length of this route from Rifle is approximately 66.7 miles. A two-to-four lane paved road would be constructed from the Piceance Creek Road to the Clear Creek Mesa.

Engineering, Economic and Technological Considerations:

The natural grades and alignment available in climbing from Dry Gulch to the ridge are somewhat steeper and more circuituous than the East Fawn Creek route.

Because of the road length, worker commute time and haul length for construction materials would be substantial. Since much of the road follows the high elevation ridges, there would probably be a large amount of winter maintenance required. As a result, associated operational costs would be comparatively high.

e. Piceance Creek Road to Clear Creek Property (Hunter Creek)

Description:

This route commences at the Piceance Creek road, Rio Blanco County Road #5, near the intersection with Hunter Creek. It proceeds up Hunter Creek and thence up West Hunter Creek to the intersection of the east Fawn Creek Route from which point it follows the east Fawn Creek route to the plant site.

The length of this route from Rifle is approximately 65.3 miles. A two-to-four lane paved road would be constructed from the Piceance Creek Road to the Clear Creek Property.

Engineering, Economic and Technological Considerations:

This route has significantly greater side drainages, handling larger water sheds than the Dry Gulch route and would require more extensive drainage works. The alignment is uniform and extensive excavation would not be anticipated.

Because of the road length, worker commute time and haul length for construction materials, would be substantial. Since much of the road follows the high elevation ridges, a large amount of winter maintenance would be required. Consequently, associated operational costs would be high compared to other alternatives.

4. ACCESS ROAD TO FRUITA UPGRADING PLANT SITE

Introduction:

In addition to access provided to the Clear Creek Property primary access will be required from the Fruita area to the plant site near Big Salt Wash. Also, an access link between the upgrading plant and the Clear Creek property will be essential.

The access link between the Fruita upgrading plant and Clear Creek property is considered as an alternative primary or a secondary, but necessary access link.

a. Douglas Pass Road to Site - Route A

Description:

This route commences at a point approximately six miles north of Highway 50 on the Douglas Pass Highway. From that point the route heads east then southeast for about 1 mile then northeast approximately four miles to the southeastern corner of the Fruita upgrading plant site.

Engineering, Economic and Technological Considerations:

This alternative access route would cost less to develop than the road between Fruita and the plant site. However, it would increase traffic on the Douglas Pass road beyond its current capacity necessitating substantial improvements. This route traverses along the ridge top and would require moderate grading and construction to install a two- to four-lane highway to Colorado State Highway standards. This route increases travel distance and time for workers from the Grand Junction or Fruita areas by as much as 11 miles.

b. Douglas Pass Road to Site - Route C

Description:

This route commences approximately 10 miles north of U. S. Highway 50 on Douglas Pass road. It parallels the railroad route beginning 1/4 mile south of Mitchell Road heading southeasterly then north into the upgrading site. The length of this route is approximately 3 miles.

Engineering, Economic and Technological Considerations:

This alternative route would cost less than the previous alternative routes since it is shorter in length. It also would parallel the railroad route and would be incorporated into the rail work in that corridor. Traffic would increase on Douglas Pass road possibly resulting in road improvements.

More grading would be required for this route compared to the others. Travel time would also be comparative.

5. INTERTIE PIPELINES - FRUITA TO CLEAR CREEK

Raw shale oil must be transported from the retorts to the upgrading plant via intertie pipelines. If the retorts and upgrading plant are located on the Clear Creek property this intertie pipeline system would be all part of the infrastructure system of the plant site. However, if the upgrading facility is located near Fruita, an intertie pipeline must be constructed to link the two plants.

a. Deer Creek Straight Line to Clear Creek Property

Description:

This intertie pipeline route begins at the Grand Valley upgrading plant site and follows the Big Salt Wash to Deer Creek. The route then ascends the ridge north of Deer Creek, heads northeast for about 1 mile to the top of Kimball Mountain, descends into Roan Creek Canyon and heads straight for the Clear Creek plant site crossing Roan Creek, Carr Creek and Brush Creek canyons. It is approximately 30 miles long.

Engineering, Economic and Technological Considerations:

Although the shortest, this route ascends and descends three steep-sided canyons before entering the Clear Creek plant site. Access is extremely limited to certain canyon floors and ridges. Pipeline construction on the canyon walls would be very difficult and costly.

b. Douglas Pass Road to Clear Creek Property

Description:

This route heads north then northwest from the Fruita upgrading site to the Douglas Pass Road. The route follows the Douglas Pass Road to East Salt Creek then northeast up East Salt Creek Canyon to Corral Canyon then north up Corral Canyon to Long Point.

Engineering, Economic and Technological Considerations:

Access to the line would be required for construction and maintenance. This route provides no significant advantages to others examined and presents geologic stability problems.

6. PRODUCT TRANSPORT CORRIDORS FROM CLEAR CREEK PROPERTY

Introduction:

A syncrude pipeline would be needed to transport up to 100,000 BPD of synthetic crude produced by the Clear Creek Project out of the region to refineries and markets.

The pipeline would be constructed from the Clear Creek plant site to tie into existing or proposed pipeline terminals. A 12" - 18" diameter pipeline will be required to transport up to 100,000 BPD of syncrude product.

a. LaSal Pipeline Connection Corridor II

Description:

A second corridor has been identified to tie into the LaSal pipeline.

Two routes have been identified in this corridor between the Clear Creek Property and the LaSal Rangely connection at the Magnolia Pump Station. They will be numbered IIA and IIB for purpose of this discussion.

Route IIA - This pipeline route begins at the Clear Creek plant site heading northwest then north near the headwaters of No Name Creek to skirt the open pit mine area. At this point the route turns east then northeast following Bull Fork onto the ridge between Dry Gulch and Hunter Creek. The route continues along this ridge, crosses Piceance Creek and ties into at the LaSal-Rangely lateral intersection at the Magnolia Pump Station.

Route IIB - This pipeline route begins at the Clear Creek plant site heading northwest then north near the headwaters of No Name Creek to avoid the open pit mine area. At this point the route turns northeast and descends East Fawn Creek, Fawn Creek, and Black Sulphur Creek; crosses Piceance Creek and ties in at the LaSal-Rangely lateral intersection at the Magnolia Pump Station.

Engineering, Economic and Technological Considerations:

Routes IIA and IIB are approximately the same length. Their hydraulic characteristics are also approximately the same. Route IIA traverses a ridge and route IIB is located mainly in a valley. There are no significant advantages between IIA and IIB. However, the LaSal-Rangely lateral intersection point does reduce the total number of pipeline miles through which the Clear Creek project syncrude oil must be pumped and may prove more economical. On the other hand, the necessary metering, breakout tankage, injection pump station and ancillary equipment required would have to be located at a point where manned operations would not otherwise exist. This may offset the savings expected from shorter pipeline distances. Therefore, these routes are considered impractical.

7. RAIL TRANSPORT CORRIDORS TO FRUITA UPGRADING PLANT SITE

a. Railroad Corridor Route A

Description:

A railroad spur would be required to transport materials to the upgrading plant and in the early years of the project to transport syncrude to appropriate refineries.

This railroad access route begins at the D&RGW (Denver and Rio Grande Western) Railroad west of Mack and heads northeast and then north along the east side of Highline Lake. The route then turns east crossing the Douglas Pass Highway and follows the main stream to Coyote Wash. At Coyote Wash the route turns north into the Grand Valley upgrading plant site. An alternate to this route would be to stay on the west side of Highline Lake.

Engineering, Economic and Technological Considerations:

An 11.1-mile railroad spur to the remote upgrading site north of Fruita is required for this alternative. The preliminary alignment begins at a Denver and Rio Grande Western Railroad tie-in point near Mack. Required facilities include reconstruction of 1,600 feet of US Highway No. 6 to provide an elevated grade separation for the spur line crossing. The route proceeds north and east with about a 2 percent maximum grade, and enters the southwest boundary of the upgrading site. This alternative is not as desirable as others because of the reconstruction of part of Highway 6 and possible interference with recreation activities at Highline Lake.

b. Railroad Corridor Route D

Description:

This route follows the same route described in (Route C) for the first three miles. It then proceeds east for about 2.5 miles just north of Highline Lake to Coyote Wash. The route then joins (Route A) continuing to the upgrading plant site.

Engineering, Economic and Technological Considerations:

This route would require elevated or at-grade crossings of U. S. Route 6 and 50 and Douglas Pass Highway. No significant grade problems exist and the route would require only moderate earthwork.

8. RAW AND/OR SPENT SHALE TRANSFER SYSTEMS FOR COMBINATION FEED PREPARATION, RETORTS AND UPGRADING PLANTS AT FRUITA SITE

Introduction:

In addition to the infrastructure needed to support the mine on the Clear Creek property and the upgrading plant at Fruita, a raw and/or spent shale transfer system would be required. Two systems have been examined: private railroad and conveyor. The corridors required for each system are considered in this section.

a. Raw and/or Spent Shale Transfer System - Railroad

Description:

A private railroad system would be developed to transport the raw shale from Clear Creek to the Fruita plant site via a tunnel route to routes up Carr, Roan or Kimball Creeks. The raw shale transfer system would be designed to transport approximately 75,000 tons per day of 31 gpt grade raw shale from the Clear Creek mine to remote retorting and upgrading facilities at Grand Valley, 14 miles north of Fruita.

Spent shale would be conveyed to a storage site at the Grand Valley plant site and fed into bottom-dump railcars. The loaded train would follow the Tunnel Route to Clear Creek, where the shale would be dumped into a storage hopper and transported by conveyor to the disposal site.

(1) Carr Creek Route. This route begins at the Grand Valley retort site and follows the Tunnel route up Big Salt Wash. The same tunnel portal in Big Salt Wash is used, however, the tunnel angles to the east and emerges in Roan Creek Canyon. From this point, the line sidehills around "Four A Point" Ridge into Carr Creek Canyon. This route rejoins the Tunnel Route at the Carr Creek Bridge and uses the same alignment from this point to the Clear Creek Mine site. The Carr Creek route replaces 4.6 miles of tunnel on the Tunnel route with 9.6 miles of railroad built at grade. Total length of the Carr Creek route is approximately 33 miles, and the tunnel length is reduced to approximately 10.6 miles. An additional major bridge structure, across the Left Fork of Carr Creek, will be required. There is no grade against the loaded train and maximum grade against the empty train is 2.65 percent. Carr Creek uses the same underground loadout at the mine as the Tunnel route.

(2) Kimball Creek. This alternate route extends from the retort site, up Big Salt Wash, following the same alignment as the Tunnel Route for approximately 12 miles. At this point, the route enters a tunnel, which extends easterly to Kimball Creek Canyon. The route then follows Kimball Creek downstream, following the canyon bottom on the north side of the creek, to Clear Creek. Here the alignment turns up Clear Creek Canyon to Roan Creek, where it joins the Roan Creek alternate and continues to the loadout. Total route length is approximately 43 miles, 4.4 miles of

APPENDICES

A Alternatives Eliminated from Detailed Study

B Impact Analysis Methods and Assumptions

- B-1 Numerical Impact Rating System
- B-2 Air Quality Modeling and Assumptions
- B-3 Land Use, Recreation, and Wilderness Impact Analysis Methods and Assumptions
- B-4 Socioeconomic Impact Assumptions

C Mitigation

- C-1 Summary Tables of Potential Environmental Impacts and Recommended Mitigation
- C-2 Detailed Social and Economic Mitigation Measures

D Map of Existing Land Uses

APPENDIX A
ALTERNATIVES ELIMINATED FROM DETAILED STUDY

The listing of alternatives in this appendix are those that the BLM has chosen not to analyze in this EIS. The alternatives are described, and major reasons for elimination are displayed.

which is tunnel. One short-span bridge is required for this route. Maximum grade against the loaded train is 2.23 percent and maximum adverse grade for the empty train is 2.65 percent. The Kimball Creek alternate uses the same above-ground loadout facilities as the Roan Creek alternate.

Engineering, Economic and Technological Considerations:

No significant differences exist between the costs of constructing and operating each of the tunnel routes.

More surface disturbance will occur with the Carr Creek, Roan Creek and Kimball Creek routes compared to the straight-line tunnel route. Several bridges will be required for the tunnel route, however, these bridges would be constructed to minimize disturbance of drainages. The tunnel route is shorter than the others, thus enabling more efficient operation of the rail transport system and lower operating costs. Because of added route length, the Carr, Roan and Kimball Creek routes could result in higher operating costs. Travel time for personnel would be more for these routes than the Tunnel Route resulting in increased operating costs. Should retorted shale be returned to the Clear Creek Property for disposal, the tunnel route would minimize those costs.

b. Raw and/or Spent Shale Transfer - Conveyor

Description:

Conveyor transport of raw oil shale along the Tunnel Route was considered as an alternative to rail transport. A conventional belt conveyor system was designed to transport 6-inch minus underground ore from Clear Creek to Chevron's Grand Valley property. Although the conveyor system eliminates the need for rail haulage, it would be necessary to build a companion railroad along the route for personnel transportation.

The route chosen for the conveyor system follows the Tunnel Route for the railroad described above. Oil shale is loaded directly onto the conveyor at its starting point, located approximately 100 feet below the Clear Creek Mine. The conveyor remains in this tunnel to a daylight point three miles southwest of the mine at Brush Creek Canyon. The route crosses the canyon on an elevated bridge and re-enters a tunnel through Horse Ridge to the Carr Creek Canyon, where it crosses another bridge. Entering another tunnel on the south side of Carr Creek, the route follows a series of tunnels with short breaks for the next 9 1/2 miles to a point in Big Salt Wash. The remaining portion of the route follows the Big Salt Wash valley to the remote retorting site at Chevron's Grand Valley property. The oil shale would be discharged onto the feed preparation plant ore stockpile.

If retorted shale were returned to Clear Creek by conveyor for disposal, a completely separate return conveyor system would be required. This system would be installed through the same tunnels as the oil shale delivery conveyor.

Retorted shale would be placed in storage barns by a double wing stacker. Material would be reclaimed from these barns, which each have a storage capacity of 50,000 tons, by a system of feeders and conveyors.

The overland shale return conveyor is designed to transport an average tonnage of 4200 tph at a rate of 850 feet per minute. The conveyor consists of 12 flights, a total length of 145,700 feet. To facilitate maintenance and repair, all conveyor drives would be installed at daylight points. Flights 1 through 5 and 12 will be above-ground; the remaining flights pass through tunnels.

Flight 11 would be installed in a new incline tunnel which connects with the surface in Clear Creek Valley with the last flight discharging directly to the retorted shale disposal system.

The return conveyor system, which would operate 18 shifts each week, would use approximately 32,000 KWH, operating at 36,000 connected horsepower.

Engineering, Economic and Technological Considerations:

Conveyor transport of raw shale is not the favored method of transporting the raw shale to the Fruita site because it is less cost effective than the rail system. Moreover, in addition to the conveyor system a railroad would be needed anyway to transport personnel to and from the mines, thus, adding substantially to capital costs.

Disposing of retorted shale at the Clear Creek site with processing occurring at the Fruita site would involve transporting approximately 900 million cubic yards of retorted shale about 36 miles back to Clear Creek. In addition to increased environmental impacts resulting from increased handling and haulage, the costs associated with transporting spent shale to Clear Creek are prohibitively high.

D. MINE TECHNOLOGY ALTERNATIVES

1. MINING METHODS

Introduction:

Three mining concepts were evaluated for development of the Clear Creek property: combination underground and open pit mine, all underground, all open pit.

The modified in-situ process was not considered to be practical, does not constitute a reasonable alternative and was eliminated from detailed study. The oil shale resource on Clear Creek is not suitable for modified in-situ. The shale can be extracted by conventional mining methods at substantially less cost.

a. All Underground Mine

Description:

A 50-million-ton-per-year underground mine producing ore at an average grade of 31 GPT would be required to sustain a 100,000 BPD operation. The annual production of an underground mine of this size would be three times the size of the underground mine in the initial proposal. The life of this mine would be comparable to the life of the underground mine in the proposed action or about 18 years.

Over 900 million tons of the rich R-7 zone would be mined within an area of approximately 13,000 acres during the 18 years of the underground mine operation.

Engineering, Economic and Technological Considerations:

Mining would be a single pass advancing room-and-pillar method within the mining horizon. Due to the depth of cover and rock strength of the oil shale, a 60 percent extraction ratio is anticipated. This allows for mining of over 900 million tons from the 40 ft. 31 GPT high grade horizon that extends throughout the property. However, this amounts to only 17 percent of the mineable 3.9 billion barrels of plus-15-GPT oil shale contained on the Clear Creek tract. This low reserve recovery makes this alternative inferior to the full open-pit or the combination open-pit and underground mine alternatives. In addition, the limited mine life would not economically justify the high capital expense required for the retorting and other facilities.

b. All Open Pit Mine

Description:

An all open-pit mining operation producing 100,000 barrels of shale oil per day from the Clear Creek property was studied. Approximately 232,000 TPD of ore would be mined from the property to achieve the 100,000 BPD requirement. The mining operation would consist of an open pit located at the Willow Creek drainage and an open pit in the Mud Springs drainage. Although these two open pits would begin operation as two separate production units, they would ultimately merge into one mine. Both open pits will utilize a common retort plant which will be situated on the ridge between Clear Creek and Willow Creek. At full production, they would each produce ore at a combined rate that will satisfy the retort feed requirement to produce 100,000 BPD.

At a cut-off grade of 15 gallons per ton the all open-pit mine would have a life of approximately 65 years. Mining will be confined to the higher grade R-7 and R-8 ore zones, the two uppermost ore zones that are readily apparent from the geological data.

Engineering, Economic and Technological Considerations:

The criteria established for this case study required locating the retort plant site on the ridge between Clear Creek and Willow Creek. Based on the criteria, mining will begin in the Willow Creek drainage because of its proximity to the plant site. Also specified was a selective mining method to be used throughout the life of the Willow Creek open pit mine. The Mud Springs Creek mine would produce run-of-mine oil shale.

The first three years of production of the Willow Creek open pit is designed to develop ore production as quickly as possible, and to remove sufficient overburden waste to allow full-scale production.

Selectively mining only the R-7 zone during this period would produce fairly high grade ore of 27 GPT. However, production quantities would be relatively small. Because of this, the mine design would utilize bench heights of 25 feet with 150-foot wide advancing benches and 120 to 150-foot wide side benches. This pit configuration would enable use of 7-cubic-yard hydraulic shovels and 50-ton trucks. When the mine reaches full production, this equipment fleet would be used to handle interburden waste because the interburden is too thinly bedded to be handled efficiently by larger equipment.

At the end of the three-year demonstration phase, the Willow Creek open-pit would begin a production buildup that would continue for one year until full production is reached. The buildup to full production will involve selectively mining the R-8 as well as the R-7 zone. This would result in an overall grade of 22 GPT throughout full mining production. As production buildup proceeds, mine design would be developed to include 50-foot high benches; advancing bench and side bench widths would remain the same. This pit configuration would allow increased production by using 25-cubic-yard electric shovels and 170-ton trucks.

All Mud Springs Creek production would come from the R-7 and R-8 zones using a run-of-mine method. This would result in an overall mining grade of 19.6 GPT throughout the life of the open pit.

There are approximately 6,000 acres of reserves that are termed unmineable by open-pit methods under this alternative. An excessive amount of overburden overlies about 3,600 acres. The waste to ore ratio in this area would cause the cost of mining these reserves to be uneconomical. Another 1,400 acres are reserved for the plant site and interim retorted shale disposal. The remaining unmineable acres are in areas where the property boundary configuration would make mining of these reserves exceedingly difficult.

The all open-pit mine limits resource recovery. Mining costs do not justify the capital expense required to develop the retorts and other facilities.

2. UNDERGROUND MINE ACCESS

Introduction:

It will be necessary to provide sub-surface access for men, equipment, utilities and fresh air in order to conduct underground oil shale mining operations. Additionally, access to the surface is required to transport raw oil shale and waste rock to the surface for processing and disposal.

a. Vertical Shafts

Description:

A vertical shaft or shafts would be sunk into the ore body to transport equipment and materials and the work force.

Engineering and Technologic Considerations:

Use of vertical shafts as the only means of mine access was evaluated briefly. Although shafts could be centrally located and often provide rapid movement of men and supplies, they are not ideally suited for transporting large production tonnages from relatively shallow mines. Vertical shafts would be better suited for deep deposits. Also, moving large equipment into the mine requires a time-consuming reassembly process. This alternative would be expected to be more costly than the preferred decline shafts.

b. Adit Access

Description:

Two adit access locations were considered for development in the ore horizon, one east of the falls in Clear Creek Canyon and one northwest of the feed plant in Willow Creek Canyon.

Engineering, Economic and Technological Considerations:

A major advantage of adit access for underground mining is that development occurs within the ore horizon on the outcrop. This fact would result in a substantial reduction in the amount of predevelopment work required compared with that for a slope or shaft access.

Of the two locations considered for adit access, the Willow Creek location was rejected because it would be located within the boundaries of the open-pit mine.

The Clear Creek adit location required 11,000,000 cubic yards of fill material and extensive road construction. Also, this location would result in additional backhaul transportation distances for men, ore, and materials because the active panels are continuously advancing away from the adit location. It was determined that an adit access design in the Clear Creek Canyon was a less desirable alternative to the combination slope and shaft design of the initial proposal. It is anticipated that this alternative would be more expensive than the proposed mine access.

3. UNDERGROUND MINING METHOD

Introduction:

Various underground mining methods have been evaluated for their suitability in large scale oil shale development. The following underground methods could be used for mining oil shale:

- Room-and-pillar
- Chamber-and-pillar
- Sublevel stoping
- Sublevel caving
- Block caving

Longwall mining was not evaluated because the vertical thickness and material strength of the ore body exceeded the capabilities of existing equipment and technology.

a. Chamber-and-Pillar

Description:

Chamber-and-pillar mining would be a modified form of room-and-pillar mining in which preproduction drifts are driven at right angles off the main or submain entries. The drifts would be expanded into chambers by fan drilling during panel retreat.

Development could occur on multiple levels depending on the height of the chamber. The extraction ratio would be comparable to room-and-pillar, if narrow barrier pillars and backfilling are employed.

Engineering, Economic and Technological Considerations:

The chamber-and-pillar method would be best suited for mining ore deposits thicker than 50 feet, a restriction which makes it impractical on the Clear Creek property.

Advantages

Chamber-and-pillar mining has the following advantages:

- Entire vertical cut made in one pass.
- All muck trammed from one level.
- Chamber ventilation straight-forward.
- Mine development contributes to total production because it is located in ore.

Disadvantages

Chamber-and-pillar mining has the following disadvantages:

- Development of chambers delays production.
- Difficulty of installing rock anchors or scale chamber roof high above floor.
- Fan drilling of chambers may create irregular floor and roof horizons.
- Chamber working conditions are potentially dangerous for men and equipment.
- Higher development requirements than room-and-pillar methods.
- Higher safety risks than room-and-pillar methods.
- Most costly than room-and-pillar methods.

Although the chamber-and-pillar mining is similar to room-and-pillar mining, there would be several problems which discourage its application in oil shale as the concept is currently envisioned. It would be questionable whether suitable equipment would be available for productively scaling and bolting very high headings. In addition, fan drilling causes irregular floors and roofs, which increases equipment operating costs and creates a roof of questionable safety. Small barrier pillars combined with backfilling are required to increase the extraction ratio to an acceptable level. These problems suggest that chamber-and-pillar mining would be not an acceptable alternate mining method to room-and-pillar mining for 40-foot seam heights as are found on the Clear Creek property.

b. Sublevel Stoping

Description:

Sublevel stoping would be a large-scale, open-stoping method. It is sometimes referred to as longhole or blasthole stoping. This method requires access to the ore body at various sublevels located between the main haulage levels. Headings would be driven from the sublevels into the ore for drilling and blasting. The ore would be then blasted in slices towards an open face. After blasting, the ore falls to the bottom of the slope by gravity and would be collected through drawpoints.

This method usually is applied to strong ore bodies that require minimal support and are surrounded by strong country rock. The ore body should be fairly well defined and regular in shape. The dip of the footwall normally should be sufficient to allow broken ore to gravitate freely. Sublevel stoping is not dependent on the width of the ore body, except that widths less than 20 feet make utilization of longhole drilling techniques more difficult.

Engineering, Economic and Technological Considerations:

Sublevel stoping requires extensive sublevel development with relatively high captial expenditures. Much of the development, however, is in ore, and production costs would be comparatively low. Production mining would be achieved exclusively by longhole drilling, with ring or fan drilling from the sublevels being the most common method. The drilling, blasting, and loading operations would be performed independently with high equipment utilization. Large outputs could be obtained with limited equipment and personnel. Waste rock dilution may occur if ore boundaries are irregular or caving occurs. Within the stope, all of the ore would usually be recovered.

Sublevel stoping would be a mining method which is suitable for mining thick sections of oil shale. It provides a safe working environment for men and equipment, and can be highly productive with production occurring at many different horizons. All blasted oil shale would be mucked from one level. Large quantities of oil shale could be stored in a stope, after initial production, to allow drilling and blasting sequences to continue despite a temporary breakdown in the ore haulage system.

Sublevel stoping differs primarily from chamber-and-pillar mining in that mucking occurs from several drawpoints and no roof support or scaling would be required within the stoped area.

Sublevel stoping might be more attractive than room-and-pillar mining in horizons thicker than 60-80 feet. However, the 40-foot mining horizons on the Clear Creek property would not be appropriate for this mining method.

Advantages

- Large production outputs can be obtained.
- Relatively safe and economical system.
- Most development can be in ore.
- High equipment utilization.

Disadvantages

Sublevel stoping has the following disadvantages:

- Stope development represents a major portion of overall cost in any sublevel stoping mine.
- Extensive ore body development is required with high capital expenditures.
- Delayed production.
- Lower tons/man-shift compared to room-and-pillar mining.
- Requires multi-level development.

c. Sublevel Caving

Description:

Sublevel caving is a method for mining large deposits in which ore is blasted from sublevels with waste material caving and filling the ore voids created after mucking. The earth's natural gravitational force stresses and caves the overlying waste rock and usually creates surface subsidence.

A deposit would typically be mined by blasting and hauling the ore from a series of interconnected sublevels. The sublevels, usually 30 to 40 vertical feet apart, would consist of a series of regularly spaced production drifts driven across the ore zone. Longhole fan drilling would be initiated from these drifts. Blasting and mucking would occur on retreat horizontally and vertically.

Engineering, Economic and Technological Considerations:

The concept of sublevel caving assumes that space previously occupied by ore is replaced with caved material after mucking. As a result, grade control could be a problem.

Sublevel caving would be a highly productive and mechanized way to mine large deposits. There would be, however, several drawbacks associated with this method, particularly in relation to mining oil shale. In addition to excessive development requirements, lack of vertical planes of weakness and toughness of the shale may prevent uniform and predictable caving. Dilution of high grade ore also may occur and the probability of surface subsidence associated with this mining method is not desirable. Thus, it was determined that sublevel caving is not applicable to mining a 40-foot seam of high-grade oil shale as is found on the Clear Creek property. Also, it would be expected that the sublevel caving method would be more expensive than the proposed room-and-pillar mining.

Advantages

Sublevel caving has the following advantages:

- Predictable ore chunk size, unlike bock caving.
- Relatively save working environment as miners work in relatively small openings.
- Can be highly mechanized using currently available high-performance equipment.
- Highly productive due to many producing faces.
- Dilution can be more carefully controlled than in block caving.
- Bulk of development headings can be highly productive.

Disadvantages

Sublevel caving has the following disadvantages:

- Oil shale not conducive to caving.
- Inability of ore to cave could cause periodic air blasts with risk of damages and injuries.
- Acceptable ore dilution requires careful planning in design and operation.
- Possibility of surface and underground subsidence.
- Substantial amount of development required before production begins.
- Ventilating a large number of dead-end headings a major problem.

d. Block Caving

Description:

Block caving would be a low-cost method of mining large, thick ore bodies using the earth's natural gravitational force to stress an ore deposit to failure, thereby initiating caving. The ore body would be divided into blocks, usually on a rectangular pattern, that would be individually developed and caved.

The block being mined would be entirely surrounded by either solid ore or mined blocks containing well-compacted cappings of waste. The top of the ore moves down in a horizontal plane with the caved capping above the ore.

Caving a block of ore is accomplished by undercutting and removing the natural support for the rock, at depth, in a large controlled lateral area. The ore body should be sufficiently weak or fractured to prevent the rock mass from breaking into large pieces, arching across the lateral area, or caving in a sporadic and catastrophic manner. Once caving begins, the ore is broken into fragments and drawn off through a systematic arrangement or ore passes at a rate that allows continuous caving.

Engineering, Economic and Technological Considerations:

Although caving is one of the lowest cost underground mining methods, only certain types of ore bodies are amenable to caving operations. Caving is more suitable for large, massive deposits with relatively uniform ore grades which are not characterized by irregular shapes or boundaries. Such is not the case within the Chevron property. The rock should be weak enough to break into fragments which will pass through ore chutes, yet strong enough not to crush and pack within the block.

The initial development of a block for caving typically would require an elaborate system of development drifts and ore passes. While the block is caving, the breakage and transportation of ore to the haulage system would be continuous with minimal manpower requirements.

The high-production, low-cost reputation of block caving makes it a desirable method for mining oil shale. There are, however, serious drawbacks which would discourage its application at the Clear Creek property at this time. As in sublevel caving, this mining method also could result in dilution of high grade ore as well as surface and underground subsidence. In addition, the cavability of oil shale would be in question. Block caving necessitates large, heavily-supported development headings and would not be applicable to a 40-foot mining horizon. Therefore, this method of underground resource recovery is not considered appropriate for use in the Clear Creek Shale Oil Project.

Advantages

Block caving has the following advantages:

- o Most economical of any underground mining method currently in use for massive, weak ore bodies.
- o High production rates with low manpower requirements.
- o Men and equipment work under lower roofs.
- o Ore stored until ready for haulage.
- o Drilling and blasting largely eliminated.
- o Trackless equipment could achieve high productivity muck from multiple drawpoints and reduce development requirements.

Disadvantages

Block caving has the following disadvantages:

- o High strength ground support needed for development and extraction openings in easily cavable ores.
- o Subsidence may result because accurate prediction of extent or shape of caved area is not predictable.
- o Significant development delays production.
- o Chunk size not readily predictable.
- o Development requires significant vertical distance below block.
- o Possibility of airblasts if ore does not cave uniformly.
- o Lack of vertical planes of weakness and roughness of oil shale may cause irregular and unpredictable caving.
- o Low grade oil shale zones would become mixed with high grade.

E. PROCESS TECHNOLOGY ALTERNATIVES

Introduction

Oil shale retorting requires heating shale to release organic material, kerogen, composed of gases and hydrocarbon liquids. Retorting categories are above ground and in-situ. In-situ processing affects thermal decomposition below ground. Above ground processing requires heating crushed shale in vessels. Heat input in above ground retorts is accomplished by direct-heat (DH) or indirect-heat (IH).

1. RETORTING

a. Lurgi LR

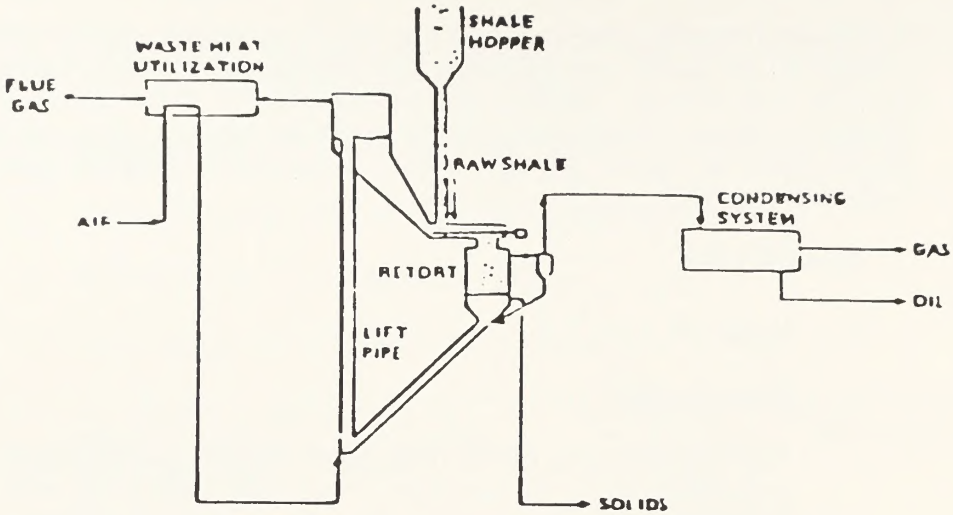
Description:

This method processes fine shale feed in the IH mode. Carbon in the processed shale is burned in the lift pipe, and the hot circulating processed shale from the lift pipe mixes with raw shale in a screw conveyor to bring about an intimate mixing of the solids.

In this process, properly sized raw shale will be delivered to a feed bin at the top of the process tower. From the feed bin the feed shale is delivered to the Lurgi mixer where it is mixed with hot, recycled, processed shale and is heated to a temperature of 900 to 1,000 F. At this temperature hydrocarbon vapors are released from the oil shale. The products of the retorting process are then passed through an oil condensation area consisting of three condensation/scrubber towers which recover the raw shale oil in three different fractions - heavy, medium and light oils. The heavy oil fraction contains fine particles of processed shale which are removed in the heavy oil dedusting area. The oil products are ultimately delivered to product storage tanks from which they are transported by tank trucks for delivery to markets.

The mixture of hot solids falls from the Lurgi mixer to a surge bin from which it enters the lift pipe. There it is contacted by a hot air stream of 840 F to initiate combustion of cokes and is lifted to the collecting bin. Residual carbon on the "fresh" processed shale will be burned as the material is lifted, along with auxiliary fuel as necessary, to achieve a temperature of approximately 1,200 F.

As the hot processed shale stream reaches the collection bin, a measured portion falls to the bottom of the collecting bin, completing the Lurgi loop while the remainder continues out of the collecting bin with flue gas to heat air and generate steam.



Lurgi LR

Engineering, Economic and Technological Considerations:

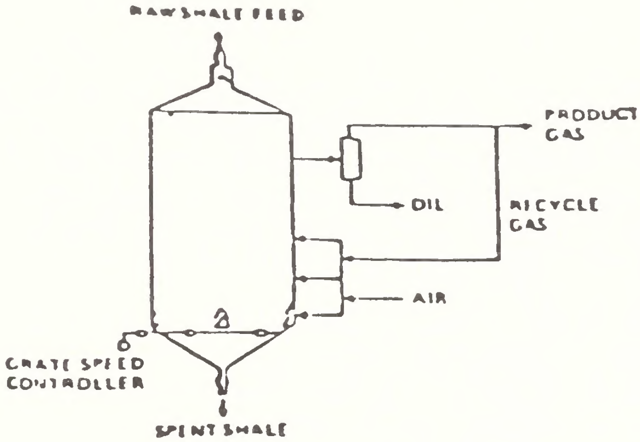
It is anticipated that the Lurgi LR process will not achieve an energy efficiency as high as the STB process.

b. Paraho DH

Description:

The Paraho process operates in DH mode on coarse shale feed in a vertical shaft retort in which the solids flow downward. Both combustion and retorting occur in the same retort vessel. The feed shale enters the top of the retort and is discharged at the bottom as retorted shale ash. The retorting action occurs in the top half and the combustion action in the middle of the vessel. A recycled gas combined with fresh air enters the bottom of the retort where cooling of the retorted shale takes place. The gas/air mixture is injected into the shale bed at multiple levels and flows upward.

The product oil leaves the top of the retort as an oil mist carried by the product gas. The hot gaseous products of combustion pass upward through the retort in countercurrent flow to the shale and are cooled before discharge. The gas carries the condensed shale oil in the form of vapor and mist out of the top of the retort to the separator. The combustible gases produced from kerogen decomposition are mixed with flue gases and form a low Btu gas by-product along with the oil. The low Btu gas, with about one tenth the heat content of natural gas, can be used for electrical generation but it must be used at the site because transportation costs would make it too expensive to use elsewhere.



Paraho Process

Engineering, Economic and Technological Considerations:

The Paraho DH retort produces a significant amount of energy in the form of undesirable low Btu gas. Additionally, the overall energy efficiency is less attractive than for STB because carbon B left on retorted shale. This fact also makes reclamation of spent shale more difficult.

c. Union B I-H

Description:

The Union B retort processes coarse shale feed and some fines in a vertical shaft retort. Within the retort rock flows upward (through the action of a rock pump) and the heating gas flows downward. The type B retort is IH.

Raw shale is introduced into the dual feed chutes, which are sealed with light oil. From these chutes, the raw shale is delivered into the retort chamber by a rock pump piston. In the retort chamber, the shale contacts hot recycle gas, which is introduced at the top of the chamber. The products of kerogen pyrolysis descent to the bottom of the retort where they are withdrawn at two levels as oil and high-Btu gas. Processed shale is ejected to chutes at the top of the retort chamber, quenched in the water seal, and conveyed to disposal.

Retort gas is cooled to condense light oils. The gas is then split into recycle gas and net product gas. The recycle gas is heated in a fired heater and fed to the top of the retort. The product gas is scrubbed, treated to remove ammonia and certain sulfur compounds, and compressed before being used as fuel.

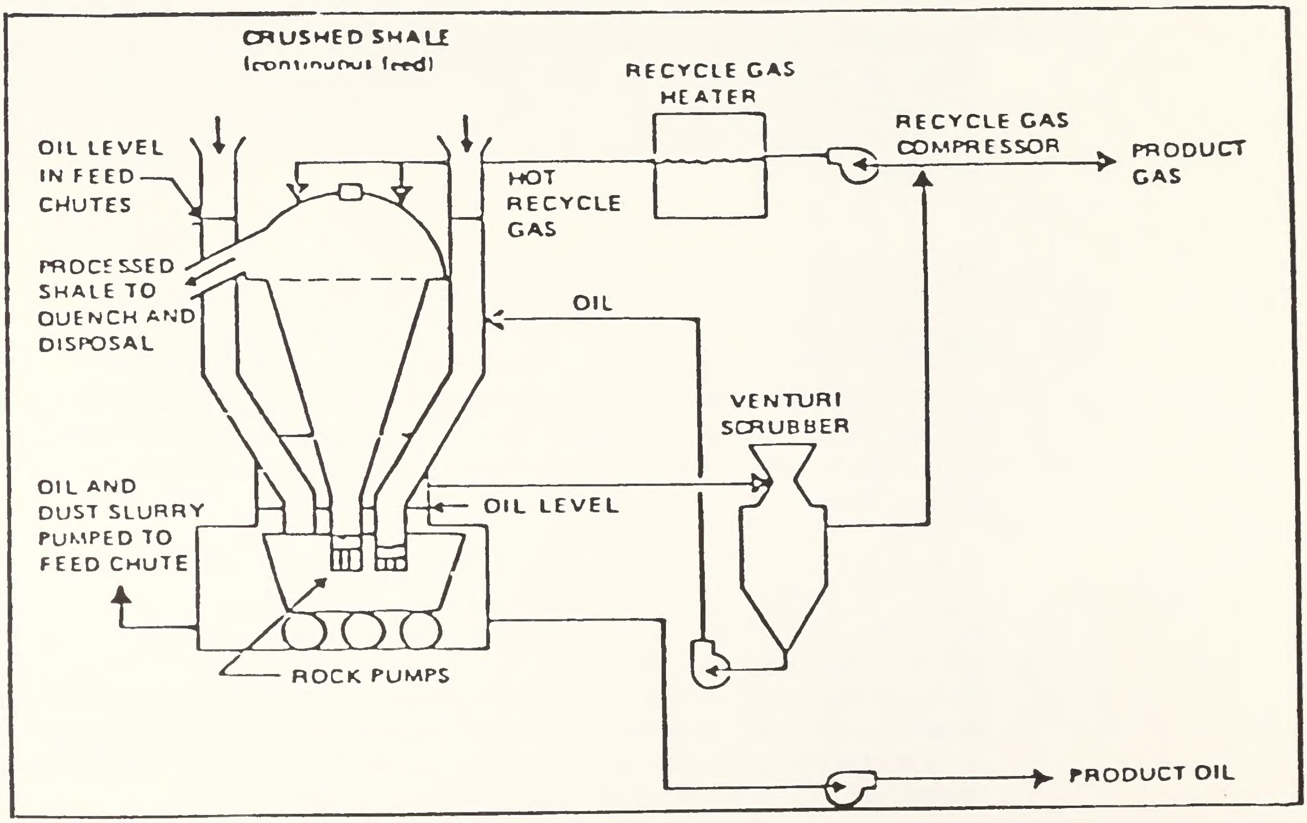
The vertical-shaft indirect-heated (IH) Union B retort has four significant features that distinguish it from the other retorting technologies:

- o <u>Moving Bed.</u> The shale is processed as a moving bed that progresses upward through the circular retort vessel. The driving force is a mechanical rock pump that forces raw shale up into the bottom of the retort via a piston-in-cylinder action.

- o <u>Concurrent Gas Flow</u>. Gas flow is downward, counter-current to the shale flow.

- o <u>Heated by Recycle Gas</u>. The only heat input to the retort is by recycle gas that is heated in a furnace external to the retort. The recycle gases are heated indirectly, and thus not diluted with the combustion gases.

- o <u>No Heat Recovery from Processed Shale</u>. The processed shale is discharged at retorting temperatures and is quenched in water seal pots.



Union B Retort

Engineering, Economic and Technological Considerations:

The Union B relies upon a rock pump for the introduction of shale to the retort. This rock pump will be subject to mechanical failure. Until the pump is successfully demonstrated at a commercial size retort module for a reasonable length of time, the success of the technology remains unproven.

d. TOSCO II

Description:

The TOSCO II method processes fine shale feed in an IH retort. The shale is heated to retorting temperature in the pyrolysis drum by hot ceramic balls. The mixture of shale and ceramic balls is then separated in a trommel.

Pyrolysis of the kerogen in the raw shale is accomplished in the pyrolysis drum by contacting the preheated shale with heated ceramic balls. In the pyrolysis drum, the crushed shale and ceramic balls are mixed to effect rapid heat transfer. The pyrolysis drum discharges directly into the accumulator.

Processed shale and balls from the drum are separated in a cylindrical trommel located with the accumulator. The warm balls pass from the accumulator to a ball elevator, while the processed shale discharges from the bottom of the accumulator to the processed shale cooler. Vaporized product shale oil and gas exit from the top of the accumulator.

Processed shale cooling is accomplished in two stages. In the first stage, the hot processed shale from the trommel is cooled in a rotating steam generator. In the second stage, the processed shale is cooled further by direct water quench in another rotating vessel. The cooled, moisturized shale is then delivered to processed shale disposal.

The ball elevator returns the balls to the ball heater, where they are heated to the required temperature by the combustion of fuel gas. The hot flue gases, after heating the balls, pass to the shale preheater.

Raw shale oil is condensed from the vapors leaving the retort section. The remaining gas is compressed and treated to remove ammonia and sulfur compounds before being used as fuel.

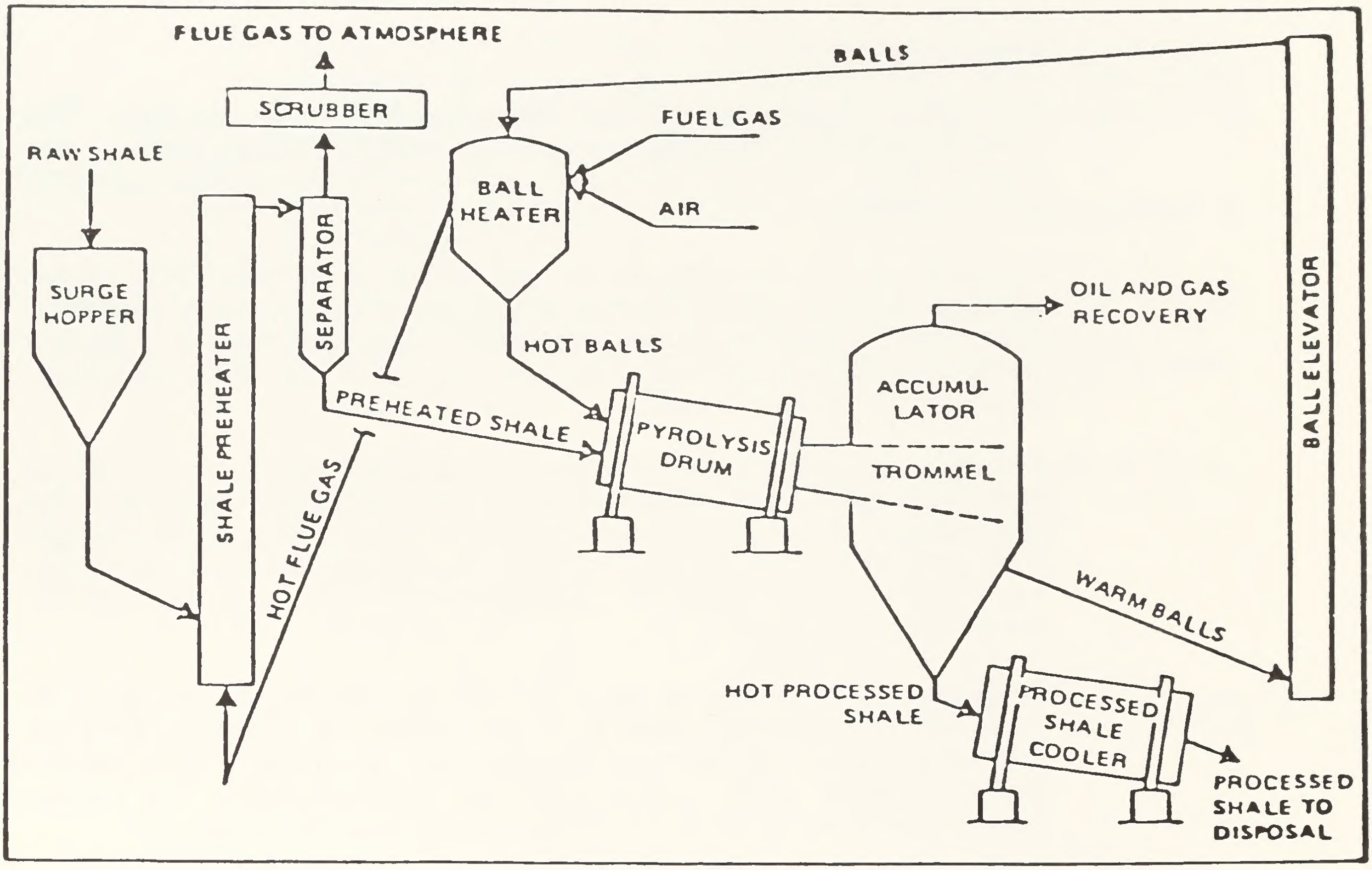
The fines-type retorting process has four significant features that distinguish it from other retorting technologies:

- Fluid Bed/Rotating Kiln. Solids transport is a mixture of fluidized bed and rotating kiln technologies. In all steps, the shale is processed as a moving bed.

- o <u>Solid Heat Carrier</u>. The major heat input is by direct contact with ceramic balls that have been heated by combustion of retort gas.

- o <u>Indirect Heat</u>. Combustion fuel gases do not mix with the retorting products, so a high-Btu gas is produced.

- o <u>Particle Size</u>. The raw shale feed must be less than ½ inch in size.



TOSCO II Retort

<u>Engineering, Economic and Technological Considerations:</u>

The TOSCO II retort relies upon circulation of ceramic balls for supplying heat to the shale. The STB process utilizes combustion of carbon on shale. Therefore the STB is more energy efficient. Comparative economics show that the TOSCO II process is not economically attractive. The STB has the added attraction of being able to handle wider variations of shale grade.

e. Superior

Description:

The Superior retort is designed for recovery of sodium bearing minerals in addition to shale oil. Shale is crushed and screened to minus 3 inch material and fed to a circular traveling grate retort. The shale goes through sequential stages of heating, retorting, burning, cooling, and discharging. Heating of raw shale is accomplished by passing hot recycled combustion gases through the shale bed. Alumina is recovered from the spent shale/calcined dawsonite and soda ash is recovered from calcined nahcolite.

Engineering, Economic and Technological Considerations:

The Clear Creek property contains less than commercially attractive quantities of nahcolite and dawsonite. This eliminates the attractiveness of the Superior process.

f. Retorting In-situ

Description:

True in-situ retorting of shale takes place by heating an underground reservoir of shale in the absence of mining. Modified in-situ occurs by mining a small (20-40%) portion of the resource, rubbilizing the resource by fracturing the shale, followed by heating/retorting in-place. Hydrocarbon gases and liquids are vented/pumped to the surface for recovery.

Engineering, Economic and Technological Considerations:

In-Situ technology has not been demonstrated to achieve commercially attractive resource recoveries. Also, environmental problems associated with leaving spent shale underground have not been solved.

Readily transported by pipeline except by maintaining the temperature above the pour point, or by adding pour point depressant. Even when this is done, the oil will still be very viscous and will require relatively high pump power. Furthermore, the raw shale oil is not interchangeable in the sense that it cannot be sold as a refined feedstock or mixed with other crudes in a common carrier pipeline.

2. UPGRADING

Introduction:

Upgrading is performed to make a feedstock suitable for refining. The following discussion is a qualitative assessment of the impact of upgrading alternatives in project economics, logistics, and environmental problems.

Upgrading Alternative Schemes

Oil shale retorting yields raw shale oil that is viscous and waxy and contains impurities such as nitrogen, sulfur, and arsenic.

Shale oil presents unusual refining problems. It is notable for high nitrogen content which can lead to poor product quality. It also contains large amounts of unsaturated hydrocarbons and metallic contaminants. Its unusual properties prevent its being mixed with crude oils for processing in most existing refineries. The raw shale oil maybe upgraded to some degree depending on its final use.

Initial hydrotreating removes contaminants and permits the use of conventional hydrocracking or fluid catalytic cracking (FCC). Distillates from coking of raw shale oil also require subsequent hydrotreating to remove residual impurities and meet final product specifications.

Many alternatives were considered for whole shale oil upgrading. Three basic shale oil processing routes for were studied: hydrotreating, coking followed by hydrotreating, and nothing.

The upgrading alternatives can be grouped according to the severity of processing, with the more severe operations resulting in the greatest change of shale oil characteristics.

a. Delayed Coking-Hydrotreating.

Description:

Figure 1 is a schematic flow diagram showing a refinery in which the shale oil is coked in a delayed coker followed by hydrotreating of the coker distillate. Coking involves thermal conversion of shale oil residue at elevated temperatures to produce coke and distillate oil fractions. In the delayed coking process, preheated residue is pumped to a drum where coking reactions take place. Gas and vapors flow to a recovery system where coker gas and distillate oils are produced. A part of the heavy oil produced is recycled to the feed. When a drum is filled with coke, flow is diverted to a second drum while the first drum is cooled and emptied.

The delayed coking process provides long residence time of oil vapors in the coking drum which is favorable for retention of fine shale solids in the coke rather than in the distillate oils. Consequently, this process is an important candidate for removal of "ash" from raw shale oil. Published experimental data indicates that delayed coking of shale oil also reduces the pour point of the oil to about $+25^{o}F$ to $+40^{o}F$. Products are diesel fuel, high octane gasoline, and liquefied petroleum gas (LPG). Again, the heavy naphtha from the first-stage hydrotreater is catalytically reformed. High octane motor gasoline is a blend of Rheniformate, C_5-C_6 from the hydrotreater, and butanes. It would be possible to produce salable diesel in the first-stage hydrotreater;

however, inclusion of a middle distillate hydrotreater provides additional refinery flexibility and permits the first-stage operation to be less severe. Jet fuel could be produced by severely hydrogenating a kerosene fraction in the middle distillate hydrotreater. The 650°F+ product is a suitable refinery fuel. Light gases supplement the 650°F+ as refinery fuel and are used also as feed for the hydrogen plant. Some C_3-C_4 is available for marketing as LPG.

Engineering, Economic and Technological Considerations:

A coker may be less expensive to construct conpared to a complex hydrotreater. The products from the coker is not as suitable for a refinery feedstock. The extent of pour point reduction depends on the extent of heavy oil recycle. It is expected that delayed coking will also remove a part of the nitrogen, sulfur, oxygen, and arsenic contained in the raw shale oil.

b. No Upgrading

Description:

In this option, no upgrading is performed at the site. The raw shale oil is shipped without modification to some offsite refinery for processing or to other available markets.

Engineering, Economic and Technological Considerations:

This option has two major drawbacks. Since the raw shale oil has a high pour point (about 85°F) (the lowest temperature at which a specific liquid will flow), the measure of internal friction or resistance to flow of a liquid), the raw shale is not readily transported by pipeline except by maintaining the temperature above the pour point, or by adding pour point depressant. Even when this is done, the oil will still be very viscous and will require relatively high pump power. Furthermore, the raw shale oil is not interchangeable in the sense that it cannot be sold as a refined feedstock or mixed with other crudes in a common carrier pipeline.

F. SPENT SHALE DISPOSAL ON THE CLEAR CREEK PROPERTY

1. SPENT SHALE DISPOSAL ON CLEAR CREEK PROPERTY - UNDERGROUND MINING PHASE

Introduction:

The large volume of retorted shale which must be disposed of is a direct result of the preparation and processing of raw oil shale. Based on estimates of volume to be mixed, a minimum disposal requirement of 604 million cubic yards is needed before backfilling into the open pit can begin.

a. North/South Clear Creek Fill

Description:

This alternative includes disposal of retorted shale on both sides of Clear Creek without disturbing the Mesa Valley floor. Clear Creek would be not diverted. Disposal to a final elevation below the existing ridge tops would provide storage for 240 million cubic yards of retorted shale.

Engineering, Economic and Technological Considerations:

Increasing the capacity of this disposal configuration to handle the required 604 million cubic yards could be achieved only by increasing the height and/or slope angle of the disposal pile. A disadvantage to raising the height of the disposal pile above existing ridge tops would be that the pile would be more vulnerable to wind erosion and would increase aesthetic impacts. Aside from inadequate disposal capacity, a further disadvantage of this alternative would be that protection of the creek bottom in the area below the 100-year floor elevation requires slopes of 3:1 or steeper to hold the planned retorted shale volume. These steep slopes may be more prone to failure and, because there is material placed on each side of the creek, the probability of some material reaching the creek bottom and being carried off-site is increased. This alternative also would have an economic disadvantage in that two overland conveyor systems would be required from the retort plant site, one on each side of the creek.

b. Clear Creek - Deep Canyon

Description:

This site would be located in the Clear Creek Canyon below the falls and above the confluence of Clear Creek and Willow Creek. The site would be just south of the southestern corner of the plant site. The site would have a limited retorted shale disposal capacity of 70 million cubic yards.

Engineering, Economic and Technological Considerations:

The proximity of this site to the plant would be an advantage; however, this is offset by its limited capacity, 70 million cubic yards, and interference with the access road into the mine property from DeBeque. The location of the mine property relative to the region and topographic considerations dictated that the major mine access road come up Clear Creek Canyon to at least the falls. Also, this scheme would require construction of some type of conduit to carry Clear Creek flow around or over the spent shale pile.

The limited capacity would require that a second out-of-pit site be developed to meet necessary storage requirements.

c. Northeast Corner of Property

Description:

This site is located in the northeast corner of the property approximately three air miles from the plant site. The disposal site would be located on the north side slopes of the Spring Creek drainage. This site would have a limited disposal capacity of 148.8 million cubic yards, with final slopes of 3:1.

Engineering, Economic and Technological Considerations:

A disadvantage of this site would be that it does not meet the minimum volume requirement of 604 million cubic yards. In this configuration the route from the retorts to this area would cross the open pit mining area and two additional valleys. Routing the disposal conveyors through the active mining area would result in significant disruption to both the mining and disposal operations. Additionally, the energy expenditure for transporting the retorted shale across two valleys, plus the risk of conveyor failure and subsequent short-term dumping in one of these valley bottoms, would not be acceptable, particularly in light of the fact that another site would be required to meet disposal requirements.

d. Underground Mine

Description:

This alternative would utilize the mined-out panels of the underground mine for disposal of retorted shale. The underground mine would handle about 16% (96 million cubic yards) of the total volume of retorted shale which must be disposed of prior to open-pit backfilling.

Engineering, Economic and Technological Considerations:

This alternative would be inferior due to insufficient capacity, as well as inability to match mining and disposal sequences. With this alternative, yet another surface disposal site would be needed because of the time required for the underground mine to advance sufficiently for backfilling to begin. If all available storage space was used, the underground mine could handle only about 16% of the total volume of retorted shale which must be disposed of prior to open-pit backfilling.

Several operational problems also would prevent disposal during mining activities. The underground mine has a relatively low ceiling height of 38 feet, which severely limits the room available in which to operate disposal equipment. Additionally, the mine may be ruled gassy, which might disqualify presently available disposal equipment from underground use due to ventilation standards. Another potential problem could be the dust and heat generated by retorted shale disposal. In the confinement of the underground mine, they could severely hamper a safe and efficient mining or disposal operation.

2. DRAINAGE CONTROL FOR SPENT SHALE OUT-OF-PIT DISPOSAL

Introduction:

Diversion of Willow and Clear Creeks would be necessary to insure mine safety and water quality. Willow Creek would be diverted to allow open-pit mining. Clear Creek will be diverted to prevent contact with retorted shale disposal in the Mesa Valley fill.

a. Willow Creek Open Channel Diversion to Clear Creek -North/South Clear Creek Fill

Description:

The Clear Creek side canyon alternative, with the channel diversion of Willow Creek, would allow disposal of 600 million cubic yards without disturbance to Clear Creek.

This site would allow disposal of 517,000,000 cubic yards of retorted shale without disturbance to Clear Creek. Clear Creek would retain its present streambed and flow from Willow Creek is diverted into Clear Creek.

West Willow Creek is diverted via deep rock cut channel into the Clear Creek drainage. The diversion would require the excavation of about 99,000,000 cubic yards of waste overburden. Storage volume of retorted shale is reduced on the north slope. This would reduce the total volume available on the hillsides to below the 600 million cubic yards required. Additional volumes available when material is elevated to 8,700 feet.

Engineering, Economic and Technological Considerations:

Retorted shale would be similarly disposed of on the north and south sides of Clear Creek with the entire fill constructed utilizing four zones of material:

- Zone I - impermeable barrier
- Zone II - moderately compacted zone
- Zone III - slope protection material
- Zone IV - main fill

The containing embankments would consist of three zones, I, II, and III, designed to provide a long-term solution to mass stability, settlement, pile runoff, and environmental considerations. The slopes of the fill would be proposed to be 2.5:1 between the benches with an overall embankment slope of 3:1. Benches would be incorporated in the overall layout of the disposal area embankments to provide a means of controlling runoff water.

The Clear Creek streambed would not be distrubed except for stream crossings for retorted shale transportation. The toe of the embankments would be kept above the flood levels of Clear Creek.

Retorted shale disposal would be established on top of the overburden waste fill developed at the southeast end of the open pit in Willow Creek.

The system used for placement of retorted shale in the open pit would be similar to that used in the side fill. The top layer of the retorted shale would be highly compacted to produce an impermeable surface and reclamation soils are replaced and revegetated.

Water from West Willow Creek would be diverted to Clear Creek via a deep channel. The channel would be cut into the native rock which prevents side wall sloughing. The channel would be also sized so that it can accommodate the 100-year flood from West Willow Creek without channel failure or overflowing. A 150-foot safety bench would separate the east side of the Willow Creek diversion channel from the north side shale disposal area.

3. RECLAMATION OF OUT-OF-PIT RETORTED SHALE

Introduction:

Disposed retorted shale would require stabilization by means of reclamation to produce an erosion-resistant landscape. Revegetation would be proposed as the most successful means of reclamation and land stabilization. Revegetation would be initiated when final retorted shale configurations are reached.

a. Revegetation Without Topsoil

Description:

Revegetation would take place directly in compacted retorted shale. Physical or chemical stabilization techniques would be utilized to reduce erosion.

Engineering, Economic and Technological Considerations:

Establishment of vegetation directly on retorted shale would require intensive management measures. The high salinity levels found in retorted shale would severely limit the kinds of plants which can grow in it. To lower the salinity to an acceptable level would require leaching with four to five acre-feet of water/acre. High sodium levels could be reduced by the addition of gypsum or sulfur. A high level of fertilization would also be required as retorted shale is quite infertile. Extensive additions of organic mulches would be required to create surface physical properties capable of supporting plant growth.

Considering the inherently adverse properties of retorted shale from a plant growth standpoint, it is clear that direct revegetation would be considerably more difficult than revegetation of soil-covered shale. Water requirements for leaching, heavy fertilization and poor physical properties of retorted shale preclude cost-effective revegetation.

G. POWER SOURCE

Introduction:

Estimates of power demand for the Clear Creek Shale Oil Project include 10 MW construction power, 50 MW for the first commercial retort, and 250 MW for full operation, which includes all plant, mining, and support operations. Steam produced on-site would be used to generate a maximum of 158 MW to supply part of the project power requirements. Additional power requirements would be supplied by one of the power source alternatives under consideration. These alternatives were selected based on analyses of regional power supply and demand as well as discussions with regional utilities and the Colorado Public Utilities Commission.

1. OFF-SITE POWER (ASSIST PUBLIC UTILITY IN BUILDING A POWER PLANT)

Description:

Chevron Shale Oil Company would purchase initial power requirements from Public Service Company of Colorado (PSCC) and assist PSCC in construction of a new facility to meet future project needs. Chevron could pay either interest on equity during construction for a share of the PSCC power plant. Chevron's investment would dedicate 290 MW of power from the PSCC plant to the Clear Creek project. The plant would serve as an integrated source in PSCC's system; thus, PSCC would provide power to the Clear Creek project in the event that this specific plant was not in service.

Engineering, Economic and Technological Considerations:

Although assisting PSCC in constructing a plant would assure a continuous power supply to the project at a somewhat fixed cost, there are several drawbacks which make this alternative less favorable than buying power outright. These disadvantages are as follows:

- o Would require an early commitment to PSCC (in 1982), prior to demonstration of the first commercial retort, in order to have plant come on-line in time to meet Chevron's power requirements.
- o Would require a large capital outlay in the early years of the project.
- o Chevron would pay demand charges at system current price when plant was not operating or operating at reduced capacity.
- o Chevron would have no control over operation, maintenance, or fuel cost.

2. CHEVRON TO BUILD OWN POWER PLANT

Description:

The alternative would involve the installation of two, 150 MW, coal-fired units at a site within 50 miles of the Clear Creek site. Environmentally appropriate sites exist near Rangely, Mack, and Delta. Chevron would construct, own, and operate the plant which would go into service at the end of the first commercial retort demonstration. Chevron would also construct, own, and operate the substation and transmission lines from the plant to the main site substation. Prior to operation of this plant, CSOC would purchase 50 MW of power from PSCC. Chevron would contract for up to 100 MW throughout the life of the project at then current prices for system backup, thus assuring 250 MW if one of Chevron's two 150 MW units was not available. The plant would be integrated into the regional transmission grid for backup.

Engineering, Economic and Technological Considerations:

The advantages associated with this option include assuring sufficient capacity for long-term needs, control over most power costs, provision of reserve power to transmission grid, and associated tax credits. The disadvantages may make this option less favorable than outright purchase from PSCC if regional power supplies are adequate to meet Chevron's demand. These disadvantages include:

- o Would require commitment before demonstration of first commercial retort to assure having plant on-line by 1989.
- o Would require large capital outlay early in project life.
- o Would require significant project management effort to assure on-time completion.
- o Chevron involvement would be required for plant operation and maintenance.
- o A contingency plan must be developed at the onset for divesting the plant in the event the project does not continue after the demonstration phase.

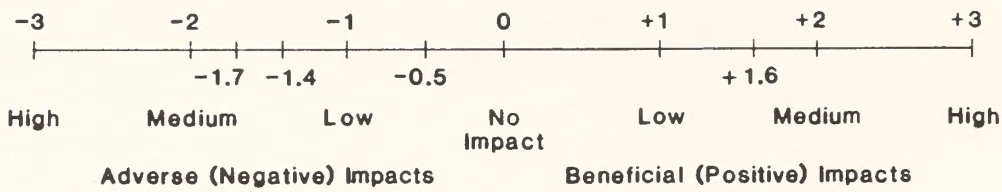
APPENDIX B

IMPACT ANALYSIS METHODS AND ASSUMPTIONS

APPENDIX B-1

NUMERICAL IMPACT RATING SYSTEM

A numerical impact rating system was used in this EIS because of: (1) the complexity of the project and its many alternatives and impacts, (2) the many environmental, social, and economic disciplines (16 or more) affected by the project, (3) the need to summarize and tally impacts, in contrast to qualitative ratings (e.g., fair, moderate, good, +, -, 0 could be alternate rating systems), and (4) the need to provide agency decisionmakers and reviewers, special interest group representative, the public, and the Operator with best professional judgments and comparisons of impacts, however subjective, from the EIS team for this large and complex proposal. The ratings are based upon best professional judgment of the relative impacts of various alternatives, along a continuum of -3 to +3, as shown below.



For purposes of comparison, it was decided to use tenths (e.g., one pipeline corridor might rate -1.4 for wildlife, while another might compare at -1.7).

The results of the overall impact analysis and comparison for the seven major project configurations and the No Action alternative are presented in Table 2.4-1.

The numerical ratings also allow comparison of the relative environmental impacts — beneficial or adverse — of project components (e.g., pipeline and transmission line corridors, reservoir sites) that could logically fit with any or all of major project configurations. Results of the impact analyses for spent shale disposal sites, access road corridors, reservoir alternatives, railroad and road corridors, water supply alternatives, transportation alternatives, spent shale disposal, and mining and processing alternatives are presented in Tables 2.4-4 and 2.4-6 through 2.4-11 in the text of the EIS (Section 2.4).

Throughout the impact analysis tables, the construction, operation and residual impacts of each alternative are assessed separately (as in Table 2.4-1 for major project configurations) or weighted and combined in the impact rating (as in Tables 2.4-4 through 2.4-10 for project components, such as alternate pipeline routes). When weights are incorporated in the impact analysis, these weights (e.g., construction 60%, operation 20%, residual 20%) are given in the footnote to the table.

The terms "construction" and "operation" are self-explanatory. For purposes of this EIS, the term "residual impacts" means those following project shutdown, decommissioning, and abandonment. For instance, especially in western Colorado, a road or a reservoir designed to serve the project will often remain long after project shutdown, creating a beneficial (or adverse) "residual" project impact.

The order of presentation for impact comparisons of various alternatives in Section 2.4 follows generally the order of project alternatives in Sections 2.1 through 2.3.

- Each major project configuration is compared as an "alternative package" in an overall sense. This "package" impact comparison, which should be especially useful for the lay reader, is given in Table 2.4.1.

- Project components (roads, pipelines, etc.) will next be presented separately by type.

- Project components on each table will be compared within the context of the project configuration to which they apply. For example, the La Sal/Parachute Creek product transport corridor (applicable to all major project configurations) will be compared to the Fruita to SOPS corridor (applicable only to Fruita I and Fruita II).

APPENDIX B-2
AIR QUALITY MODELING AND ASSUMPTIONS

COMPLEX I, which was used to predict impacts from the upgrading and retorting facilities, is a steady state, multiple-source, Gaussian dispersion model. It was designed for use with stack emission sources in complex terrain, where terrain elevation exceeds source stack heights and duplicates the basic algorithm of the VALLEY (EPA 1977a) model. The model uses sequential hourly meteorological data (wind speed, wind direction, temperature, stability class and mixing height), and centers the 22.5 degree sector averaged plume on the hourly wind directions. The values of wind speed are adjusted to stack height by standard wind shear profile equations and exponents. For this study, the wind profile exponents given in the Regional Workshop on Air Quality Modeling (EPA 1981) were employed. During nonstable conditions, the plume is assumed to be reflected at the mixing height; therefore, if the effective plume height is above the mixing height, the entire plume is assumed to be trapped above the mixing height with no ground-level impact. Mixing height is not considered during stable dispersion conditions.

COMPLEX I options which were utilized in this study include buoyancy-induced dispersion, gradual plume rise, and half-height plume path coefficient for nonstable conditions. The buoyancy-induced dispersion option accounts for buoyant growth of a plume caused by entrainment of ambient air according to the methods of Pasquill (1976). Gradual plume rise accounts for downwind transport of the plume during the rising phase according to the procedures outlined by Briggs (1972) and was employed in this modeling study because several receptors along the eastern property boundary are located within 1 kilometer of some emission sources. This distance may be less than the distance to final rise during some atmospheric conditions. The half-height correction for unstable conditions is based on the analysis by Egan (1975) of a plume embedded in a potential flow approaching a hemispherical terrain object, which indicates that a half-height correction to the Gaussian formula will provide an estimate of the peak ground-level concentration expected.

With the COMPLEX I model, maximum concentrations are generally predicted during stable plume impingement at the nearest distance downwind where the elevation of the rising terrain equals the effective stack height of the plume. Therefore, to select receptors associated with maximum impact in high terrain, the effective stack height for each of the source types was calculated using the PTPLU MODEL (EPA 1980b). The PTPLU model calculates plume rise using the standard Briggs (1969, 1971, 1975) equation.

The ISCST model which was used to predict impacts from the mining facility, is a steady state, multiple source Gaussian dispersion model. The generalized Briggs (1971, 1975) plume-rise equations, including the momentum terms, are used to calculate plume rise as a function of downwind distance. A wind profile exponent law is used to adjust the observed mean wind speed from the measured height.

The particle deposition algorithm in the ISC model requires specification of deposition velocities and reflection coefficients for each particle size class. Five particle size classes were used in modeling the Clear Creek project fugitive dust sources. Table B-2-1 presents the mass fraction, gravitational settling velocity, deposition velocity and reflection coefficient for each particle size class.

The mass distribution for the five specified size categories is based on an average of particle size measurements made by PEDCo/MRI (1981) at surface coal mining operations in the western United States. The gravitational settling velocities were calculated from the Stokes equation using an assumed particle density of 2 g/cm^3. Selection of deposition velocities and reflection coefficients is described in detail in Appendix 4 of the mining and retorting PSD application (Chevron 1982d).

Ozone impacts were predicted using the EPA's (1980c) Empirical Modeling Approach (EKMA) and a variation of this model. The standard version of EKMA incorporates a photochemical mechanism designed for urban areas in which transportation sources dominate the emission inventory. This is clearly not the case for the Grand Valley upgrading facility. For the purpose of this

Table B-2-1 PARTICLE SIZE DISTRIBUTION AND DEPOSITION PARAMETERS

Particle Size Class	Range of Particle Size (um)	Mass Distribution[a]	Characteristic Particle Diameter (um)	Gravitational Settling Velocity[b] (m/sec)	Deposition Velocity (m/sec)[c]	Reflection Coefficient
1	0-2.5	3%	1.6	0.0001	0.002	0.82
2	2.5-5	4%	3.9	0.0009	0.006	0.71
3	5-10	9%	7.8	0.0036	0.01	0.50
4	10-15	5%	12.7	0.0095	0.019	0.26
5	>15	79%	22.2	0.0294	0.029	0.03

[a] PEDCo/MRI (1981). Mass distribution shown for fugitive sources. The mass distribution for sources controlled by a baghouse were linearly adjusted assuming no particles >15 microns.

[b] Based on Stokes law for particles of spherical shape with diameter equal to the characteristic particle diameter for each size class. The density of the particles was assumed to be 2 g/cm^3.

[c] From Sehmel and Hodgson (1980).

study, a chemical mechanism, based on the latest kinetic and mechanistic data for selected hydrocarbon photo-oxidations (Atkinson et al. 1982), and capable of incorporating hydrocarbon species more appropriate for the types of emissions expected to occur from operation of the upgrade facility, was substituted into the EKMA framework (ERT/EKMA). A full discussion of this modification is presented in Appendix C of the upgrading facility PSD application (Chevron 1982f). Ozone impacts were also examined with the standard EPA/EKMA model. The results are based on three transport scenarios and three specific historical-meteorological conditions, and indicate that emissions from shale oil upgrade facilities will have minimal impact on ambient maximum ozone concentrations.

Impacts of Particulate Matter

Particulate matter may include a wide range of particle sizes, forms, and chemical compositions. Each of these factors affects the potential environmental impact of the particulates which are emitted. Particulates which are deposited on plant surfaces can remain as a dry dust, can be removed by wind or rain, or can form a hard incrustation. The primary effects of particulates on vegetation include: (1) inhibiting gas exchange, (2) increasing leaf temperature, and (3) reducing photosynthesis. Particulate deposits may be directly toxic to vegetation if they contain toxic elements which can be hydrated and taken up through leaf surfaces.

The soil forms the major sink for particulate matter. Again, the chemical and physical characteristics of the particulates determine the nature of the impacts produced in the soil environment. Litter decomposition, mineralization, and nutrient cycling may all potentially be affected by particulate deposition. The deposition of soluble toxic elements can be harmful to plants if they are taken up through the roots.

Particulate matter is generally not considered to be a pollutant which produces significant environmental impacts on soils and vegetation. Literature addressing the impacts of particulates on vegetation are quite limited. Generalized impact assessments for particulates are difficult to conduct since the chemical composition, deposition rate, and solubility of potentially toxic elements must be known in order to evaluate the potential impact of these emissions.

Impacts of Oxides of Nitrogen

The primary NO_x constituents are nitric oxide (NO) and nitrogen dioxide (NO_2). Plant injury is thought to be primarily a function of exposure to NO_2. The combustion of fossil fuels and industrial processes are two important anthropogenic sources of NO_x.

The potential for NO_2 impacts on vegetation is a function of the pollutant dose, environmental conditions of exposure, plant species exposed, and the genetic and physiologic characteristics of the exposed plants (Middleton et al. 1958). The air quality impact analysis shows regional compliance with NO_2 NAAQS of 100 ug/m^3 (annual average). This standard is considered adequate to protect vegetation from injury.

Evidence of plant response to toxic levels of NO_x can be divided into three major categories: (1) acute injury; (2) chronic injury; and (3) physiological effects. Acute injury is manifested by collapse of cells with subsequent development of identifiable necrotic patterns. Symptoms usually result from short exposures (hours) to varying levels of NO_2 and appear within 2 to 48 hours after exposure.

Chronic injury is caused by intermittent exposure, over longer periods, to low concentrations of gas. It results in chlorotic or other pigmented patterns in leaf tissue and may be accompanied by loss of leaves (leaf-drop) (HEW 1971). Physiological effects frequently associated with pollutant exposure cause growth alterations, reduced yields, and changes in quality of plant products.

Symptoms of NO_2 injury appear as irregular white or brown collapsed lesions on tissue between the veins and near the leaf margin (Southwest Energy 1972).

Impact of SO_2 on Vegetation in the Grand Valley

The vegetation in the Grand Valley region can be divided into six major habitat types: river woodland, phreatophytic shrub, marsh, agricultural, desert, and pinyon-juniper (ECI 1976). The river woodland habitat is prevalent along the Colorado River drainage. Phreatophytic shrub habitats occur along wastewater drainages and on a great variety of agricultural waste areas with high water tables. Marsh habitat develops near seeps along irrigational canals and in lowland areas which are regularly inundated by surface water. Agricultural habitat exists on cultivated lands which rely on irrigation water. Desert shrub habitat and pinyon-juniper habitat occur on nonirrigated lands in the region. Pinyon-juniper habitat is of limited extent and is primarily located along the southwestern edge of Grand Valley.

Excessive dosage of SO_2 can adversely impact vegetation by producing foliar injury and inducing accelerated leaf senescence. In addition, biomass production is believed to be influenced by SO_2 exposure. Long-term exposure to SO_2 may also lead to reduced vegetation growth and yield.

Impact of SO_2 on Vegetation at Arches National Park

The dominant vegetation habitats at Arches National Park are pinyon-juniper, blackbrush, cottonwood parmarisk, sagebrush, and shadscale (Chevron 1982f). Pinyon-juniper and blackbrush are found in abundance throughout the park. Cottonwood parmarisk occurs in dry washes and along riverbanks where water is available. Sagebrush is highly localized and can only be found in limited areas of the park. Shadscale occurs in areas where soil conditions are poor.

The basic equation is:

$$= Q/UA$$

where: = ground-level pollutant concentration (ug/m^3)
Q = pollutant emission rate (ug/sec)
U = ventilation wind speed (m/sec)
A = cross-sectional area normal to the ventilating wind defined by the narrowest city side and the mixing height

This equation yields maximum concentrations during stable nighttime dispersion when wind speed and mixing height are at a minimum. Mean wintertime (worst-case) values for these parameters measured at Grand Junction are 3.1 m/sec wind speed and 276 m mixing depth (Holzworth 1972). The length of the shortest city side is about 5 km for Grand Junction and 1.25 km for Fruita. The 1-hour concentration estimates predicted were converted to longer averaging times by assuming three hours of persistance for 3-hour averages, and 6-hour of persistance for 8-hour and 24-hour averages.

APPENDIX B-3

LAND USE, RECREATION, AND WILDERNESS IMPACT ANALYSIS METHODS AND ASSUMPTIONS

The land use impact analysis was conducted by preparing and ground-truthing a land use map of the study areas and projecting the number of acres to be disturbed in the future (e.g., by mining) in each land use category versus the number of acres in current use (e.g., agricultural production) for each of these categories. The recreation and wilderness impact analysis was conducted by preparing maps of the recreation and wilderness areas affected by the project and incorporating projected labor force information (see Section 4.12, Socioeconomics) for each of these areas, thereby determining relative degree of impact for each area.

Assessment areas for land use, recreation, and wilderness differed significantly. The land use assessment areas were smaller in scale and more localized than the recreation and wilderness areas. These latter studies, in contrast, were more regional in nature.

Assumptions underlying this section include the following:

- Approximately 9,000 workers will be employed by the project during the peak construction year (1994); approximately 5,100 operations workers will be employed when the plant becomes fully operational (2002).
- Approximately 1,500 single-status workers will be housed in the construction worker facility located in Garfield County for the duration of the construction period.
- Sixty-five percent of all constructions workers are assumed to be non-local workforce; all operations workers are assumed to be local residents.

The radius percentage method chosen to determine impact to the community recreation facilities and recreation management areas is as follows:

- Grand Junction is the major population center between DeBeque and Fruita and was chosen as the center point from which radii were drawn.

- Radii were drawn at increments of 25 mi from the center until the furthest recreation management area was reached, then impact percentages were assigned to each radii as follows:

Miles From Center Point	Percentage of "Impact Persons" Visiting That Area
25 miles	25%
50 miles	15%
75 miles	5%

APPENDIX B-4

SOCIOECONOMIC IMPACT ASSUMPTIONS

APPENDIX B-4

SOCIOECONOMIC IMPACT ASSUMPTIONS

Major assumptions governing the body of the facilities, services, and fiscal projections for analysis of the socioeconomic impacts of the CCSOP are as follows:

- All financial projections were made in 1982 dollars to avoid confusion due to the effects of inflation and allow for consistent future year comparisons.
- Projections of revenues, expenditures, and fiscal balances have been made for the purpose of assessing and comparing the potential effects of future growth under the various alternatives and do not represent future year budgets. Annual budgets must by law be balanced, and local governments make adjustments, as necessary.
- These projections are based on three years of historical budgetary data, and assume that the current taxation and rate structures continue to be applied by each entity for the duration of the study period.
- Information on planned capital facilities expansions and cost standards were obtained from local officials, and/or locally-adopted Capital Improvements Programs. In most cases, these plans represent improvements needed to correct existing deficiencies or postponed capital plans and are not induced by the projected growth. Projections of future capacity and capital requirements are based on decision rules incorporating assumptions about capacity standards, planning period, and lead time.
- Funding for capital projects was entered into the projections only where sources of funding (grants, loans, or bond issues) had already been identified and/or committed. It is logical to assume that continued use of grants, bonding and third party funding will occur. But, as no assumptions as to the availability or amounts can logically be made, no attempt to project such sources had been made. School mill levies were projected to test the 20 percent statutory limit.
- No assumptions about phasing of capital projects were made unless previously identified by the agency. The estimated cost of the facility appears in the year in which the threshold determining need for additional capacity is crossed. Financing, third party funding, and phasing approaches are considered mitigation strategies.

- The fiscal effects result in large measure from the projected spatial allocation of the direct CCSOP employees, the size of the community and location of business and services which influence where secondary workers and their families are most likely to locate. The spatial allocation projections considered distance from residential areas to the project facilities, availability of housing, local capacities to accommodate growth (primarily water, sewer, and schools) and the likely attractiveness of the community to families moving into the area.

- A basic assumption that largely affects the mitigation is that with the shutdown of the Colony Project, even though there is considerable assessed valuation projected in a number of entities, the voters will not want to assume any risk of being left with public debt should the CCSOP or Union falter. Hence, it may be difficult to sell bonds in the early stages of the project, even though bond financing is the normally accepted method of financing public facilities.

- Projections of operation and maintenance costs associated with existing facilities were based on existing expenditure levels. Induced operation and maintenance costs associated with new capital facilities are based on the assumption that these costs average 10 percent annually of the total capital cost.

Table B-4-1 presents a summary of basic activities in the six-county area which was analyzed for socioeconomic impacts.

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE

BAS File Number	Description	County	Sector	Time Period
1	Ag. Proprietors	Delta	Ag. Proprietors	1980 - 2000
2	Basic Ag. Labor	Delta	Ag. Labor	1980 - 2000
3	Orchard Valley Oper.	Delta	Mining	1980 - 2000
4	Somerset Mine Oper.	Delta	Mining	1980 - 2000
5	Mt. Gunnison Mine Operation	Delta	Mining	1980 - 2000
6	Hawks Nest - East & West Operation	Delta	Mining	1980 - 2000
7	Red Canyon Mine Operation	Delta	Mining	1980 - 2000
8	Blue Ribbon Operation	Delta	Mining	1980 - 2000
9	Bear Mine Operation	Delta	Mining	1980 - 2000
10	Tomahawk Operation	Delta	Mining	1980 - 2000
11	Mt. Gunnison Const.	Delta	Construction	1981 - 1986
12	Lower Gunnison Salinity Project	Delta	Construction	1985 - 1991
14	Basic Construction	Delta	Construction	1980 - 2000
15	Basic Manufacturing	Delta	Manufacturing	1980 - 2000
17	Rio Grande Railroad	Delta	TCPU	1980 - 2000
18	Basic Trade	Delta	Trade	1980 - 2000
19	Basic Services	Delta	Services	1980 - 2000
20	Basic Government	Delta	Government	1980 - 2000
21	Basic NFP	Delta	Other	1980 - 2000

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
22	Ag. Services	Delta	Ag. Labor	1980 - 2000
23	Ag. Proprietors	Garfield	Ag. Proprietors	1980 - 2000
24	Basic Ag. Labor	Garfield	Ag. Labor	1980 - 2000
25	Loma Complex - Const.	Garfield	Construction	1985 - 1990
26	Loma Complex - Oper.	Garfield	Mining	1980 - 2000
27	Basic Manufacturing	Garfield	Manufacturing	1980 - 2000
28	Basic TCPU	Garfield	TCPU	1980 - 2000
29	Rio Grande Railroad	Garfield	TCPU	1980 - 2000
30	Basic Trade	Garfield	Trade	1980 - 2000
31	Basic Services	Garfield	Services	1980 - 2000
32	Basic Government	Garfield	Government	1980 - 2000
33	Basic NFP	Garfield	Other	1980 - 2000
34	Glenwood-Dotsero Salinity	Garfield	Construction	1992 - 1993
35	Basic Construction	Garfield	Construction	1980 - 2000
36	Afg. Services	Garfield	Ag. Labor	1980 - 2000
37	Ag. Proprietors	Mesa	Ag. Proprietors	1980 - 2000
38	Basic Ag. Labor	Mesa	Ag. Lavor	1980 - 2000
39	Roadside and Cameo - Operation	Mesa	Mining	1980 - 2000
40	Fruita #1 and #2 - Operation	Mesa	Mining	1980 - 2000

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
42	Uranium - Admin.	Mesa	Mining	1980 - 2000
43	Uranium - Mining	Mesa	Mining	1980 - 2000
44	Oil & Gas Drilling	Mesa	Mining	1980 - 2000
45	Oil & Gas Production	Mesa	Mining	1980 - 2000
46	Basic Mining	Mesa	Mining	1980 - 2000
47	Basic Construction	Mesa	Construction	1980 - 2000
48	Grand Valley Salinity	Mesa	Construction	1980 - 1990
49	Fruita #1 and #2 - Construction	Mesa	Construction	1983 - 1990
50	Southwest #1 Const.	Mesa	Construction	1984 - 1989
51	Basic Manufacturing	Mesa	Manufacturing	1980 - 2000
52	Rio Grande Railroad	Mesa	TCPU	1980 - 2000
53	Cameo Unit #1 and #2 - Operations	Mesa	TCPU	1980 - 2000
54	Southwest #1 Oper.	Mesa	TCPU	1987 - 2000
55	Basic TCPU	Mesa	TCPU	1980 - 2000
56	Basic Trade	Mesa	Trade	1980 - 2000
57	Basic Services	Mesa	Services	1980 - 2000
58	Basic Government	Mesa	Government	1980 - 2000
59	Basic NFP	Mesa	Other	1980 - 2000
60	Ag. Services	Mesa	Ag. Labor	1980 - 2000
61	Ag. Proprietors	Moffat	Ag. Proprietors	1980 - 2000

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
62	Basic Ag. Labor	Moffat	Ag. Labor	1980 - 2000
63	Uranium - Mining	Moffat	Mining	1980 - 2000
64	Oil & Gas Drilling	Moffat	Mining	1980 - 2000
65	Oil & Gas Production	Moffat	Mining	1980 - 2000
66	Colo Wyo - Operation	Moffat	Mining	1980 - 2000
67	Eagle #9 - Operation	Moffat	Mining	1980 - 2000
68	Eagle #5 - Operation	Moffat	Mining	1980 - 2000
69	Trapper - Operation	Moffat	Mining	1980 - 2000
70	Basic Construction	Moffat	Construction	1980 - 2000
71	Craig Unit #3 - Construction	Moffat	Construction	1981 - 1983
72	Eagle #5 - Const.	Moffat	Construction	1980 - 1981
73	Basic Manufacturing	Moffat	Manufacturing	1980 - 2000
74	Craig Unit #1 and #2 - Operations	Moffat	TCPU	1980 - 2000
75	Craig Unit #3 Oper.	Moffat	TCPU	1981 - 2000
76	Basic TCPU	Moffat	TCPU	1980 - 2000
78	Railroads	Moffat	TCPU	1980 - 2000
79	Basic Trade	Moffat	Trade	1980 - 2000
80	Basic Services	Moffat	Services	1980 - 2000
81	Basic Government	Moffat	Government	1980 - 2000
82	Basic NFP	Moffat	Other	1980 - 2000

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
83	Ag. Services	Moffat	Ag. Labor	1980 - 2000
85	Ag. Proprietors	Rio Blanco	Ag. Proprietors	1980 - 2000
86	Oil & Gas Drilling	Rio Blanco	Mining	1980 - 2000
87	Oil & Gas Production	Rio Blanco	Mining	1980 - 2000
88	Northern Minerals Meeker Area Complex	Rio Blanco	Mining	1980 - 1982
89	Basic Construction	Rio Blanco	Construction	1980 - 2000
90	Basic Manufacturing	Rio Blanco	Manufacturing	1980 - 2000
91	Basic TCPU	Rio Blanco	TCPU	1980 - 2000
92	Basic Trade	Rio Blanco	Trade	1980 - 2000
93	Basic Services	Rio Blanco	Services	1980 - 2000
94	Basic Government	Rio blanco	Government	1980 - 2000
95	Basic NFP	Rio Blanco	Other	1980 - 2000
96	Basic Ag. Labor	Rio Balnco	Ag. Labor	1980 - 2000
97	Deserado Mine Const.	Rio Blanco	Construction	1981 - 1984
98	Deserado Mine Oper.	Rio Blanco	Mining	1981 - 2000
99	Deserado Railroad Construction	Rio Blanco	Construction	1982 - 1983
100	Deserado Railroad Operation	Rio Blanco	TCPU	1984 - 2000
101	Moon Lake #1 Const.	Rio Blanco	Construction	1981 - 1985
102	Moon Lake #1 Oper.	Rio Blanco	TCPU	1982 - 2000
103	Moon Lake #2 Const.	Rio Blanco	Const.	1988 - 1992

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
104	Moon Lake #2 Oper.	Rio Blanco	TCPU	1989 - 2000
105	Ag. Services	Rio Blanco	Ag. Labor	1980 - 2000
106	Ag. Proprietors	Routt	Ag. Proprietors	1980 - 2000
107	Basic Ag. Labor	Routt	Ag. Labor	1980 - 2000
108	Edna Strip Operation	Routt	Mining	1980 - 1997
109	Seneca Strip Operation	Routt	Mining	1980 - 2000
110	Energy Strip #1, #2, and #3 - Operations	Routt	Mining	1980 - 2000
111	Hayden Gulch Oper.	Routt	Mining	1980 - 2000
112	Meadows #1 Operation	Routt	Mining	1980 - 1985
113	Trout Creek #2 Oper.	Routt	Mining	1985 - 2000
114	Basic Construction	Routt	Construction	1980 - 2000
115	Trout Creek #2 Const.	Routt	Construction	1983 - 1985
116	Basic Manufacturing	Routt	Manufacturing	1980 - 2000
117	Hayden #1 and #2 - Operation	Routt	TCPU	1980 - 2000
118	Basic TCPU (Railroad)	Routt	TCPU	1980 - 2000
119	Basic TCPU	Routt	TCPU	1980 - 2000
120	Basic Trade	Routt	Trade	1980 - 2000
121	Basic F.I.R.E.	Routt	Fire	1980 - 2000
122	Basic Services	Routt	Services	1980 - 2000
123	Basic Government	Routt	Government	1980 - 2000

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (continued)

BAS File Number	Description	County	Sector	Time Period
124	Basic NFP	Routt	Other	1980 - 2000
125	Ag. Services	Routt	Ag. Labor	1980 - 2000
129	Metals #1	Routt	Mining	1980 - 2000
130	Apex #2	Routt	Mining	1980 - 2000
131	Miidcontinnent Res.	Pitkin	Mining	1980 - 2000
132	Sunlight Mine	Garfield	Mining	1980 - 2000
143	Rio Blanco Construc.	Rio Blanco	Construction	1980 - 1982
144	Multiminerals Admin.	Mesa	Mining	1980 - 2000
145	Rio Blanco Operation	Rio Blanco	Mining	1980 - 1982
146	Oxy (Log. Wash) Oper.	Mesa	Mining	1980 - 1982
147	Oxy (Logan Wash) Base	Mesa	Mining	1980 - 1982
148	Oxy (C-B) Base	Mesa	Mining	1980 - 1982
149	Oxy (C-B) Operation	Rio Blanco	Mining	1980 - 1982
150	Union Operations	Garfield	Mining	1980 - 2000
151	Oxy (C-B Construc.)	Rio Blanco	Construction	1980 - 1981
153	Union Construction	Garfield	Construction	1980 - 1993
155	Commuter Into Delta County	---	Other	1980 - 2000
156	Commuter Adjust Out of Mesa County to Delta County	---	Other	1980 - 2000
193	Red Canyon Construc.	Delta	Construction	1983 - 1985

Table B-4-1 SUMMARY OF BASIC ACTIVITIES IN SIX-COUNTY STUDY AREA INCLUDED IN NO ACTION ALTERNATIVE (concluded)

BAS File Number	Description	County	Sector	Time Period
194	North Thompson Creek Construction	Garfield	Construction	1982 - 1983
195	North Thompson Creek Operations	Garfield	Mining	1981 - 2000
196	Grassy Creek Mine #1	Routt	Mining	1980 - 2000
230	Colony Operations, Shutdown	Garfield	Mining	1980 - 1982
231	Colony Construction, Shutdown	Garfield	Construction	1980 - 1982
234	Multimineral Operation, Shutdown	Rio Blanco	Mining	1980 - 1982

APPENDIX C

MITIGATION

C-1 Summary Tables of Potential Environmental Impacts and Recommended Mitigation

C-2 Detailed Social and Economic Mitigation Measures

APPENDIX C-1

SUMMARY TABLES OF POTENTIAL ENVIRONMENTAL IMPACTS AND RECOMMENDED MITIGATION[a]

[a] Cultural resources mitigation is addressed in Section 4.10.

Table C-1-1 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION UNDERGROUND MINE - CLEAR CREEK MESA

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION	<u>Surface and Ground Water</u>	
	Ground water contamination from underground mine activities	*Containment of high TDS surface water at Spillway 1 (West Willow Creek) and Spillway 2 (Clear Creek) for settlement, before releasing into mined-out portion of the underground mine
		*Proper routing and/or confinement of surface waters diverted underground to prevent infiltration to and degradation of ground water (or surface water)
		*Control of oil and grease spills and proper storage of such chemicals to prevent ground water degradation
		*Diversion and treatment of mine inflows before release into ground water
		Minimize ground water exposure to blasted rock exposed to ammonium nitrate
		Monitor underground by-pass water quality
		Compliance control program for mine inflows and surface flows diverted through the mine
	<u>Wildlife</u>	
	Displacement of wildlife resulting from increased human access to and activity in sensitive areas	Restrict access to key wildlife use areas; closure of such areas during high use/concentration
		*Equip machinery to suppress noise
		Avoid wetland areas through siting alternatives
		Avoid construction of project facilities on or near key wildlife use areas (nesting, fawning, calving areas)
		Restrict ORV use

Table C-1-1 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION UNDERGROUND MINE - CLEAR CREEK MESA (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
RECLAMATION (POSTOPERATIONAL)	Wildlife	
	Decrease in wildlife habitat quantity and quality	Restore premining level of interspersion of shrubs, grassland, and forest cover
		Restore forest cover in all topographic situations suitable for tree plantings
		Establish brush piles throughout reclaimed areas to increase availability of cover for small animals
	Vegetation	
	Loss of candidate threatened or endangered plant habitat	Maintain surface water flows and quality at Clear Creek Falls area
		Avoid or minimize disturbance to talus slopes and cliffs in developing access roadway
	Surface and Ground Water	
	Ground and/or surface water quality	Determine (and improve as needed) the quality of water passing through the abandoned excavations before releasing into Clear Creek

* Committed mitigation.

Table C-1-2 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION
SURFACE MINE - CLEAR CREEK MESA

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION	Surface and Ground Water	
	Surface and ground water contamination	*Safe routing of all surface flow from spring discharge around all disturbed areas
		*Proper control of oil, grease, and diesel and spills
		*Use poor quality runoff collected in the pit as spent shale moisturizing water
		Prevention of underdrain clogging
		*Proper routing or containment of underdrain discharge if it has poorer quality than receiving waters
		Replacement of wells or water lost to affected users
		*Design diversion channels constructed for Mud Springs, No Name Creek, and East Willow Creek to handle a 25-yr flow
		Compliance control program
	Wildlife	
	Avifauna (bird) mortality resulting from electrocution	Avoid riparian and wetland areas through siting
		Avoid key raptor foraging, roosting and nesting areas through siting
	Wildlife mortality resulting from collisions with vehicles	*Use lower speed limits to reduce collisions
		Avoid key wildlife use areas through siting
		*Reseed roadside areas with unpalatable herbaceous species to lessen attraction of big game to reseded areas
		Construct fencing and underpasses

Table C-1-2 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION SURFACE MINE - CLEAR CREEK MESA (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION (Cont.)	Wildlife (Cont.)	
	Wildlife mortality resulting from illegal harvest	Subsidize law enforcement programs
		Employee education program
		Stringent corporate policies
	Decrease in wildlife habitat quantity and quality	Restore premining level of interspersion of shrubs, grassland and forest cover
		Avoid wetland areas through siting alternatives
		Restore or create forest cover in all topographic situations suitable for tree plantings
	Land Use	
	Loss of rangeland for domestic livestock grazing	Compensation
RECLAMATION (POSTOPERATIONAL)	Wildlife	
	Prolonged displacement of wildlife resulting from increased human access to and activity in sensitive areas	Avoid blasting during nesting, fawning, calving, breeding and nesting seasons
		*Equip machinery to suppress noise
	Net reduction of big game carrying capacity after reclamation	Off-site habitat enhancement (fertilization)
		Control grazing pressure on allotments into which big game dispersal occurs
		Modify game harvest if necessary
	Vegetation	
	Loss of threatened and endangered vegetation and habitat	Minimize disturbance of talus slopes and cliff areas
	Loss of self-sustaining vegetation	Re-establish mixtures of native plants suited to various topographic sites

* Committed mitigation.

Table C-1-3 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION
FEED PREPARATION, RETORT, AND UPGRADING
CLEAR CREEK MESA AND GRAND VALLEY PLANT SITES

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION	Surface and Ground Water	
	Surface water drainage contamination	*Proper drainage of areas not used for processing facilities to prevent contamination of precipitation and runoff; especially from, near, or around the spent shale piles
		*Proper containment of spills and leaks
		*Contingency plans for handling accidental spills
	Wildlife	
	Decrease in wildlife habitat quantity and quality	Avoid removal of vegetation in riparian/wetland areas through use of siting alternatives
		Restore forest cover in all topographic situations suitable for tree plantings
		Fencing of surge basins and drainage ponds
		Avoid wetland and riparian areas through siting alternatives
	Avifauna mortality resulting from electrocution	Avoid key raptor foraging, roosting, and nesting areas
		Design powerlines to avoid electrocution and entanglement per 30 CFR Sec 816.97 (c)
	Wildlife mortality resulting from collisions with vehicles	Construct fencing and underpasses
		*Use lower speed limits to reduce collisions
		Avoid key wildlife use areas through siting
		*Reseed roadside areas with unpalatable herbaceous species to lessen attraction of big game to reseeded areas

Table C-1-3 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION
FEED PREPARATION, RETORT, AND UPGRADING
CLEAR CREEK MESA AND GRAND VALLEY PLANT SITES (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION (Cont.)	Wildlife (Cont.)	
	Net reduction of big game carrying capacity after reclamation	Off-site habitat enhancement
		Control grazing pressure on allotments into which big game dispersal occurs
		Modify harvest if necessary
	Soils	
	Loss of prime farmland or irrigated cropland	Compensation or siting
	Reduce erosion; stabilize slopes	Revegetate immediately
	Erosion	Revegetate "initial disturbance only" areas
	Miscellaneous	
	Spills	*Spill prevention program for (1) API surge basin and (2) plant area drainage pond
RECLAMATION (POSTOPERATIONAL)	Wildlife	
	Decrease in wildlife habitat quantity and quality	Restore premining level of interspersion of shrub, grassland, and forest cover
		*Reseed roadside areas with unpalatable herbaceous species to lessen attraction of big game to reseeded areas
		Restore vegetational diversity using native species of high value as food and cover for wildlife
		Restore or create forest cover in all areas suitable for tree plantings

Table C-1-3 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION
FEED PREPARATION, RETORT, AND UPGRADING
CLEAR CREEK MESA AND GRAND VALLEY PLANT SITES (concluded)

Project Phase	Major Impact/Concern	Mitigation Measures
RECLAMATION (POSTOPERATIONAL) (Cont.)	<u>Vegetation</u>	
	Loss of self-sustaining vegetation	In revegetation, utilize mixtures of native plants which correspond with original vegetation and land use objectives

* Committed mitigation.

Table C-1-4 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION
ACCESS ROADS, RAILROADS, AND POWER TRANSMISSION LINES
FRUITA AND ROAN CREEK 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 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 wetland areas through siting alternatives
	Avifauna mortality resulting from electrocution	Avoid river, reservoir, and wetland areas through siting
	Avoid key raptor foraging, roosting, and nesting areas	Design powerlines to avoid electrocution and entanglement per 30 CFR Sec. 816.97 (c)
	Wildlife mortality resulting from collisions with vehicles	*Use lower speed limits to reduce collisions
		Avoid key wildlife use areas through siting
		Construct fencing and underpasses
		*Reseed roadside areas with unpalatable herbaceous species to lessen attraction of big game to reseeded areas

Table C-1-4 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION ACCESS ROADS, RAILROADS, AND POWER TRANSMISSION LINES FRUITA AND ROAN CREEK CORRIDORS (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION (Cont.)	Wildlife (Cont.)	
	Displacement of wildlife resulting from increased access to and human activity in sensitive habitats	Restrict access to key wildlife use areas - closure of such areas during high use/concentration periods
		Avoid construction on or near key wildlife use areas (nesting, fawning, calving areas)
		Restrict ORV use
		Timing of construction and blasting to avoid breeding/nesting seasons
		*Equip machinery to suppress noise
	Wildlife mortality via illegal harvest	Employee education program
		Stringent corporate policies
		Subsidize law enforcement programs
	Miscellaneous	
	Potential landslides, slumping or other mass wasting processes	Avoid areas susceptible to such activity
RECLAMATION (Postoperational)	Wildlife	
	Decrease in wildlife habitat quality and quantity	Where preservation is impossible, reestablish permanent ponds and marshes
	Soils	
	Reclamation	Rip, level, and topsoil all nonpaved roads and unused useful railroads
	Toxic overburden, subsoil or soils	Bury in the core of roadfill slopes

Table C-1-4 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION ACCESS ROADS, RAILROADS, AND POWER TRANSMISSION LINES FRUITA AND ROAN CREEK CORRIDORS (concluded)

Project Phase	Major Impact/Concern	Mitigation Measures
RECLAMATION (Postoperational) (Cont.)	Vegetation	
	Disturbance of vegetation	Minimize disturbance of vegetation by overlapping rights-of-way and limiting mechanical disturbance during construction
	Loss of threatened or endangered plant populations	*Conduct searches of all proposed alignments and route accordingly

* Committed mitigation.

Table C-1-5 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION ROAN CREEK AND BIG SALT WASH (GARVEY GULCH) RESERVOIRS

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION	Surface and Ground Water	
	Surface water contamination	*Proper construction techniques to prevent introduction of high TDS/TSS water in the reservoir or Roan Creek
		*Control of oil, grease, and diesel spills
		Proper control during construction to ensure minimal aquifer disruption or damage
		Monitor water quality and quantity changes downstream of dams
	Quick release of stormwater resulting from a heavy rainfall and/or snowmelt	Water level control structures
	Wildlife	
	Pressure on game fish populations	Control recreational fishing by the general public, miners, and their families; consider use of project reservoirs as sport fisheries
	Decrease in wildlife habitat quantity and quality	Revegetate shoreline areas with emergent aquatic species, shrubs, trees, grass, and sedges to provide food and cover for wildlife
	Wildlife mortality resulting from illegal harvest	Employee education program
		Subsidize law enforcement programs
		Stringent corporate policies (such as gun control)

Table C-1-5 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION ROAN CREEK AND BIG SALT WASH (GARVEY GULCH) RESERVOIRS (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION (Cont.)	Wildlife (Cont.)	
	Displacement of wildlife resulting from increased human access to and activity in sensitive habitats	Restrict access to key wildlife use areas; closure of such areas during high use/concentration
		Restrict ORV use
		Timing of construction and blasting to avoid breeding/nesting seasons
		*Equip machinery to suppress noise
	Soils	
	Loss of prime farmland	Compensation or siting
	Vegetation	
	Loss of threatened and endangered plant populations and habitat	Compensation through restriction of access to other populations
		Avoid impact through siting alternatives
	Land Use	
	Loss of domestic livestock rangeland	Compensation or siting
	Miscellaneous	
	Erosion prevention at spillway toe	*Proper spillway design to prevent undercutting of the toe; use of riprap, gabions, or similar techniques
	Slope stability - reservoir dams	*Acceptable (proper) engineering design
	Dam failure	*Monitoring and an emergency dam failure program

Table C-1-5 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION ROAN CREEK AND BIG SALT WASH (GARVEY GULCH) RESERVOIRS (concluded)

Project Phase	Major Impact/Concern	Mitigation Measures
RECLAMATION (POSTOPERATIONAL)	<u>Wildlife</u>	
	Displacement of wildlife resulting from increased access to human activity in sensitive habitats	Restrict access to key wildlife use areas; closure of such areas during high use/concentration

* Committed mitigation.

Table C-1-6 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION LA SAL, FRUITA, AND ROAN CREEK PIPELINES

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 the 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
		Reseed disturbed areas with native species of high value as food and cover for wildlife
		Establish brush piles throughout reclaimed areas to increase availabilty of cover for small animals
		Avoid wetland areas through siting alternatives
	Wildlife mortality resulting from illegal harvest	Subsidize law enforcement programs
		Employee education programs
		Stringent corporate policies
	Displacement of wildlife from increased human access to and activity in sensitive habitats	*Equip machinery to suppress noise
		Restrict access to key widlife use areas - closure of such areas during high use/concentration periods

Table C-1-6 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION LA SAL, FRUITA, AND ROAN CREEK PIPELINES (continued)

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION (Cont.)	Wildlife (Cont.)	
		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)
		Closures to ORV's as necessary
	Soils	
	Bank erosion during pipeline installation	Protect all areas of the bank 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
	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

* Committed mitigation.

Table C-1-7 SUMMARY OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION OFF-SITE

Project Phase	Major Impact/Concern	Mitigation Measures
CONSTRUCTION AND OPERATION	<u>Wildlife</u>	
	Increase wildlife habitat quantity and quality to handle increased use	Off-site habitat enhancement through use of aerial application of N and/or 2-4 D
		Utilize nest boxes and platforms to provide nest sites in areas where nesting raptor densities are low and prey densities will support additional nesting raptors
	Displacement of wildlife from increased human acess to and activity in sensitive habitats	Restrict access to key wildlife use areas - closure of such areas during high use/concentration
		Restrict ORV use

APPENDIX C-2

DETAILED SOCIAL AND ECONOMIC MITIGATION MEASURES

APPENDIX C-2

DETAILED SOCIAL AND ECONOMIC MITIGATION MEASURES

HOUSING

- The Operator proposes to build a construction camp accommodating up to 1,500 single-status workers. This camp will be located near the project in Garfield County under the Proposed Action, Clear Creek, and Fruita I alternatives and in Mesa County under the Fruita II Alternative.

- The Operator will make available to the local development industry information on employment levels, its construction schedule, and the type, quality and price of units that may be desired by its employees. Information on housing availability will also be made available to new residents through a referral center.

- The Operator will consider the following techniques to stimulate housing construction:

  - 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

  - Providing land or improved lots to developers

- Keeping housing prices to an affordable level is often identified as an impact in rapidly developing areas. The Operator will consider the following techniques to ensure its employees can afford housing:

  - Setting price ceilings for units built by developers receiving financial support or guarantees from the Operator

  - Buying down interest rates if they are at a level which precludes employees from entering the market

  - Underwriting mortgages for a period of time for employees

- Affordable housing for seniors has already been identified as a concern in the study area. The Operator will work with local seniors groups and the Housing Authority to determine the number of mobile home pads or housing units it could set aside for seniors in housing developments receiving financial support from the Operator.

- Quality development and construction will be emphasized whenever the Operator provides financing or guarantees to builders. Similarly, through its technical assistance, the Operator will encourage local governments to establish design review standards and processes.

- The Operator will encourage, through its mitigation activities, growth to locate in areas where there is existing capacity in utility systems and community facilities or where expansion of facilities has been planned.

- The Operator will encourage local governments to tie land use decisions to utility service areas and planned extensions, in an effort to keep utility systems efficient.

GOVERNMENT FINANCE AND COMMUNITY INFRASTRUCTURE

- The Operator will encourage and assist local governments and service districts to put utilities affected by the Operator on an enterprise fund basis so that system costs are paid for by revenues generated from users, and growth will pay its way.

- Several services may benefit from being provided or coordinated at the county or regional level, either because of the nature of the service or because differences in the size of the tax base between entities may lead to unacceptable differences in the level of service. Such services may include transportation, planning, parks and recreation, fire and solid waste. At the time the Operator begins implementing its mitigation efforts, it will work with affected entities to identify and discuss the appropriate strategy for providing these services.

- In order to ensure any required utility expansion occurs in proper sequence with the Operator's growth, the operator will consider prepayment of residential plant investment fees.

- Before any commitment is made to contribute to new capital facilities, the Operator will 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 the Operator increment of growth creates a cumulative surplus in both counties that is more than sufficient to cover all of the incremental public costs attributable to the project, and the projected incremental shortfalls in the municipalities. Thus, revenue sharing between the counties and municipalities would appear to be one key to overcoming potential fiscal problems. The Operator will work cooperatively with Garfield and Mesa counties to discuss the feasibility of this approach.

- 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 funds that would otherwise go to the State Department of Local Affairs discretionary impact assistance fund. The Operator proposes to use the severance tax credit mechanism to provide financing to those municipalities and other units of government that face revenue shortfalls related to the Clear Creek Shale Oil Project. This will require a formal agreement between the Operator, local government, and the state.

- The Operator may also consider the following options for financial assistance:

  - Additional technical assistance to pursue matching state or federal funds

  - Prepayment of property taxes

  - Bond programs in which the Operator makes debt service payments for the first few years until the tax base catches up

  - Bond or loan guarantees

  - Lease back arrangements where the Operator builds facilities and leases them back to local government as the tax base catches up

HUMAN SERVICES

- The need for specific human service programs is often difficult to assess ahead of time. Thus, the Operator's approach will be to work with existing human service coordinating organizations to determmmine the extent of the Operator's impact and the most effective methods of alleviating any difficulties. Such techniques may include:

  - Technical assistance

  - Financial assistance for additional staff persons or new programs

  - Developing an employee and family orientation program to help new residents adjust to the community

- The Operator proposes to include recreation facilities as part of the construction camp complex.

MITIGATION MEASURES SPECIFIC TO GARFIELD COUNTY

Land Use & Development

- The Operator will work to ensure that any development that it guarantees or supports is consistent with the goals and policies of the county and municipalities within it. The County will be encouraged to support municipal efforts to manage growth. In particular, the Operator encourages the County to tie its land use decisions to utility service areas and planned utility extensions and adhere to its Comprehensive Land Use Plan goals of requiring new development to locate in or near existing urban centers.

County and Municipal Cooperation

- As stated previously, the County is expected to have more than sufficient revenues to cover its costs of growth. Municipalities, however, are more limited in the size and number of revenue sources available to them. The County is encouraged to analyze a use tax and potential distribution formulas. Analyzing sales tax distribution schemes to cope with the lead time problem is also suggested. However, the Operator recognizes that the County must carefully consider its own financial needs as well.

- There are some services which might be more efficiently provided all or in part by the county rather than by municipalities. This would avoid overlap or gaps in service and also take advantage of the larger county tax base. Such services include parks and recreation, fire protection and solid waste. By lifting these from the municipal level, municipalities would be able to use their limited financial resources for services of a more urban nature that are best provided by a municipality.

- The Operator will work with emergency services in both counties to develop a coordinated approach to address major emergencies or accidents at or in the vicinity of the project facilities.

Housing and Community Services

- The Operator feels that an urban level of services is necessary in Battlement Mesa. The Operator is prepared to work with the county to ensure this is provided and if necessary will make funding for facilities or staff available to the county.

Other Actions

- Other issues may arise over the effect of growth on countywide services such as museum, library, and medical services. The Operator is prepared to work with the county to find solutions to difficulties attributable to the Operator's activities.

MITIGATION MEASURES SPECIFIC TO THE RIFLE AREA

The Rifle area has not been identified as an area where the Operator will encourage project direct employees and population to locate. Any new growth occurring in Rifle that results from the Operator's activity in the general vicinity will be stimulated by people or businesses who have made an independent decision to locate in Rifle rather than areas where the Operator is providing assistance. However, the Operator will work cooperatively with Rifle to monitor growth and to resolve the Operator-related growth problems, if they should occur.

Several growth management actions could be taken by local government entities in Rifle to prepare the communities further for any growth which may occur.

Utilities

- The City of Rifle is encouraged to carefully analyze plant investment fees and monthly service charges for the water and sewer systems so that both utilities are operating on a self-sufficient "paying its own way" basis.

Capital Facilities

- Before financial commitments are made to capital facilities, supporting revenue sources should be identified that are stable and sufficient to cover the induced operating and maintenance costs.
- Capital facilities of a regional nature (such as a recreation center) that may be proposed for Rifle may benefit from administration by the county or a district controlled by the county. In this way, oil shale project facilities can be included as part of the tax base.

MITIGATION MEASURES SPECIFIC TO THE BATTLEMENT MESA AREA

Location of a large proportion of the population arising from the Operator's operations in the Battlement Mesa Planned Unit Development is a key element in the spatial allocation analysis. As stated previously, this strategy can take advantage of existing and planned capacity (in community facilities and services, housing, etc.) and thus reduce the effects of rapid population growth on communities less prepared to absorb it. Battlement Mesa maintains adequate capacity to absorb CCSOP growth as well as growth that might eventually occur if the Colony Project were revived. The Operator thus anticipates directing many of its mitigation efforts to this area. Listed below are several of the key options which the Operator may take to ensure there are sufficient housing and community facilities to meet the demands of its population.

Housing

- Discussions will be held with Battlement Mesa, Inc. to ensure adequate land for housing is reserved for the first years of employment.

- Guarantees and/or construction loans may be made to home builders to stimulate housing construction during the first phases of the Operator's activity in the area. It is anticipated that after such time, private developers will be willing to assume risks without the Operator's support.

- Developers selected to build housing to accommodate the Operator's employees will have to meet standards set by the Operator as to the quality of design, type, and quantity of units.

- Similarly, ceiling prices for units may be set so that the units are affordable. Other actions such as subsidizing interest rates and/or rental rates will also be considered.

Community Infrastructure and Services

- Prepayment of plant investment fees will be considered if necessary to reserve sufficient capacity in the utility systems.

- The available capacity of the utility systems will be evaluated for thresholds which may be exceeded due to the Operator's incremental growth. If it appears this may occur, negotiations will be made with the appropriate agency(ies) to ensure that any necessary expansion will occur in a timely manner.

Governmental Relations

- The Operator will work with the county to ensure an adequate level of county services (such as sheriff's protection) is committed to the area and revenues are available for the operation of community services and facilities.

- A strategy will be developed which deals with the financial, institutional and timing issues surrounding Battlement Mesa's relationship with Parachute and the county. Such options include remaining an unincorporated subdivision, annexation or separate incorporation.

MITIGATION MEASURES SPECIFIC TO THE PARACHUTE AREA

As with Rifle, it is anticipated that population growth from the Operator's activities will not be encouraged to locate in Parachute. However, the Operator will be sensitive to issues which may arise such as additional traffic on streets in Parachute and additional police calls, and is willing to work with the community to resolve problems attributable to the Operator-related population.

MITIGATION MEASURES SPECIFIC TO MESA COUNTY AREA

Under all alternatives, it is anticipated that Mesa County will receive the greater proportion of population growth resulting from the Clear Creek Shale Oil Project. The Operator anticipates focusing mitigation efforts on the Grand Valley area (roughly the area from Palisade to Fruita). This sub-section outlines several actions which the Operator may pursue at the county level to help manage growth occurring in the area. These may include the following:

Land Use and Development

- The Operator may provide assistance to the county to develop a land use plan and regulations to avoid the potential for development to become scattered through the De Beque valley (causing difficulties in providing government services, among other things). The Operator has already assisted De Beque with its Master Plan.
- In all areas of the County, the Operator will encourage the County to tie its land use decisions to utility service areas and planned utility extensions. This will help minimize the cost of providing water and sewer service in the county.
- In general, the Operator will encourage the county to support the land use plans and goals of the individual minicipalities within it. In particular, the Operator will ensure that any development receiving financial support or guarantees from the Operator will comply with county or municipal (as appropriate) growth management goals.
- The Operator is sensitive to local efforts to protect agricultural and orchard land from urban development and will consider this in working with housing developers.

County and Municipal Cooperation

- Fiscal analyses undertaken as part of this study indicate that the county will benefit financially more than the individual municipalities. To help overcome potential difficulties at the municipal level, the Operator will encourage the County to analyze the feasibility of redistributing a greater proportion of the countywide sales tax revenues back to the municipalities. Another solution which may be explored in addition, is transferring some services that are more regional in nature such as parks and recreation from the municipal to the county level. These local government decisions will require careful analysis.

- Fire protection is another service that may benefit from coordination at the county level for two reasons. First, it would avoid overlap or gaps in service. Second, because of the location of project facilities there will be an uneven distribution of tax base which could create an uneven level of service throughout the county. Service levels could be streamlined by some county support.

- The Operator will work with emergency service agencies in Mesa and Garfield counties to develop a coordinated plan to deal with major industrial or other accidents in the vicinity of project facilities.

Housing

- Cooperation with the local housing authority and senior's associations will determine whether housing units and mobile home spaces should be reserved for seniors in subdivisions or developments receiving financial assistance from the Operator.

Human Services

- Support for human services in the area will be funneled through the existing human services council.

Other Actions

- The Operator is aware that issues may arise over the effect of growth on other county services such as the Vocational-Technical College, library and county museum. The Operator is willing to work with the County to find solutions to difficulties attributable to the Operator's activities.

- The Operator will provide information concerning the skill levels necessary for CCSOP employment, and will encourage the development of local training programs. The Operator will also adopt a policy of hiring qualified Mesa and Garfield County locals whenever possible.

MITIGATION MEASURES SPECIFIC TO THE GRAND VALLEY AREA

The Operator anticipates that a large proportion of its workforce and associated population will locate in the Grand Valley. The housing industry in this area has indicated it has the capacity to build a substantial number of housing units annually. Thus, while the Operator will provide information and incentives to stimulate the market, it may play a much less visible role than in Battlement Mesa. Capacities of the primary utility systems in the valley have been planned to accommodate growth also. Most of the specific actions which the Operator may take to alleviate or avoid difficulties have been outlined in the previous section; the following are amplifications:

Housing

- The Operator will work with the local development industry to assure sufficient housing is available when needed. Actions may include:
    - Guaranteed occupancy in mobile home parks, apartments and/or subdivisions for a certain number of years
    - Guarantees and/or financing for builders
    - Depositing funds in local banks to supplement capital available in local communities
    - Setting standards for location of units, design and mix of type, and price ranges for builders taking advantage of the Operator incentives
    - Providing land or developed lots
- If either of the Fruita Alternatives are pursued by the Operator, these incentives may be focused on the Fruita area to ensure the housing industry can respond adequately.
- The Operator will provide as much information as possible regarding employment levels and timing so that the local development industry can be more responsive to the operator's needs.
- The Operator's efforts to stimulate housing for the elderly will be concentrated in the Grand Valley as this is where the problems potentially could be most serious.

Utilities

- It may be necessary to prepay plant investment fees to guarantee sufficient and timely expansion of water and sewer systems if either Fruita alternative is pursued.

MITIGATION MEASURES SPECIFIC TO THE DE BEQUE AREA

Because the basic community infrastructure to accomodate a large increase in population is not in place or planned for De Beque, the Operator does not anticipate that significant population growth associated with its activities will locate in the area. However, the location of the project north in the Roan Creek Valley will have an effect on the Town. The Operator will work cooperatively with DeBeque to determine project-related growth impacts. Specific actions to alleviate or avoid negative effects may include:

- The Operator may offer technical assistance to the Town to assist it to achieve its land use goals in the De Beque Valley. Town and County cooperation will be necessary to avoid scattered development in the valley.

- The Operator may also offer technical assistance to the town to help establish zoning and development regulations so that compatible uses develop around the Operator's rail facilities. The Operator will work with the Town to resolve any issues surrounding the provision of services to the rail facilities or annexation to the town.

- The Operator will work with the community to develop a highway bypass around the community.

APPENDIX D

MAP OF EXISTING LAND USES

(IN POCKET)

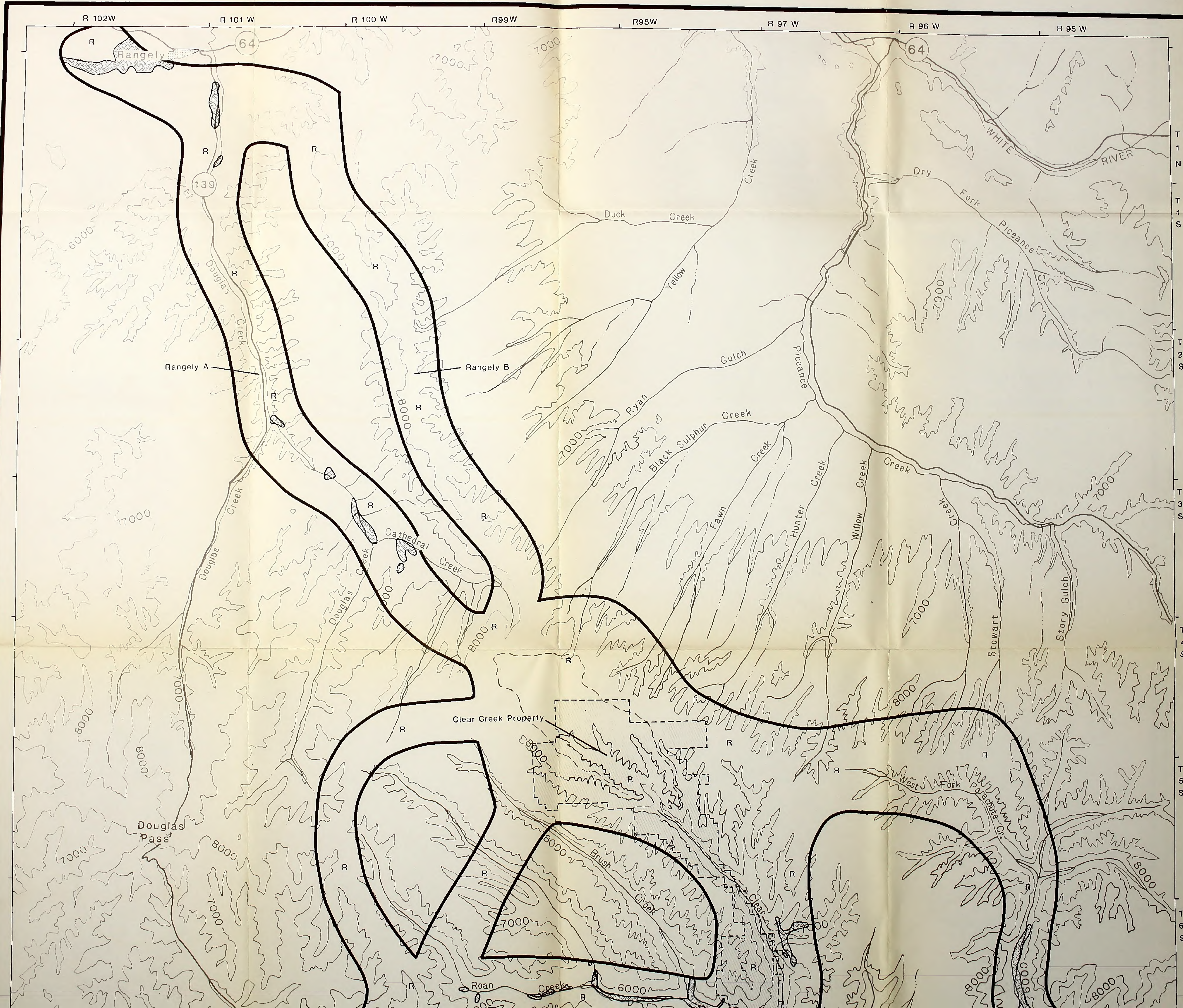
Appendix D

Chevron Clear Creek Shale Oil Project

EXISTING LAND USE
ALTERNATIVE PROJECT AREAS

Compiled by:
Camp Dresser & McKee Inc.
11/23/82

SHEET 1 of 1



R 102W
R 101 W
R 100 W
R99W
R98W
R 97 W
R 96 W
R 95 W
Rangely
64
139
T 1 N
T 1 S
T 2 S
T 3 S
T 4 S
T 5 S
T 6 S
WHITE
RIVER
Dry Fork Piceance Cr.
Duck Creek
Yellow Creek
Ryan Gulch
Piceance Creek
Black Sulphur Creek
Fawn Creek
Hunter Creek
Willow Creek
Stewart Creek
Story Gulch
Douglas Creek
Cathedral Creek
Rangely A
Rangely B
Clear Creek Property
West Fork Parachute Cr.
Douglas Pass
Brush Creek
Clear Cr.
Roan Creek
6000
7000
8000
R

Appendix D

LEGEND	
R	Rangeland
(stippled pattern)	Agricultural
(dotted pattern)	Residential (See Fruita, Grand Junction)

Sources:

Chevron, 1981g
Chevron, 1981h
Chevron, 1982a
Chevron, 1982b
U.S. Bureau of Reclamation, 1976
U.S.G.S. Grand Junction Quadrangle 1:250,000, 1969

Note:

Prime Farmland maps are available from U.S. Soil Conservation Service for Garfield and Mesa Counties (SCS, 1979)

N

SCALE
1 : 126,720
1/2 INCH - 1 MILE

Chevron Clear Creek Shale Oil Project

EXISTING LAND USE

ALTERNATIVE PROJECT AREAS

Compiled by:
Camp Dresser & McKee Inc.
11/23/82

SHEET 1 of 1