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ENVIRONMENTAL BASELINE REPORT FOR CHEVRON'S PROPOSED SYNCRUDE PIPELINE ROUTES: CLEAR CREEK TO LA SAL AND CLEAR CREEK TO RANGELY

Prepared for

CHEVRON SHALE OIL COMPANY
Denver, Colorado

Prepared by

ENVIRONMENTAL RESEARCH AND TECHNOLOGY, INC.
Fort Collins, Colorado

April 1982

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EXECUTIVE SUMMARY

This report provides baseline natural resources information for two alternative syncrude pipeline routes from Chevron's Clear Creek property to Rangely and for six alternative syncrude pipeline routes from the Clear Creek property to the proposed La Sal Syncrude Pipeline. These descriptions are based on a review of existing data sources and on data collected by ERT during helicopter reconnaissances of the proposed pipeline corridors. Studies for the Rangely pipeline routes were conducted in October 1980; those for the La Sal pipeline routes were conducted from October to December 1981.

Climate and Air Quality

The climate of the Roan Plateau region is continental and semi-arid. Precipitation and temperature are directly influenced by elevation, thus local climates may vary considerably. Average annual precipitation ranges from 9 to 21 inches. Temperatures vary from highs of about 100°F during summer to lows below 0°F during winter. Prevailing winds are from the west with variations due to local topography. Air quality in the area is generally very good, with occasional high particulate concentrations during summer and fall resulting from "fugitive dust" from vehicular traffic on dirt roads or oil shale development activity.

Topography and Geology

The proposed pipeline routes are in northwestern Colorado between the White and Colorado Rivers, in the Piceance Basin. Elevations range from 4,900 to 9,400 feet. Most of the area is a plateau standing 1,000 to 4,000 feet above the nearby river valleys. In general, the land surface slopes gently downward from the rim toward the central part of the plateau, with the greatest dips occurring on the eastern and northern slopes. The Roan Plateau, a lightly dissected divide separating the White and Colorado River drainages, crosses the south-central part of the basin from east to west.

The Piceance Basin is a large northwest-trending structural downwarp. Although none are known to be active, numerous old faults are present in

the study area. These northwest-trending, high-angle normal faults are in the northeastern part of the basin. Faults and joints are often calcite-filled, and all joints tend to close with depth in the lower portions of the Green River Formation.

Soils and Reclamation Potential

Soils maps depict units composed of two or three kinds of soils that occur in association with each other. They are mapped together because of the mapping scale, similarities in reclamation capability, and other soil characteristics.

Water Resources

Drainage is divided by the southern edge of the Roan Plateau separating flow to the north and to the south. The area to the north is drained by Piceance Creek into the White River drainage system; the area to the south is drained by Roan Creek and Parachute Creek into the Colorado River drainage system. Piceance Creek, Parachute Creek, Roan Creek, and a few of their major tributaries are perennial streams. Surface water resources of the Piceance Basin are moderately developed for irrigation; those of Parachute Creek and Roan Creek are fully developed.

The principal subsurface water-bearing zones in the basin are the Tertiary (Eocene) Uinta Formation, the upper Green River Formation, and the stream valley alluvium. Springs are numerous at the contact between the Uinta Formation and the Green River Formation. The valley alluvium, however, is the principal source of usable groundwater. Horizontal permeabilities in the area are normally much greater than vertical permeabilities.

Vegetation

Vegetation types on the study area include plateau sagebrush, plateau mixed shrub, valley mixed shrub, pinyon-juniper, aspen, grassland, agricultural land, conifer, saltbush, greasewood, valley sagebrush, and valley riparian. Distribution of each type is primarily controlled by topography and its influence on moisture availability. Percent cover and productivity of the vegetation types vary greatly from site to site; differences are related to variation in moisture availability and soil properties.

Barneby's columbine (Aquilegia barnebyi), fescue (Festuca dasyclada), and dragon milvetch (Astragalus lutosus) are species that may be threatened or endangered, but insufficient information is available about them. Sullivantia (Sullivantia purpusi) is on the Colorado Heritage Inventory working rare plant list. Barneby's columbine and sullivantia were found on small (less than 25 acres) seep areas next to the falls on Clear Creek and No Name Creek. The fescue is presently known from scattered locations along the south face of the Roan Cliffs from Anvil Points westward to the Roan Creek drainage. Dragon milkvetch has been found in numerous (20-30) locations in the Piceance Basin and the Roan Cliffs in Garfield and Rio Blanco Counties.

Wildlife

The mule deer is the most important big game species in the region. Winter range is typically below 7,400 foot elevation on sagebrush and pinyon-juniper habitats while summer range is generally aboe 6,800 feet in sagebrush, mountain shurb, aspen, and spruce-fir habitats. Critical mule deer winter ranges or concentration areas occur in the area south of the confluence of Douglas and Cathedral Creeks and in Gillam Draw. Elk are fewer in number than mule deer but have been steadily increasing in recent years. Both summer and winter ranges are above 7,000 foot elevation, with spruce-fir and aspen used as cover from spring through fall and mountain shrub and pinyon-juniper used in winter.

Four game bird species - sage grouse, blue grouse, mourning dove, and chukar occur in the region. Waterfowl are uncommon because of the lack of suitable habitat.

Two endangered species, the bald eagle and the peregrine falcon, are potential inhabitants of the region. The bald eagle winters each year along the White River but is unlikely to occur along the study corridors. Peregrines have been observed performing courship activities in Parachute Creek Canyon and the CDOW has designated the upper portion of Parachute Creek Canyon and its main forks as potential nesting habitat. Since nest sites preferred by peregrines are high cliff ledges, usually near water, the potential for their nesting within the pipeline corridor is very low.

Aquatic Ecology

On the Roan Plateau, Willow Creek and West Fork Parachute Creek support trout populations consisting of rainbow trout and cutthroat trout, respectively. Piceance Creek contains mainly coldwater nongame fish species such as mountain sucker and speckled dace, while Clear Creek supports no fish in the sections proposed for pipeline crossings. Benthic macroinvertebrates and periphyton communities in these creeks are indicative of streams that undergo extreme fluctuations in some physical and chemical conditions.

Cultural Resources

Known prehistoric resources in the study area reveal diversified and extensive occupation. From previous investigations in the vicinity of the proposed route, several periods of prehistoric occupation have been established for the area. Recurrently used prehistoric camp sites tend to be situated vertically and horizontally close to a reliable water source in lowland areas such as floodplains and finger ridges overlooking drainages. Historic occupation and exploration began in the 1800's in the form of homesteading and cattle ranching.

Visual Resources

The proposed pipeline corridors are characterized by rugged, arid topography with steep, eroded cliffs and gently sloping to rolling plateaus. Significant man-made visual features in the region include the communities of DeBeque, Parachute, and Battlement Mesa; developments at the Cathedral Bluffs Oil Shale Project (Tract C-b), Union Oil Project, Colony Project, and Occidental Logan Wash Project; and Interstate 70.

Land Use and Transportation

Grazing by livestock and wildlife is the primary land use within the areas traversed by all of the alternative synfuel pipeline routes. Private ranching operations have evolved around the use of public lands and intermingled private and state lands. Hay is typically produced on private land to feed livestock during the winter.

Recreational resources in the region include hunting and fishing. Big game species include mule deer and elk; huntable populations also

exist for small game and upland game birds. Fishing pressure along Douglas Creek and its tributaries is probably light (BLM 1980), because the smaller trout streams do not contain populations large enough to sustain much fishing pressure. The Bluff Road provides access to the Cathedral Bluffs where hikers, campers, and sight-seers may view wildlife species and geologic formations.

Backcountry roads are the principal transportation routes crossed by all the proposed pipeline routes. Most are single-lane, low-use facilities with only occasional grading and seldom with a gravel surface. Portions passing through large tracts of private land are often closed to public entry. Ranchers and mineral exploration crews are the principal year-round users of these roads, but hunters use them extensively in the fall months.

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1.0 INTRODUCTION

This report provides baseline descriptions of two alternative syncrude pipeline routes from Chevron's Clear Creek property to Rangely and of six alternative syncrude pipeline routes from the Clear Creek property to two selected points on the proposed La Sal Syncrude Pipeline (Figure 1-1). These descriptions are based on a review of existing data sources and on data collected by ERT during aerial reconnaissances by helicopter of the proposed pipeline corridors. These studies were conducted to provide baseline natural resources information required for various environmental assessment documents. Studies for the Rangely pipeline routes were conducted in October 1980, while data was collected from October to December 1981 for the La Sal pipeline routes. Since the La Sal study was conducted one year later, additional or updated information was available from the BLM, SCS, and ERT's own baseline studies that was not available for the Rangely study.

Rangely Pipeline Routes

ERT investigated two pipeline routes from the Clear Creek property to Rangely. The more western route (Route A) included a small deviation route near Rangely as depicted in Figure 1-1. Route A begins on Skinner Ridge at about 8,500 ft elevation and proceeds northward for about 7 miles before it drops off the plateau into the Soldier Creek Valley and follows Soldier Creek to its confluence with lower Cathedral Creek. It then continues northward following the valley floor of East Douglas and Douglas Creeks for about 30 miles before it exits out of the valley and heads west for about 5 miles to Chevron's existing facility west of Rangely. For about the last 6 miles before reaching the Rangely facility, Route A crosses an extremely rugged area of hogback ridges with numerous rock outcrops and limited access. A possible deviation from this route would continue to follow the Douglas Creek Valley along Highway 139 for about 4 miles before heading west, following an existing pipeline for about 4 miles to the Rangely facility.

Route B also begins on Skinner Ridge and follows Route A for about 7 miles to the point where Route A drops into the Soldier Creek Valley. Route B does not drop into the valley but continues for another 20 miles

Figure 1-1

Alternative Pipeline Routes From Clear Creek Site To Rangely And La Sal

along the ridgetop following the Cathedral Bluff road. At about milepost 25, the route drops off the bluff and heads northwest along Big Ridge for about 10 miles before heading west toward Rangely through Gillam Draw. It meets the possible deviation of Route A south of Rangely and follows it to the Rangely facility.

La Sal Pipeline Routes

For the La Sal pipeline routes, alternatives start at Chevron's Clear Creek property and connect with the proposed La Sal Pipeline near Magnolia Camp (Figure 1-1). Route 1 begins at mile 0 on the Clear Creek property and circles the Clear Creek facility to the west and north crossing West Willow, East Willow, and No Name Creeks. The route continues in a north-northeasterly direction following the ridge between Hunter and East Fawn Creeks, crosses Piceance Creek, and ends at the proposed La Sal pumping station at Magnolia Camp. The total length of Route 1 is about 26.5 miles.

Route 1A (route segments 1-1A-1) is common with Route 1 from mile 0 through mile 5.2 where it turns in a north-northeastly direction and follows East Fawn Creek to Black Sulphur Creek and Black Sulphur Creek to Piceance Creek. Route 1A then turns to the northeast and becomes common with Route 1 from mile 23.3 to the end point of Route 1. The total length of alternative Route 1A is about 26.5 miles.

The four other La Sal pipeline alternative corridors (2, 2A, 2B, 2C) start at Chevron's Clear Creek property and connect with the proposed La Sal-Parachute Creek Pump Station at Davis Point (Figure 1-1). Route 2 (route segments 1-2) is common with Route 1 from mile 0 to mile 6.3 and then follows the Ridge Road to the east to mile 7.6 of Route 2. Route 2 then turns away from the Ridge Road to follow Wet Fork to about mile 13 of Route 2 where it again generally follows the Ridge Road until about mile 15.8 (Route 2). It turns southward to Davis Point where it connects with the Parachute Creek Pump Station of the proposed La Sal Pipeline. The total length of alternative Route 2 is about 25 miles.

Route 2A (route segments 1-2-2A-2) is common with Route 2 from mile 0 through approximately mile 7.6 where Route 2A turns southeast and follows Wolf Creek to the confluence of Wolk Creek and the West Fork of

Parachute Creek. Route 2A continues northeast to join Route 2 at mile 13 and is common with Route 2 to the end point. The total length of alternative Route 2A is about 26.5 miles.

Route 2B (route segments 2B-2A-2B-2) starts at Chevron's Clear Creek facility and extends southeast where it follows Clear Creek to the junction of Clear Creek and Buck Gulch (approximately mile 9.2 of Route 2B). Route 2B turns to the northeast following Wiesse Creek to its source, then turns to the east and joins with Route 2A from about mile 0.7 through mile 1.9 of Route 2A. Route 2B then turns southeast for about 1.5 miles and again turns northeast following Jackrabbit Ridge to about mile 20 of Route 2B. It turns north and joins Route 2 from about mile 15.2 to the end of Route 2. The total length of alternative Route 2B is about 28 miles.

Route 2C (route segments 1-2-2C-2) is common with Route 2 from mile 0 through mile 7.6. Route 2C then turns northeast and continues following the Ridge Road to about mile 13.4 of Route 2 where it becomes common with Route 2 to its end. The total length of alternative Route 2C is about 26.5 miles.

2.0 METHODOLOGY

Agency contacts with the Meeker, Craig, and Grand Junction BLM offices and the Grand Junction SCS office; literature surveys; and helicopter reconnaissances were conducted in October 1980 for the alternative pipeline corridors to Rangely and from October to December 1981 for the alternative pipeline corridors to the proposed La Sal pipeline pump station sites.

2.1 Climate and Air Quality

Since construction and operation of a syncrude pipeline is not expected to affect any climatic or air quality parameters of the region significantly, no studies other than a brief review and summarization of existing literature were conducted for the purpose of these corridor studies.

2.2 Topography and Geology

The primary objective of this discipline was to identify any geological hazards or other geotechnical considerations that could influence the routing, design, or construction planning for the proposed pipeline. This included identifying faults, seismic potential in the region, areas of slope instability, shallow bedrock, expansive soils, and subsidence hazard. The second objective was to collect surficial geology information related to topography, geomorphology, stratigraphy, and soils origin. Mineral resources would not be significantly affected by pipeline construction or operation and are not discussed in detail.

Golder Associates, under subcontract to ERT, collected information from the U.S. Geological Survey (USGS) and used information available from the Clear Creek baseline study reports to characterize the geology of the region. They also collected seismic information, developed a predictive model, and prepared a report on seismic hazards in the region for the Rangely pipeline studies. This report was also used to identify seismic hazards for the La Sal pipeline studies. Aerial reconnaissances of the corridors were used for further assessment geotechnical concerns. Areas noted as potential hazard areas were documented with photographs.

The geologic maps prepared for the corridor areas are based on published information (see references), field reconnaissance (from the air and ground), and interpretation of aerial photos. The corridor area selected for geologic mapping is approximately 1 mi in width, with the proposed pipeline in the center. Geologic contacts on the maps represent geologic units that were based on USGS quadrangle maps and inferred from the field reconnaissance and air photo interpretation. The majority of the inferred geology was simplified because detailed mapping of the study area could not be accurately performed based only on field reconnaissance. For example, on the Rangely alternatives map (Map 1), the Mesaverde Group has been mapped as just K_{mv} in all areas except the Rangely Quadrangle.

2.3 Soils and Reclamation Potential

Soils studies were conducted to determine the extent and status of existing soil information for the area, provide a description of soils occurring in the corridors, describe physical and chemical characteristics of soils that may influence revegetation, and provide input to revegetation planning for the selected corridor.

An ERT soils scientist and reclamation specialist reviewed available soils information prior to the field reconnaissances. At the time of the field surveys, ERT contacted the U.S. Soil Conservation Service (SCS) in Grand Junction and collected soils information for the study areas. ERT also interviewed the BLM in Grand Junction regarding available data and reclamation problems in their district. For the Clear Creek to La Sal corridors, soils narratives and mapping were available from both site-specific Chevron data and SCS data from Rio Blanco County. The Rangely corridor study used only SCS data.

Aerial reconnaissances of all proposed corridor routes were conducted by helicopter. Stops were made along each route to allow qualitative evaluations of topsoil depth, soil type, erosion potential, and other physical and chemical constraints on revegetation. The aerial reconnaissance provided data on the desirability and environmental suitability of each of the routes relative to reclamation concerns. Soils were mapped using existing information provided by the SCS and Chevron.

2.4 Water Resources

Water resouces studies consisted of collecting sufficient information to describe existing surface and groundwater resources and characterize existing water uses. Information was obtained from the BLM, ERT's Clear Creek Baseline Report, and the field reconnaissance.

2.5 Vegetation

Vegetation studies for the pipeline corridors were completed to identify and describe vegetation communities, plant successional trends, land use practices, existing wildlife habitat, and any potential habitats for threatened or endangered species. In addition, vegetation maps and acreage calculations of communities to be disturbed were prepared as part of the study. The plant ecologist collaborated with the reclamation specialist in evaluating revegetation potential.

For information on the existence of threatened and endangered plants and their habitats, livestock stocking rates, and future land use plans, ERT contacted the BLM offices in Craig, Meeker, and Grand Junction.

Stereo color aerial photography of 1:64,500 scale obtained from the U.S. Fish and Wildlife Service was used for vegetation mapping on the Rangely alternatives. Vegetation was interpreted and mapped onto 1:24,000 USGS quadrangles. For the La Sal alternatives, vegetation mapping was done on 1:50,000 scale maps from 1:24,000 color aerial photos obtained from the BLM. Both surveys used a 1-mile corridor to define the mapping boundaries for the pipeline routes.

Aerial reconnaissance of the pipeline routes was used to verify cover type and land use and observe any evidence of successional trends. Observers also made ocular estimates of total cover at each stop.

2.6 Wildlife

Wildlife studies of the pipeline corridors were completed to describe qualitatively the use and quality of habitats present along the pipeline routes. Emphasis was given to identifying critical or important habitats such as elk and mule deer wintering areas, sage grouse strutting grounds, riparian habitats, and habitats of threatened and/or endangered species. Because the studies were conducted at different times, the Rangely study concentrated on describing the wildlife resources in the

study region, while the La Sal study attempted to qualitatively evaluate the quality of the wildlife habitat along each route alternative.

Prior to field investigations, wildlife information collected for the Clear Creek baseline reports and published information pertinent to the region were reviewed. Additional wildlife data was collected during meetings with the BLM. Critical winter range for elk and mule deer (as designated by CDOW Wildlife Resources Information), riparian habitats, and any known habitats of threatened and endangered species were also mapped from available information.

During the aerial reconnaissances of the Rangely and La Sal corridor alternatives, an ERT wildlife biologist recorded the types of wildlife habitat present, their quality, and evidence of use. In addition, all wildlife observed during the flyover were recorded.

2.7 Aquatic Ecology

Primary emphasis was given to identifying the presence of threatened or endangered species (Colorado cutthroat trout) and recreationally important species (trout).

Prior to the field reconnaissances, the ERT aquatic biologist reviewed published information on the water quality and hydrology of streams in the study area and contacted the Colorado Division of Wildlife (CDOW) regarding the resident fisheries and potential occurrence of threatened and endangered fish species in potentially affected streams.

Because of the paucity of available information relevant to the small streams potentially affected by the Rangely pipeline alternatives, some limited qualitative sampling was conducted at proposed stream crossing locations. Stream habitats were characterized and grab samples of benthic communities were collected and identified. Fishes were investigated using a backpack electroshocking unit. For the La Sal pipeline alternatives, existing information available in the Clear Creek baseline reports and for Piceance and Parachute Creeks was used to characterize aquatic life in the study area.

2.8 Cultural Resources

The objectives of the cultural resource studies conducted for the pipeline routes were to identify any sites listed or eligible for listing on the National Register of Historic Places (NRHP) and describe the resources likely to occur along the pipeline corridors. The Laboratory of Public Archaeology (LOPA), under subcontract to ERT, conducted a file search of Colorado Historical Society, LOPA, Colorado State University, University of Colorado, and BLM records to identify the occurrence or potential for cultural resources, including historical and archaeological resources, along the routes. Paleontological investigations were not included in the program.

LOPA archaeologists also participated in the aerial reconnaissances of the pipeline corridors. This provided the project archaeologist with an overview of the regional topography and helped identify areas that warranted investigation from the ground. LOPA archaeologists later visited these areas of special interest. All recorded sites and any new sites identified during the reconnaissance were mapped.

2.9 Visual Resources

Visual resources studies were conducted to identify sensitive areas along the routes and to describe the visual and aesthetic quality of the existing environment. Mr. Merlyn Paulsen, under subcontract to ERT, collected information on Visual Resource Management (VRM) Classifications from BLM offices in Grand Junction and Meeker. Mr. Paulsen also viewed the routes during the aerial reconnaissances. From the air, he documented the study area's visual and aesthetic characteristics and any sensitive areas with photographs.

VRM classifications developed by the BLM were mapped for a 1-mile wide corridor along each route. The classes provide guidance on the intensity of management needed, or the degree of modification which is acceptable in the study area. The process used to assign management classes integrates three major considerations: (1) the existing scenic quality of the landscape, (2) the relative sensitivity of residents and visitors to changes in visual characteristics of the area, and (3) the distances between the evaluation area and observation points from which it is usually observed. In the BLM methodology, each of these factors

is subjectively evaluated and assigned a relative value ranking (e.g., high viewer sensitivity). The five management classes are defined by the various combinations of values of the three primary factors.

2.10 Land Use

The primary objectives were to characterize existing land use practices and recreational resources along the corridors. Pertinent information regarding land use and recreational resources in the study area was summarized from published information and from data collected during the field reconnaissance.

3.0 RESULTS AND DISCUSSIONS

3.1 Climate and Air Quality

3.1.1 Regional Setting

The climate of the Roan Plateau region is continental and semi-arid with warm summers and cold winters. Precipitation and temperature are directly influenced by elevation, thus local climates may vary considerably. Average annual precipitation ranges from 9 to 21 inches (BLM 1980). Precipitation at the higher elevations occurs mainly as snowfall from late September to April with highest accumulations in December, January, and February. Rainfall at lower elevations occurs in late spring, late summer, and fall, with the majority falling in thunderstorms of short duration and high intensity. Temperatures vary widely throughout the year from highs of about 100°F during summer to lows below 0°F during winter. The number of frost-free days varies with elevation. Prevailing winds are from the west with variations due to local topography.

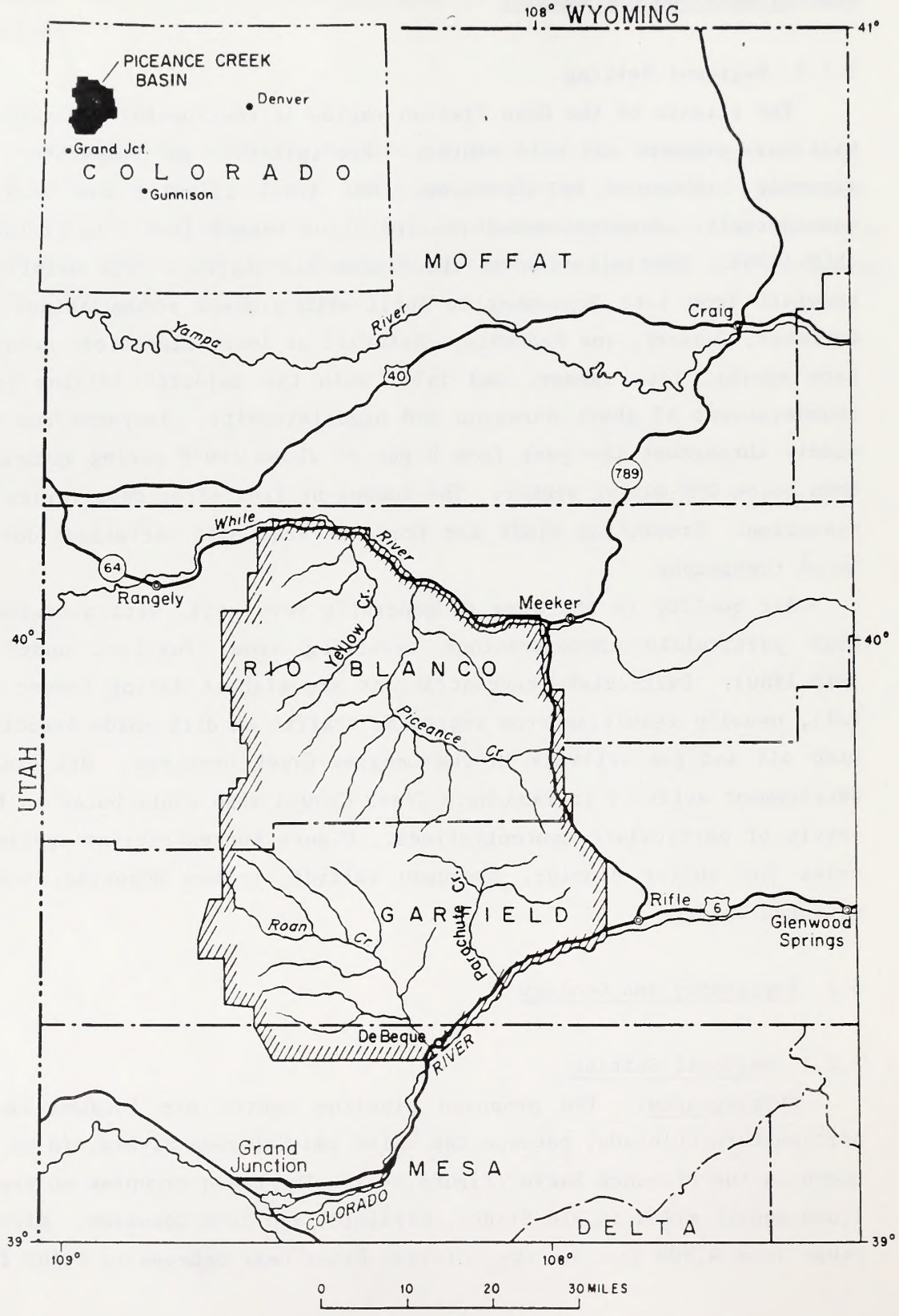
Air quality in the area is generally very good, with occasional high particulate concentrations resulting from "fugitive dust" (BLM 1980). Particulate concentrations are highest during summer and fall, usually resulting from vehicular traffic on dirt roads associated with oil and gas activity in the Douglas Creek drainage. Oil shale development activity in Parachute Creek Canyon also contributes to local levels of particulate concentrations. Minute concentrations appear to exist for sulfur dioxide, hydrogen sulfide, carbon monoxide, and nitrogen oxide.

3.2 Topography and Geology

3.2.1 Regional Setting

Physiography. The proposed pipeline routes are located in northwestern Colorado, between the White and Colorado Rivers, in an area known as the Piceance Basin (Figure 3-1). The basin occupies an area of 1,600 square miles in Rio Blanco, Garfield, and Mesa Counties. Elevations range from 4,900 feet on the Colorado River near DeBeque to 9,400 feet

Figure 3-1 INDEX MAP SHOWING THE PICEANCE CREEK BASIN



After Coffin, et al., 1971

at the crest of the cliffs northwest of Rifle. Most of the area is a plateau that stands 1,000 to 4,000 feet above the nearby river valleys. The southern and highest part of the plateau has been deeply dissected and terminates in the Roan Cliffs, a very irregular line of high, precipitous cliffs with talus slopes at the base. Other parts of the plateau rim are more regular, lower, and less precipitous, except for the Cathedral Bluffs in the northwest.

In general, the land surface slopes gently downward from the rim toward the central part of the plateau with the greatest dips occurring on the eastern and northern slopes. The central part of the plateau is characterized by north- to northeast-trending parallel ridges and valleys that have a local relief of 200 to 600 feet and are asymmetric in nature, with long gentle slopes toward the plateau interior and short steep slopes facing the rim. The differential resistance to erosion is reflected in the step-like nature of the cliff faces. The Roan Plateau, a lightly dissected divide separating the White and Colorado River drainages, crosses the south central part of the basin from east to west.

The northern and larger part (887 square miles) of the basin is drained by the White River and its tributaries, principally, Piceance and Yellow Creeks. Piceance Creek drains about 620 square mile and Yellow Creek drains about 260 square miles. Streams in this part of the basin are numerous and relatively long with gentle gradients and narrow alluvial valleys. The southern part of the basin is drained by the Colorado River and its tributaries, principally Parachute and Roan Creeks. The few streams present in this part of the basin are relatively short with steep gradients or falls from the plateau to the canyon bottoms. In the west-central part of the basin drainage appears to be structurally controlled with patterns ranging from trellis to parallel. Figure 3-2 shows the physiography of the basin.

Stratigraphy. The rocks exposed along the proposed La Sal pipeline routes range in age from Middle Eocene (Tertiary) to Quaternary. The stratigraphic sequence exposed along the proposed Rangely pipeline routes range in age from Upper Cretaceous to Recent. The oldest rocks are exposed near the White River crossing at Rangely. The youngest

geologic formation in the corridor area is the alluvial, colluvial, and talus deposits of Quaternary age primarily found along streams and slopes. From Rangely to the Clear Creek property, both Routes A and B cross progressively younger sedimentary units, except where crossing recent deposits. Most contacts in the study area are conformable and often gradational. The oldest rocks within the La Sal corridor area are contained within the fluvatile and lacustrine deposits of the Green River Formation of the Middle Eocene (Tertiary) age. Thickness of this formation decreases from east to west.

In the corridor areas, the Green River Formation has been subdivided, in ascending order, into three basic members: the Douglas Creek, Garden Gulch, and Parachute Creek Members. At the present time the U.S. Geological Survey (USGS) is in the process of redefining the lower members of the Green River Formation. This report uses the existing nomenclature which states that the Garden Gulch Member overlies the Douglas Creek Member.

The geologic units encountered within the Rangely and La Sal corridor areas are described in Appendix C and illustrated on Maps 1 and 2. Descriptions of Mancos Shale (of late Cretaceous age) through the Wasatch Formation apply only to the Rangely corridor alternatives; the remaining descriptions (Green River Formation through deposits of Quarternary Age) apply to both study areas.

Structural Geology. The Piceance Basin is a large northwest-trending structural downwarp. It is asymmetric with gently dipping limbs on the south and west and more steeply dipping limbs on the north and east. The northwest-trending axis is offset to the east in subsurface materials. The basin is bordered on the northeast and east by the Axial Basin anticline and the White River uplift, on the southwest by the Uncompahgre uplift (an ancient feature of low topography but high structural relief), on the west by the Douglas Creek arch, and on the northwest by the Blue Mountain and Rangely anticlines and the Uinta uplift. The structural features of the Piceance Basin and surrounding areas are shown in Figure 3-2.

The most prominent evidence of folding is the Piceance Creek dome in the northeastern part of the basin. This dome is 10 miles long and

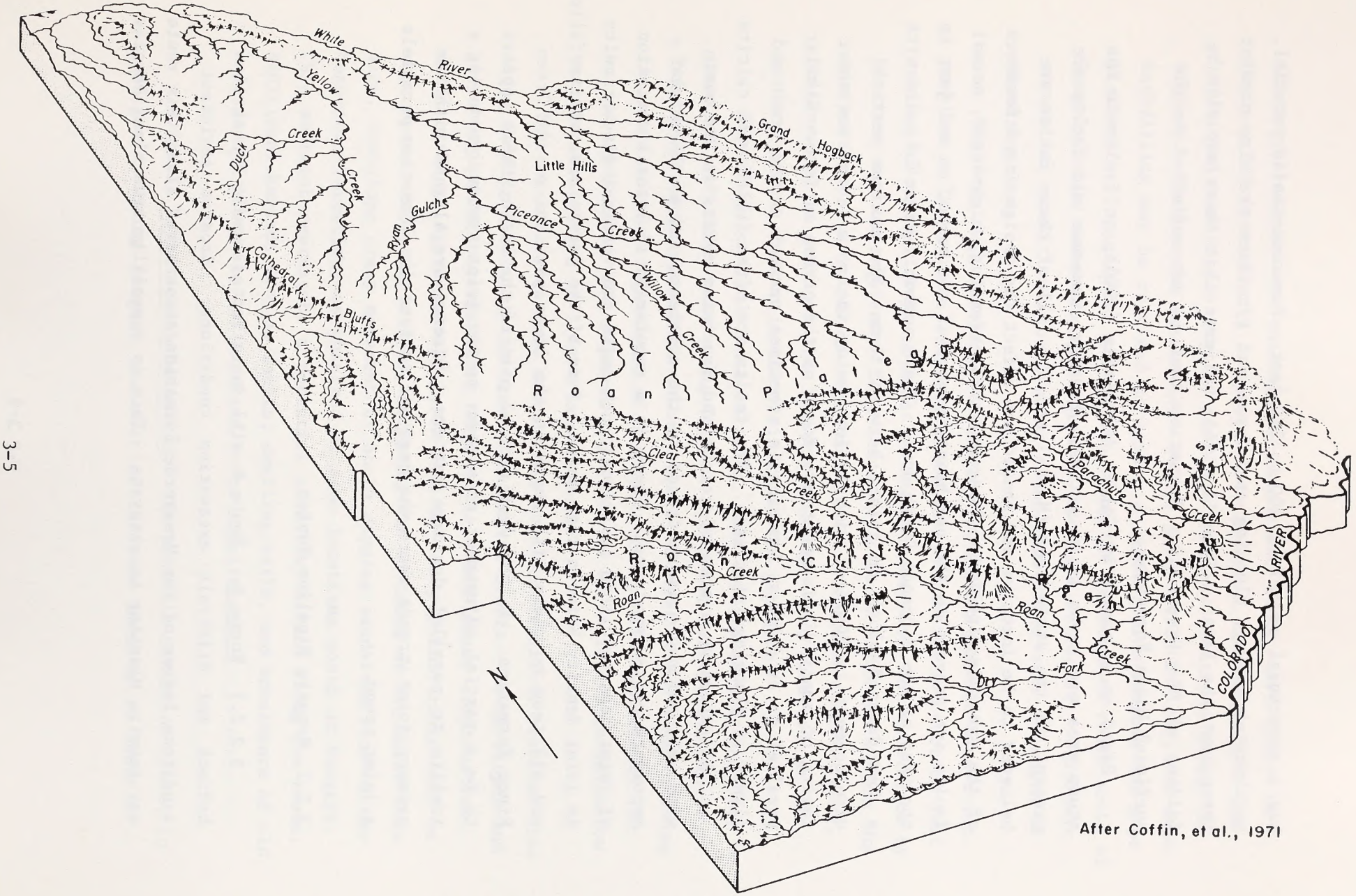


Figure 3-2 BLOCK DIAGRAM OF PICEANCE CREEK BASIN

has a structural relief of 200 to 250 feet. Numerous small, parallel, northwest-trending, plunging anticlines and synclines are also present throughout the basin. Donnell (1961) believes that there may also be folding of the Green River Formation that is not reflected in the surficial Uinta Formation.

Based on a report by Golder Associates (1980), no faults in the study area are known to be active. However, numerous old faults are present in the study area (Maps 1 and 2). All of these faults are believed to be inactive and should not affect the design or performance of the syncrude pipeline. These northwest-trending, high-angle, normal faults are present in the northeastern part of the basin, on and just to the west of the Piceance Creek dome. These commonly occur in pairs with a down-dropped block or graben between them. The maximum vertical displacement is 200 feet with 50 feet being the norm. Numerous minor faults of small displacement are found on the graben surface. Similar parallel or en echelon faulting is sometimes present on the crest and flanks of plunging anticlines. The faults are often filled with calcite.

An extensive system of joints and fractures exists in the basin, with well-defined primary trends to the northeast and northwest and a secondary east-west trend. There is a regularity in lateral variation of joint density within individual rock units and vertical discontinuity in joint density between rock units. Some of the joints are calcite-filled, and all tend to close with depth in the lower portions of the Green River Formation. In the west central part of the basin, there appears to be a partial adjustment of streams to the joint system, producing a trellis to parallel drainage pattern. Streams are aligned with the primary joint trends where the regional surface dip direction parallels a joint trend.

3.2.2 Rangely Pipeline Routes

3.2.2.1 Route A. Route A will be affected mostly by shallow bedrock and difficult excavation conditions. Erosion resistant sandstone ledges of the Mesaverde Formation encountered along this route may require blasting to excavate. This is especially true along Douglas

Creek where numerous outcrops of sandstone occur very close to Highway 139 (see Map 2). Special construction considerations and additional excavation may be necessary at many locations along the highway. This could result in a sharp, jagged trench floor, and sand backfilling may be required to assure a smooth, firm surface for pipe placement. Topographic constraints along the recommended route south of Rangely could make transportation of the sand difficult. Difficult excavation conditions could occur along this route over a length of about 8 miles.

The Sego and Castlegate Sandstone will also present excavation problems. These units are very resistant to erosion and outcrop just south of Rangely. Bedrock is at or near the surface, and excavation by blasting may be required. Excavation may also be difficult within the terrace deposits south of the White River. Cemented conglomerates, believed to be part of the Terrace Alluvium, were observed on the surface near a roadcut in the vicinity of the pipeline.

Depending on final route location, numerous stream crossings may be required for this route along Douglas Creek and East Douglas Creek. Relatively large excavation volumes could be expected for each crossing in order to meet Department of Transporation (DOT) requirements for buried crossings. DOT requires pipelines to be buried 48 inches below maximum scour depth or 1 foot into bedrock.

The corridor area most susceptible to slope stability problems lies along Soldier Creek, at the base of Cathedral Bluffs. Steep slopes and slope stability hazards along this route could cause construction difficulties. Approximately 3,000 feet of the pipeline route will be over areas with steep slopes, including the crossing of Big Horse Draw. Slow, downslope creep movement of south dipping sandstone beds of the Mesaverde Formation was observed at some locations south of Rangely. This movement represents a potential stability hazard along the route. Additional hazards such as faults, swelling soils, and subsidence of old underground mines are not expected to be significant.

3.2.2.2 Route A with Deviation. The possible deviation route, in addition to being longer, has most of the same hazards as Route A.

Shallow bedrock is expected over a length of approximately 4 miles, compared to approximately 3 miles along the shorter Route A. Steep slopes will occur over an approximate length of 1,950 feet, compared to about 2,050 feet over Route A. Swelling soils could be a hazard for a distance of approximately 0.8 miles.

Numerous small coal mines are located near Rangely within the Main Coal Unit of the Mesaverde Group (Map 1). At least three mines are present in or near the corridor. Such old mines tend to subside the overlying ground surface upon collapse. A pipeline constructed near such a mine could undergo differential displacement that could cause severe damage. Additional potential hazards such as unstable slopes due to downslope creep movement, stream crossings, and faults are expected to be similar to those encountered along Route A.

3.2.2.3 Route B. The proposed Route B could involve excavation difficulties over a length of about 2.5 miles. Route B crosses the Parachute Creek, Garden Gulch, and Douglas Creek members of the Green River Formation approximately between mile posts 25 and 30 (Map 1). Bedrock is expected to be shallow (0 to 5 feet), and excavation difficulties will be limited to isolated sections where outcrops of erosion resistant sandstone occur. In addition to crossing the White River, the Route B location would cross Douglas Creek once and Gillam Draw twice, depending on the final alignment. Steep slopes are encountered only along the upper portion of Big Ridge, near Cathedral Bluffs, for a distance of about 250 feet and at the head of Gillam Draw. No evidence of unstable slopes was observed during the field reconnaissance.

Swelling soils could be encountered in excavations into the Buck Tongue Member of the Mancos Shale south and east of Rangely. The potential for swell, however, is believed to be small and probably would not impact the pipeline. No detailed geology or fault mapping was available for the majority of Route B. Based on the seismic study, however, the hazard potential from possible fault displacement is small.

3.2.3 La Sal Pipeline Routes

3.2.3.1 Route 1 (Route Segment 1 Only). The pipeline along Route 1 would be affected by steep topography, shallow and resistant bedrock, near surface groundwater conditions, stream crossings, and geologic hazards. The majority of Route 1, from mile 5 to mile 22, traverses fairly gentle and mild topographic conditions that are typical of the ridges on the plateau area. Slopes are generally less than 20 percent and pipeline construction conditions and long-term stability conditions should be good. Areas where steep slopes and increasingly difficult construction conditions could occur exist from mile 0 to 5. Route 1 traverses three separate drainages where sideslopes range from 20 to 25 percent. From mile 22 to 26 the pipeline route traverses slopes ranging from 20 to 57 percent.

Excavation is not expected to be difficult along this route, except in an isolated area near mile 26 where resistant sandstone ledges were observed during the field reconnaissance. The depth to bedrock is generally shallow within the Route 1 corridor area and residual soils have developed over the parent rock materials in most areas not covered by Quaternary deposits. Depths to competent bedrock in this area can generally be expected to be greater than 3 ft, and excavation problems should be minimal.

Geologic hazards such as landslide and rockfall potential, seismic hazards, and swelling and collapsible soils are expected to be minimal along this route. Two faults are crossed near mile 24 (Map 2). Based on the seismicity report (Golder Associates 1980), however, the area is seismically inactive and these faults are not expected to present a significant hazard to long-term pipeline performance. Minor rockfalls were observed at the base of the steep slopes near mile 26.

3.2.3.2 Route 1A (Route Segments 1-1A-1). The majority of Route 1A (mile 2 to 16) runs along the East Fawn Creek valley and contains stream deposits which are associated with high groundwater levels. Numerous stream crossings are possible along this route, but geological hazards are expected to be minimal. While eight faults are located between miles 12 and 15 along Route 1A, the area is considered seismically inactive (Golder Associates 1980).

3.2.3.3 Route 2 (Route Segments 1-2). The pipeline route generally runs along Ridge Road, which is the drainage divide between Piceance Creek to the north and Clear Creek to the south (Figure 3-1). By staying along the ridge crest, this route avoids such geologic problems as high groundwater in stream channels, stream crossings, landslide areas, and construction difficulties associated with working on steep slopes. Bedrock will be generally shallow, 2 to 3 feet, and should be excavated with little or no difficulty.

The short portion of the route which follows the Wet Fork drainage (approximately 6 miles) crosses areas having near surface groundwater and relatively steep slopes. Some construction difficulties can be expected along this portion of Route 2. Geologic hazards such as faults and landslides appear to be non-existent. Based on available literature, no faulting or landslide debris are located along the Route 2 corridor area.

3.2.3.4 Route 2A (Route Segments 1-2-2A-2).

The first 2 miles along Route 2A's deviation from Route 2 follow a ridge in which minimal geologic constraints would exist. The rest of the route, however, follows along a stream valley in which near surface groundwater, stream crossings, and relatively steep slopes occur.

3.2.3.5 Route 2B (Route Segments 2B-2A-2B-2). Route 2B will be affected by geologic constraints such as topography, shallow bedrock conditions, high groundwater levels, numerous stream crossings, and landslide potential. This route drops in elevation approximately 1,200 feet between miles 1 and 2. Bedrock is near surface and excavation is expected to be difficult. A near vertical cliff, approximately 100 feet in height, is also located along this stretch. A similar situation exists from miles 10 to 11, where the route rises in elevation approximately 1,000 feet. A near vertical cliff, approximately 100 feet high, is included in this section.

From miles 2 through 10, the pipeline route runs along Clear Creek. This stream valley consists primarily of stream, fan, and terrace alluvium, is flanked throughout its length by talus and landslide debris, and contains near surface groundwater. Numerous stream

crossings could exist along this route. Locating the route near the base of the hillside could result in unstable excavations. Talus or landslide deposits are marginally stable and undercutting of the toe could cause unstable conditions within the slope. Shallow alluvial stream deposits, with potentially high groundwater levels, are located along Wiesse Creek from miles 11 to 14.

The remainder of Route 2B generally follows along Jackrabbit Ridge, where geologic conditions are favorable for pipeline construction. High groundwater levels could exist from mile 21 to 23, where the route enters a stream valley with moderately steep slopes and alluvial deposits.

3.2.3.6 Route 2C (Route Segments 1-2-2C-2). Route 2C is identical to Route 2 except for the portion of the route which continues to follow along the Ridge Road rather than following the Wet Fork drainage. This eliminates construction problems associated with near surface groundwater and steeper slopes along the Wet Fork portion of Route 2.

3.3 Soils and Reclamation Potential

3.3.1 Regional Setting

This assessment is based on soil characterizations and existing information and deals only with the various route segments in Rio Blanco County. Comparable soils data for the pipeline route in Garfield County were not available when the study was conducted. Table A-1 in Appendix A outlines the potential chemical and physical constraints for each soil mapping unit located along the proposed routes. This table was used to develop the specifics discussed below. All mileage values cited below are approximate.

Soils map units are depicted on Maps 3 and 4. These units are composed of two or three kinds of soils that occur in association with each other, but are mapped together because of the mapping scale and similarities in reclamation capability and other soil characteristics. The major criteria for grouping soils into mapping units were geographic association and similarities in:

- Rock fragment content
- Depth to bedrock

- Climatic regime (temperature, moisture, length of growing season)
- Percent Slope
- Thickness of A (surface) horizon.

3.3.2 Rangely Pipeline Routes

3.3.2.1 Route A. Route A is 42.8 miles long. Soils exhibiting a combination of slope, high coarse fragment content, low available water capacity (AWC), significant erosion hazard, and shallow soil depth constraints are found on 13.4 miles of the route. Soils that are calcareous and alkaline to the degree that range seeding is not advisable occur on 10.3 miles of the route. Moderate to strongly alkaline or calcareous soils and soils which are strongly alkaline at depth are found on 5.0 and 2.1 miles, respectively. Revegetation with these materials would be difficult. Soils exhibiting possible constraints due to slope and high erosion hazard occur on 1.8 miles of the route. Similarly, soils not constrained by slope yet exhibiting a high erosion hazard are found along 2.1 miles. Mapping units having little soil material (rock outcrop, badlands, etc.) occur on only 0.1 miles though some complexes contain these "soil" types in varying percentages.

Soils along 16 miles of Route A are suited to range seeding. Suitability for range seeding, however, may not be a totally accurate measure of revegetation potential due to soil/overburden mixing. However, it can serve as an indication of reclamation potential given appropriate construction practices.

3.3.2.2 Route A with Deviation. Characteristics of soils along the 48.0 miles of this alternative differ slightly from Route A. Soils exhibiting the combination of slope, high coarse fragment content, low AWC, significant erosion hazard, and shallow soil depth constraints occur along 14.5 miles slightly more than Route A. Strongly calcareous and alkaline soils, which are not suited to range seeding, are found on 11.4 miles of the route as compared to 10.3 miles of Route A. The mileage of soils in other constraint catagories parallel those of Route A with the exception of units exhibiting limited soil material. Units of

this type occur on 0.8 miles of this alternative. Soils on approximately 15.9 miles of this route are suitable for range seeding.

Soils in the upland portions of this route and Route A appear to pose few chemical problems for revegetation. Erosion will be a problem, however, due to slope and perhaps surface soil texture. Rill erosion was observed throughout much of this area. Gully erosion appears to be occurring between ridges and soil creep was observed on several hillsides.

Soils in Douglas Creek appear to have high levels of salts and sodium as evidenced by white salt surface deposits and native vegetation (greasewood, four-wing saltbush). These soils are very unstable when disturbed and are susceptible to wind and water erosion. Severe streambank cutting was observed along Douglas Creek. These soils may contain a high percentage of coarse fragments at lower depths in the profile.

3.3.2.3 Route B. Route B is about 48.2 miles long. Soils exhibiting a combination of revegetation constraints exist on 29.7 miles of the route. Strongly calcareous and alkaline soils occur on 1.7 miles. Strongly alkaline soils at depth and soils with a high erosion hazard are found on 1.6 and 1.2 miles, respectively. Soils with a combination of slope and high erosion hazard constraints and mapping units exhibiting limited endemic soil materials occur on 9.6 and 1.1 miles of this route, respectively. Approximately 21.5 miles of this route are suited to range seeding.

Route B does not contain significant mileage of soils limited by chemical characteristics. However, this alternative does exhibit a higher mileage of soils constrained by slope, coarse fragment content, and erosion hazard. Route B appears to offer the greatest potential for reclamation/revegetation of a disturbance associated with pipeline construction.

3.3.3 La Sal Pipeline Routes

3.3.3.1 Route 1 (Route Segment 1 Only). Route 1 crosses two soil moisture and temperature regimes. Above about 7,400 feet, the soils receive 18 to 20 inches of precipitation annually and typically have

cold mean annual soil temperatures. The growing season is relatively short, about 80 days. Below about 7,400 feet, at approximately mile 14, the soils have warmer mean annual temperature regimes, but annual precipitation drops to about 14 inches. The growing season lengthens to 90 to 100 days.

Route 1 exhibits the greatest range of soil characteritics among the route alternatives. Approximately 2 miles (7 percent) of the pipeline are occupied by the Starman-Rock Outcrop-Irigul complex, which is characterized by shallow, rocky soils on steep slopes above 7,400 feet. Approximately 5 miles (about 17 percent) of the route are occupied by the Parachute-Dateman complex on relatively flat high ridgetops. A similar portion of the route is occupied by the steeper Parachute-Dateman-Irigul complex, which occurs on sideslopes. The Irigul soil is shallow and stony.

The Rhone-Northwater-Silas Variant association occupies about 2.8 miles (approximately 10 percent) of the pipeline route, on high, cold sideslopes and swales. These are deep, organic-enriched, loamy soils.

The major soil type along Route 1 is the Rentsac-Redcreek-Castner complex, which occupies about 7 miles (approximately 24 percent) of the route. These are shallow, stony soils on ridgetops and sideslopes, typically under pinyon-juniper woodland. Associated with this unit is the Rock Outcrop-Torriorthents complex, which also contains shallow, rocky soils and occupies about 6.4 miles (22.5 percent) of the route. Both of these units occur along the warmer, drier portion of the route towards Piceance Creek, between miles 15 to 26.

Minor soils along Route 1 are the Camborthids-Haplargids complex, the Veatch-Work complex, and the Glendive-Havre-Nihill Variant association. These soils are moderately deep and generally loamy in texture. Combined, they occupy about 1.5 miles (about 5 percent) of the route. They occur along drainageways and on flatter ridgetops in the warmer, drier portion of the route in the vicinity of Piceance Creek.

3.3.3.2 Route 1A Route Segments (1-1A-1). Route 1A transects soil temperature and moisture regimes similar to Route 1. However, the majority of Route 1A contains deep, loamy soils in the drainageway. The

Rhone-Northwater-Silas Variant association occupies about 4 miles (about 22 percent) of the route, from the starting point to mile 4. These are cold, organic-enriched soils with short growing seasons. From mile 4 to 16, the route is occupied by the Glendive-Havre-Nihill Variant complex. These are deep, loamy soils formed primarily from streamlain alluvium. In the vicinity of Piceance Creek, from mile 14 to 16, these soils are used for irrigated and sub-irrigated pasture and haylands. The Glendive-Havre-Nihill Variant complex occupies about 11.5 miles, or 64 percent, of Route 1A. The remaining portion of the route is occupied by the Rock Outcrop-Torriorthents units, from mile 16 to 18.

3.3.3.3 Route 2 (Route Segments 1-2). The soil resources along Route 2 are characterized by cold soil temperature regimes and a short (approximately 80 day) growing season. About 5 miles of the route are occupied by the Parachute-Dateman Complex on flat ridgetops. The Parachute-Dateman-Irigul complex, on steep sideslopes, occupies an additional 8.5 miles. These units are composed of moderately deep and shallow soils with high contents of rock fragments. Depth to bedrock ranges from about 10 to 30 inches. Approximately 5 miles of Route 2 are occupied by the Rhone-Northwater-Silas Variant association, which is characterized by deep, loamy soils. About 1 mile of the route is occupied by the Starman-Rock Outcrop-Irigul unit, which is very steep and shallow to bedrock.

In summary, the soils along Route 2 exhibit a wide range of stoniness and depth to bedrock. About 15 miles of the route occur over steep sideslopes formed by side drainages on the plateau. The soils along Route 2 receive 18 to 20 inches of annual precipitation, but the growing season is limited to about 80 days.

3.3.3.4 Route 2A (Route Segments 1-2-2A-2). The soil resources on Route 2A are essentially the same as those described for Route 2, although the units occur in different proportion. About 4 miles of Route 2A (along the deviation from Route 2) is occupied by the deep, loamy soils of the Rhone-Northwater-Silas Variant association. The steeply sloping Parachute-Dateman-Irigul complex occupies approximately 1.2 miles of this route. An additional 1.3 miles are occupied by the

flatter Parachute-Dateman complex on ridge crests. The Starman-Rock Outcrop-Irigul complex occupies the remainder of the Route 2A deviation from Route 2.

3.3.3.5 Route 2B (Route Segments 2B-2A-2B-2). Soil resources occurring along mile 1 of Route 2B are the Rhone-Northwater-Silas Variant association and the Parachute-Dateman-Irigul Complex. These soil units were previously described under Routes 1 and 2. Between miles 1 and 11 of Route 2B, the pipeline crosses vertical cliffs of the Green River Formation and associated talus slopes. Soils occurring adjacent to and intermingled with the cliffs are included in the Starman-Rock Outcrop-Irigul Complex as previously described. Soils occurring on the talus sideslopes are in the Lolo-Grobutte association. These are deep, highly permeable soils containing up to 8 percent rock fragments. The low cohesion of these soils, combined with their steep slopes, severely limits their suitability for use as a pipeline right-of-way. The topography and rockiness of the Starman-Rock Outcrop-Irigul Complex further decreases the suitability of this route.

The Clear Creek valley between miles 2 and 10 is occupied by deep, gravelly and sandy soils of the Rivra-Rivra Variant-Bitton assocation. These soils are highly permeable and overlie the water table. The remainder of Route 2B is occupied by soils as described for Route 2.

3.3.3.6 Route 2C (Route Segments 1-2-2C-2). Soil resources along Route 2C are generally the same as those described for Route 2. The Parachute-Dateman complex occupies a greater proportion of Route 2C, since it follows the ridgetop.

3.4 Water Resources

3.4.1 Regional Setting

Drainage in the study area vicinity is divided by the southern edge of the Roan Plateau separating flow to the north and to the south. The area to the north is drained by Piceance Creek into the White River drainage system; the area to the south is drained by Roan Creek and Parachute Creek into the Colorado River drainage system. As discussed

in the previous section, the Roan Plateau has moderate relief with elevations up to 8,000 feet. The plateau has been deeply dissected as a result of regional uplift with relief up to 4,000 feet between the plateau and canyon floors.

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

Chemical analyses of water samples collected at points on Piceance Creek indicate total dissolved solids (TDS) of about 600 mg/l on the average. Concentrations of dissolved solids, sodium, chloride, and fluoride all increase in the downstream direction (Weeks et al. 1974).

The principal subsurface water-bearing zones in the basin are the Tertiary (Eocene) Uinta Formation, the upper Green River Formation, and the stream valley alluvium. The Uinta Formation, exposed over much of the basin, is recharged directly from infiltration of precipitation, estimated to be 0.8 inches annually (Weeks et al. 1974). Springs discharging up to 3 cfs are numerous at the contact between the Uinta Formation and the Green River Formation. The Parachute Creek Member contains the most permeable rocks in the Green River Formation. Within the Green River Formation, the fractured A and B Grooves exhibit a degree of secondary permeability and porosity and represent relatively significant regional aquifers. The valley alluvium, however, is the principal source of usable groundwater. Although of limited extent, short term discharge rates can be as high as 1,000 gpm. Groundwater flow is controlled by recharge on the uplands with downdip flow toward Piceance Creek. Horizontal permeabilities are normally much greater than vertical permeabilities. Locally, shallow groundwater movement is toward the tributary valley bottoms.

The Roan Creek and Parachute Creek basins are characterized by streamflow to the south cutting across the structural dip toward the

Colorado River. Both drainage basins show evidence of structural control by separate pairs of parallel synclines-anticlines trending north-northwest. 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. At this point, the 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 with relief up to 2,000 feet. Alluvium and terrace deposits of Quaternary age occur as stream valley deposits along Clear Creek. These deposits range from 5 to 20 feet thick on the plateau and average 100 feet thick in the canyon bottom. Landslide and talus deposits of Quaternary age occur at the base of the steep Roan Cliffs. Valley floor widths range from 25 to 100 feet on the plateau and from 500 to 1500 feet in the canyon bottom.

Surface water records indicate that Parachute Creek, Roan Creek, and reaches of some of the major tributaries are perennial. Springs discharging during the dry season often account for the majority of the flow. Streamflow may disappear where the alluvium is thick and then reappear where the alluvium thins and the saturated zone reaches the channel bottom. Precipitation in the valley bottoms is supplemented with irrigation diversions, groundwater discharge, and runoff from adjacent uplands. The water resources of Roan Creek and Parachute Creek are fully developed for irrigation. Chemical analyses of water samples collected at points on Roan Creek and Parachute Creek drainages show TDS ranging from 188 to 520 mg/l. Concentrations of TDS, sodium, chloride, and fluoride all increase in the downstream direction.

3.4.2 Rangely Pipeline Routes

3.4.2.1 Route A. Streams that may be affected by the proposed pipeline construction include Soldier Creek, Lake Creek, Cathedral Creek, East Douglas Creek, Douglas Creek, and the White River. All are perrenial streams. Soldier and Lake Creeks are tributaries of Cathedral Creek, which empties into East Douglas Creek.

Soldier Creek

Soldier Creek is a headwater stream that receives runoff from the Roan Plateau and eventually empties into Cathedral Creek. Soldier Creek originates at an elevation of about 8,500 feet and flows into Cathedral Creek at an elevation of about 6,800 feet. The stream is narrow, with widths ranging between 3 and 8 feet and depths of 4 to 10 inches. Because of soil characteristics in the area, the stream is turbid, particularly during periods of snowmelt. The stream lies in an eroded gulley with steep-cut banks and meanders considerably throughout its course. The bottom substrate in riffle areas is predominantly gravel and silt with some cobble; pools are characterized by silt-dominated bottoms.

Lake Creek

Lake Creek is the best quality stream in the study area. The stream is a tributary of Cathedral Creek, originating at an elevation of about 7,200 feet. Widths range from about 3 to 6 feet, while depths range from less than 4 to approximately 36 inches. The stream is relatively clear compared to other waters in the Douglas Creek drainage. Silt loads are probably periodically high, since silt and gravel dominate the bottom substrate.

Cathedral Creek

Cathedral Creek is characterized as a small headwater that is shallow (depths generally less than 2 feet) and narrow (widths between 5 and 15 feet). Most of the stream is situated within highly erodable gullies that meander through sagebrush and greasewood bottoms (BLM 1980). The unstable channel banks and gullies results in a great deal of erosive cutting during storm events. Serious bank sloughing and sediment-laden stream beds were noted during low flow conditions.

East Douglas Creek

The stream is larger with widths from about 5 to 20 feet and depths of 4 to 16 inches. The water in East Douglas Creek is turbid but less than conditions in Cathedral Creek. The bottom substrate is mainly silt and gravel with small amounts of cobble.

Douglas Creek

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.

Table 3-1 summarizes the USGS gaging station's data in the area of interest. 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 groundwater. Snowmelt runoff occurs during the months of May and June. High intensity short duration thunderstorms cause the main streamflow peaks during the summer months of July and August. Water usage for Douglas Creek and its tributaries is presented in Table 3-2. Douglas Creek carries an insignificant percentage of water in the White River.

White River

The White River originates on the White River Plateau in the White River National Forest and flows west to its confluence with the Green River in Utah. In the study area, spring snow melt and summer thunderstorms contribute most of the surface runoff, with peak discharges and sediment yields normally resulting from the summer thunderstorms. Near Rangely, the flow ranges from 237 to 3,940 ft^3/s, and an average of 6,636 tons of suspended sediment is discharged per day (BLM 1980).

3.4.2.2 Route A With Deviation. No additional streams are crossed by the deviation; conditions would be the same as those described above.

3.4.2.3 Route B. Route B would cross only Douglas Creek and the White River; conditions would be the same as those described above.

3.4.3 La Sal Pipeline Routes

3.4.3.1 Route 1 (Route Segment 1 Only). The first segment of Route 1, from mile 0 to mile 5.5, is located within the Roan Creek Basin (Clear Creek drainage). The second segment of Route 1, from mile 5.5 to mile 26.5, is located within the Piceance Creek basin.

TABLE 3-1

GAUGING STATION SUMMARY FOR WHITE RIVER AND DOUGLAS CREEK

Name and Location	Drainage Area	Period of Record	Dischage (cfs) Max	Min	Avg	Comments
White River above Rangely SW¼SE¼ SEC 27 T2N, R101W	2,790 mi^2	4/72 - Present	4,260	62	634	5 yr. water quality records available
Douglas Creek @ Rangley SE¼, NW¼, T1N, R101W	425 mi^2	10/76 - 9/78	3,250	0	- [1]	No water quality records available

Source: U.S.G.S. Water Resources Data for Colorado, water year 1978 Water Data Report CO-78-3

[1]No average discharge presented, period of record too short.

TABLE 3-2

IRRIGATION WATER USE FOR DOUGLAS CREEK AND TRIBUTARIES

Name	Source	Annual Total Water Volume (acre feet)
Middle Creek Ditch	Douglas Creek	489.1
Lewis Ditch	Douglas Creek	154.4
Mitchell Ditch	East Douglas Creek	255.0
Bowman Ditch	Bowman Draw	87.6
Pool Ditch	Lake Creek	128.7
Soldier Creek Ditch	Soldier Creek	378.2

Source: Annual Water Division Report, Division of Water Resources State of Colorado, 1978.

The surface water resources along the first segment are limited to minor flows from limited runoff and spring discharge at the headwaters of Clear Creek. The route crosses Willow Creek and East Willow Creek at right angles. Numerous springs discharge from the Uinta Formation at less than 0.1 cfs each. These streams are classified as intermittent with channel flow occurring from April to August, primarily as a result of snowmelt runoff. Bank cutting and gully development are significant along Willow Creek and East Willow Creek. Vertical walls from 5 to 15 feet high exist along the eroded banks. Snowpack development is substantial during winter months due to the higher elevation (8,000 feet) and the north-northeast slope aspects.

The groundwater resources along this route segment are limited to minor recharge from the infiltration of precipitation in the surficial Uinta Formation and silty loam soils. Most of this infiltration later discharges as springs into the stream valleys on the plateau. The alluvium in these valleys appears to be less than 10 feet thick. High water table conditions exist only during months of snowmelt runoff. Water use along this segment is limited to stock watering. There are no surface water storage facilities or diversion structures along the route.

The surface water resources along the second segment are limited to very minor runoff as the route follows the crest of Hunter Ridge to Piceance Creek. Infiltration of precipitation is very high because of a sandy loam cover and an underlying permeable section of the Uinta Formation. Piceance Creek is the only stream crossing along this route segment and is the major stream in the area. Average annual flow is approximately 15 cfs with peak flows in excess of 400 cfs (Weeks et al. 1974). The alluvial valley floor is approximately 2,000 feet across with alluvial deposits averaging about 150 feet thick. The stream channel is about 40 feet across and mildly meandering. Bank cutting along the outer valley walls is significant. The south valley wall is about 30 feet high, developed vertically into sandstone. The north valley walls are eroded into less resistant shales and siltstone with slopes exceeding 57 percent. Gully development becomes severe in these shale-siltstone units at mile 22 to mile 23. Snowpack conditions are moderate along this route. Available water resources are heavily

developed for irrigation. There are, however, no surface water storage facilities or diversion structures along this route.

3.4.3.2 Route 1A (Route Segments 1-1A-1). The middle segment of Route 1A, extending from mile 5.5 to 23.5, is located within the East Fawn Creek and Fawn Creek stream valley bottoms from mile 5.5 to 14. The segment then follows the stream valley bottom of Black Sulphur Creek down to mile 15.5 where it crosses Piceance Creek.

The surface water resources along this middle segment of Route 1A are the result of limited runoff and spring discharge collecting in the respective drainages. Runoff is limited because the evaporation and infiltration rates are high, but the drainage area is relatively large. Springs discharge contribution is significant. The streams are classified as intermittent in the upper reaches while the lower reaches are perennial. Gully development and bank erosion is significant along those reaches where the lithology is primarily composed of siltstone. Vertical walls up to 25 feet high exist along stream channels. The alluvial valley along the upper reaches ranges from 100 to 300 feet across, while the lower reaches of the alluvial valley range from 400 to 800 feet across. The valley floor is about 1200 feet across at the confluence with Black Sulphur Creek. The major stream crossing along this route is Piceance Creek. Conditions at Piceance Creek at this crossing point are similar to those at the Route 1 crossing point.

The groundwater resources along this route segment are limited to recharge from infiltration of precipitation in the highly permeable soils cover associated with the Uinta Formation. Spring discharges of up to 3 cfs each have been observed in the adjacent valleys. The groundwater conditions in the Piceance Creek alluvium at this crossing point are similar to the conditions at the crossing point along Route 1. Available water resources are moderately developed for irrigation. There are no surface water storage facilities or diversion structures along the proposed route.

3.4.3.3 Route 2 (Route Segments 1-2). The entire length of Route 2 is located within the Roan Creek (Clear Creek drainage) and Parachute Creek basins. The surface water resources along the route are limited

to minor runoff along the drainage divide between the Roan Creek and Parachute Creek basins and the Piceance Creek basin. Soils are relatively permeable with high evaporation rates allowing little runoff. Gully development is not significant. A few small springs discharge in adjacent gullies. Snowpack development is not signficant.

Some near surface groundwater could be encountered along the portion of the route following Wet Fork (approximately 6 miles). There is a spring-fed stock pond at the bottom of the Wet Fork drainage. The groundwater resources along this route are limited to minor recharge from infiltration of precipitation into the silty loam soils and the underlying permeable Uinta Formation. Water use is limited to stock watering. There are no surface water storage facilities or diversion structures.

3.4.3.4 Route 2A (Route Segments 1-2-2A-2). Route 2A is entirely within the Parachute Creek drainage. The surface water resources along this route segment are limited to minor flows from runoff and spring discharge at the headwaters of Parachute Creek. The route segment follows the stream valley along Wolf Creek from mile 2.5 to mile 5.5 to where it crosses Wolf Creek at a right angle. The streams are intermittent with channel flow occurring from April to August as a result of snowmelt runoff and from significant summer precipitation events. Gully development and bank cutting are moderate because of a permeable sandy loam soil. Snowpack development is high due to narrow valleys and steep north-northeast facing slopes.

The groundwater resources along this route segment are limited to minor recharge from infiltration of precipitation into the sandy loam soils and underlying Uinta Formation. Along the valley bottoms the alluvium appears to be less than 20 ft thick on the average. High water table conditions are likely to exist only during the period of snowmelt runoff. Water use is limited to stock watering. No surface water storage facilities or diversion structures occur along the route.

3.4.3.5 Route 2B Route Segments 2B-2A-2B-2). Route 2B is located within the Roan Creek basin (Clear Creek drainage) and Parachute Creek basin. The surface water resources along the segment from mile 0 to 1

are limited to minor flows in the upper reaches of Clear Creek on the Roan Plateau. Bank cutting is moderate. Numerous springs discharge into the valley bottom. At mile 1 the route enters Clear Creek Canyon at the Clear Creek fall line. The route follows the bottom of Clear Creek valley to mile 11. Valley floor widths range from 600 to 1,200 feet. There are nearly 2,000 feet of relief with vertical valley walls developed into resistant members of the Green River Formation. Stream segments alternate from gaining to losing reaches. The lower reaches on this route are perennial with average annual flows in excess of 5 cfs. Peak flows for the period from 1970 to 1980 were in excess of 325 cfs. The water quality for the lower canyon flows averages 600 mg/l total dissolved solids. Quality of the springs and alluvial groundwater is similar to that in lower Clear Creek. Snowpack development in the canyon is moderate.

The groundwater resources in the lower canyon are significant for the area. Precipitation infiltrates at relatively high rates into the alluvial floors. The alluvium also recharges from losing reaches and from spring discharge out of the upper Green River Formation migrating into the valley talus at the canyon walls. Wells in the alluvium produce up to 800 gpm for short term withdrawals. Major springs discharge from the alluvium in the lower reaches of Clear Creek (mile 8). These springs discharge about 10 cfs and account for streamflow during dry periods. The alluvium averages 100 feet in thickness. Depth to water ranges from 30 to 70 feet in the upper, losing reaches. Water resources in this area are fully developed for irrigation uses. There are numerous diversion structures.

From miles 11 to 14 the route follows Wiesse Creek on the Roan Plateau. The surface water resource is limited to minor runoff due to high infiltration and evaporation rates. The channel is typically dry except from April to August when it is fed by snowmelt runoff or from significant summer precipitation events. The valley floor ranges in width from 50 to 100 feet. Snowpack development is moderate.

The groundwater resource along this segment is limited to minor recharge from infiltration of precipitation into the silty loam soils and underlying Uinta Formation. Springs discharge (less than 0.1 cfs each) at the base of the Uinta Formation into the valley bottom. The

alluvium appears to be less than 10 feet thick and is saturated only during periods of snowmelt runoff. Bank cutting is moderate. Water use is limited to stock watering. There are no surface water storage facilities or diversion structures along this segment.

The next segment of Route 2B, from miles 15 to 23.5, follows Jackrabbit Ridge. The surface water resources are limited to minor runoff. The segment crosses West Fork Parachute Creek at mile 22. Surface flows are limited to minor runoff and springs discharge into the valley. The stream is classified as intermittent with channel flow occurring from April to August as a result of snowmelt runoff and from significant precipitation events. The valley floor at the West Fork Parachute Creek crossing is about 200 feet across. Snowpack development is high because of the north-northeastern configuration of the valley at this point. Snowpack development is moderate on the ridge.

The groundwater resource along this segment is limited to minor recharge from infiltration of precipitation into the silty loam soils and into the underlying Uinta Formation. Numerous small springs (less than 0.1 cfs each) discharge from the base of the Uinta Formation into the valley bottom. Alluvium in the West Fork Parachute Creek valley is less than 20 feet thick. The alluvium is typically saturated only during periods of snowmelt runoff. Water use is limited to stock watering. There are no surface water storage facilities or diversion structures along this portion of the route.

3.4.3.6 Route 2C (Route Segments 1-2-2C-2). Water resources for Route 2C are identical to those of Route 2 except for the portion of the route which follows Ridge Road rather than Wet Fork, eliminating the likelihood of encountering near surface groundwater along this section of the route.

3.5 Vegetation

3.5.1 Regional Setting

Vegetation types in the study area include plateau sagebrush, plateau mixed shrub, pinyon-juniper, aspen, grassland, agricultural land, conifer, valley mixed shrub, saltbush, greasewood, valley

sagebrush, and valley riparian. Distribution of each type is primarily controlled by topography and its influence on moisture availability. Other factors that influence plant distribution include soils (depth, texture, parent material, organic content, moisture holding capacity, and chemistry) and the interaction between different strata within a vegetation type.

Percent cover and productivity of the vegetation types vary greatly from site to site; differences are related to variation in moisture availability and soil properties (Cook 1974). Plateau sagebrush communities occur on slopes with a variety of inclinations, aspects, and soil depths (Bechtel Corp. and ECI 1975, Cook 1974). Shrub size and density appear to be dependent on elevation, exposure, and their influence on available moisture. Below about 6,500 feet, soils are derived from interbedded layers of shales and sandstones (Cook 1974) and are dry and shallow. Shadscale and spiny horsebrush are commonly important associated shrubs, while a sparse understory is composed of western wheatgrass, Hood's phlox, squirreltail, and bluegrasses. Above 6,500 feet, big sagebrush is still the dominant species, but additional shrubs (bitterbrush, mountain mahogany, serviceberry, and snowberry) are common. Understory species include junegrass, wheatgrasses, Indian ricegrass, needle grasses, lupine, and yarrow. Total plant cover averages 32 percent, with big sagebrush providing 20 to 100 percent of this cover (BLM 1980). Productivity varies with shrub density. Open stands of big sagebrush are estimated to produce 800 to 1,800 pounds per acre (BLM 1980).

The mixed shrub type is restricted to protected topographic positions such as gullies, foothills, and northerly exposures at an elevational range of about 7,000 to 8,500 feet. The dominant species are Gambel oak, Utah serviceberry, mountain mahogany, and snowberry. Distribution and local dominance of these species are influenced by moisture requirements (Cook 1974). Gambel oak requires the most water and dominates the more moist sites providing up to 80 percent cover. Utah serviceberry dominates drier sites. Shrub canopy here ranges as high as 80 percent. Both oak and serviceberry occur together on sites of intermediate moisture. Mountain mahogany, snowberry, chokecherry, and big sagebrush may become local dominants or share dominance along

the moisture gradient (Cook 1974). Productivity of the mixed brush type ranges from 900 to 1,500 pounds per acre (BLM 1980). Common herbaceous species include wheatgrasses, Indian ricegrass, needle-and-thread, bluegrasses, carex, yarrow, lupine, and fringed sage.

Pinyon-juniper occurs on all aspects and slopes. It occupies about the same elevational range and soil types as the big sagebrush type. The two types are separated primarily by soil depth, with pinyon-juniper growing on the shallower soils. Where soil depth is intermediate, the two types intergrade. Species composition of the pinyon-juniper type is highly variable and depends primarily on elevation and soil parent material. Below 7,000 feet, Utah juniper dominates the tree stratum. On shales, few shrubs are present. The understory consists of scattered, stunted plants of junegrass, beardless wheatgrass, Indian ricegrass, needle-and-thread, and squirreltail. Pinyon pine and big sagebrush are present on sandstone-derived soils. Understory species include junegrass, wheatgrasses, needle-and-thread, and Indian ricegrass. Where the shale and sandstone-derived soils are deeper, pinyon-juniper grades into big sagebrush. Above 7,000 feet, pinyon pine is the dominant tree species. The influence of soil parent material on species composition and productivity is less pronounced than at lower elevations (Cook 1974). Big sagebrush, rabbitbrush, bitterbrush, mountain mahogany, chokecherry, and serviceberry comprise the shrub layer. Understory species include Indian ricegrass, wheatgrasses, needle-and-thread, Hood's phlox, and beard-tongue. Fire has historically played an important role in maintaining open stands of pinyon pine with productive understories. The control and subsequent reduction in fires during the past century has resulted in the accumulation of leaf litter in the type. This in turn has repressed the development of shrub and herbaceous understories. As a result, juniper canopy cover has increased while understory cover and productivity has decreased. Productivity of forage of the type is highly variable, ranging from negligible in dense juniper stands to 300 pounds per acre in open stands (BLM 1980).

The aspen type occurs at elevations of about 7,000 to 8,000 feet. The scattered stands, generally only a few acres in areal extent, typically grow on steep, north-facing slopes. Soils are characteristically deep loams (ECI 1977). The microclimate of aspen

stands is generally more moist and cooler than the other vegetation types because of snow accumulation and protection of the stands from solar radiation. As a result, the shrub and herbaceous understories are often lush. Shrub cover averages 60 percent (Cook 1974) and is commonly composed of Gambel oak, big sagebrush, serviceberry, snowberry, and common juniper. Sedge, bluegrasses, needle grasses, native timothy, fescue, Indian paintbrush, lupine, and yarrow are common components of the herbaceous stratum. Productivity is estimated to range from 900 to 1,500 pounds per acre (BLM 1980).

Small patches of grasslands occur on gentle sideslopes, in valleys, and on windswept ridges at all elevations, but it is most prevalent below 7,000 feet. Soils are generally shallow and range from rocky to gravelly. At lower elevations, the dominant species are western wheatgrass and needle-and-thread. Common high elevation species include bluegrass, junegrass, Idaho fescue, and Green's rabbitbrush.

Agricultural lands are used for grass or alfalfa hay production. All agriculture in the study area is restricted to level lands along Piceance Creek and Clear Creek.

The conifer type occupies steep terrain ranging from 30 to 70 percent slopes, and ranges in elevation from the valley floor (6,500 feet) to the ridgetops (8,000 feet). Douglas fir stands occur on northwest- to northeast-facing slopes and characteristically include an understory with little diversity, low productivity, and extensive accumulated ground cover (litter). The soils of this type range from the shallow loamy-skeletal type of the higher elevation conifer sites to the deeper loamy-skeletal type of the lower elevation conifer sites on valley slopes. The tree overstory canopy is composed of a nearly pure stand of Douglas fir. Understory structure is variable. The dense stands of Douglas fir have a sparsely vegetated understory. The more open stands contain a well developed shrub stratum with few forbs and grasses at ground level. The dominant low-growing shrubs include myrtle pachystima and creeping barberry. Common chokecherry, Woods rose, and mountain snowberry are the tallest growing shrub species found in this community. The few forbs and grasses common in the understory are bedstraw, elk sedge, and littleseed ricegrass.

The valley, dry-slope mixed shrub vegetation type occurs along the southwest- and west-facing slopes of the steep (up to 70 percent slope) sides of the canyons. The soils underlying the sites are loamy-skeletal, mixed, of the Grobutte and Lolo soil series. Several shrubs including Utah serviceberry dominate the shrub stratum. The sparse understory consists of thistle, bedstraw, corymbed eriogonum, Louisiana sagebrush, and Indian ricegrass. Other important species include milkvetch, mountain pepperweed, and western wheatgrass. A high percentage of litter and rock (primarily rock) accounts for most of the ground cover.

The saltbush vegetation occupies the steep valley sideslopes in the lower portion of Clear Creek Canyon. Type composition consists of scattered shadscale saltbush and Indian ricegrass.

Greasewood is the most common cover type occurring in bottomland areas along Douglas Creek below 6,600 feet elevation. Greasewood is dominant on deep, poorly drained alluvial soils with moderate to high salt levels. Associated shrub species include big sagebrush, rabbitbrush, and shadscale. Understory cover is rare and extremely sparse. Herbaceous species commonly associated with the type include western wheatgrass, cheatgrass, mustard, Russian thistle, and fringed sage. The BLM estimates cover at about 28 percent with productivity of about 400 to 700 pounds per acre (BLM 1980).

The valley sagebrush vegetation type is generally found in the well-drained, flat valley bottoms and alluvial fans. Soils are relatively deep and non-saline. Associated shrub species include greasewood, rabbitbrush, shadscale, and fringed sage. Greasewood is present where the surface soil contains some salinity and increases in density as salinity concentrations increase. Understory species include Indian ricegrass and wheatgrasses.

Valley riparian vegetation is restricted to narrow bands bordering the streambeds of Buck Gulch and Clear Creek. Species composition, cover, and productivity vary from site to site, and are influenced by elevation, geographic location, soil type, moisture availability, and past and present land use, especially grazing. The valley riparian vegetation type is often dominated by willow, cottonwood, or box elder trees. Understory species include bluegrasses, sedges, rushes, dandelion, clovers, thistle, and milkweed. The riparian type is

important because it is capable of supporting higher population densities and greater species diversities of plants and animals than any of the other rangeland vegetation types (BLM 1980).

Threatened and Endangered Species

On December 15, 1980, the U.S. Fish and Wildlife Service published a list of candidate threatened and endangered plant species for the United States in the Federal Register (FR 45(242): 8240-82569). This list includes plants in three categories. Category One candidate species consists of species about which sufficient information is known to initiate listing recommendations; Category Two species include those that may be threatened or endangered, but for which insufficient information is not available; Category Three species were previously proposed, but were found to be more common than previously believed.

Three Category Two species and one species included on the Colorado Heritage Inventory working rare plant list were found on or near the Chevron Clear Creek study area:

Barneby's columbine (Aquilegia barnebyi)	Category 2
fescue (Festuca dasyclada)	Category 2
dragon milkvetch (Astragalus lutosus)	Category 2
sullivantia (Sullivantia purpusii)	Colorado Natural Heritage Inventory List

A brief discussion of the habitat requirements for each species, and the distribution of the species in the region and in the study area are discussed below.

Barneby's columbine (Aquilegia barnebyi) and sullivantia (Sullivantia purpusii) grow on seeps and below waterfalls on steep sandstone or siltstone cliffs in drainages along the Roan Cliffs, eastward into Glenwood Canyon and southward into Gunnison County where the plants occupy similar sites on limestone and granite (U.S. Forest Service 1979). Both species were found on small (less than 25 acres) seep areas next to the falls on Clear Creek and No Name Creek. Other good potential habitat for these species includes seep and waterfall areas on Willow Creek, Sheep Gulch, and Tom Creek.

The fescue grass (Festuca dasyclada) and dragon milkvetch (Astragalus lutosus) occupy talus slopes that form below outcrops of the Green River Formation. The fescue is presently known from the eastern Piceance Basin (vicinity Rio Blanco) and from scattered locations along the south face of the Roan Cliffs from Anvil Points westward to the Roan Creek drainage (Emrich and Painter 1978). Dragon milkvetch is known from eastern Utah (Uintah County) and has been found in numerous (20-30) locations in the Piceance Basin and the Roan Cliffs in Garfield and Rio Blanco Counties (U.S. Forest Service 1979). The talus habitat for both species is narrowly defined. The talus cannot be so unstable that plants of any sort cannot establish themselves, nor so stable that big sagebrush, skunkbush sumac, or Indian ricegrass can invade and outcompete the fescue and the milkvetch. The fescue particularly favors small gravelly talus that forms below highly oxidized oil shale outcrops. These talus slopes are typically reddish and easily distinguishable on color aerial photography.

3.5.2 Rangely Pipeline Routes

3.5.2.1 Route A. Nine vegetation types occur along the 42.8 miles of Route A. Vegetation cover types are depicted on Map 5. Greasewood, sagebrush, and pinyon-juniper are the dominant cover types with 31, 29, and 24 percent of the pipeline corridor length composed of these cover types (Table 3-3). The remaining percent includes riparian (8 percent), bare ground (1 percent), mixed brush (2 percent), agriculture (3 percent), and grasslands (<1 percent). Distribution of each type is primarily controlled by topography and soils. Percent cover and productivity of the vegetation types varies greatly from site to site, probably related to variations in soil property (Cook 1974).

Route A contains the most riparian vegetation of any of the routes studied (8%). This cover type is present as a narrow band along Cathedral Creek, East Douglas Creek, and Douglas Creek. In some areas its areal extent has been reduced by irrigated hayfields. Other types present along Route A include mixed brush, agricultural lands, irrigated hayfields, and a very small portion (less than 1 percent) of grassland (Table 3-3).

TABLE 3-3

ACRES OF VEGETATION POTENTIALLY DISTURBED BY PIPELINE CONSTRUCTION[1]

	Grassland	Sagebrush	Pinyon-Juniper	Aspen	Mixed Brush	Greasewood	Agriculture	Conifer	Riparian	Bare	Total Disturbance	Total Miles
Route A												
Acres	0.6	73.9	61.2	0	4.8	80.0	8.5	0	21.2	3.0	259.3	42.8
(rounded) %	0.2	28.5	23.6	0	1.8	30.8	3.3	0	8.2	1.2		
Route A with deviation												
Acres	0.6	92.7	65.5	0	4.8	80.0	8.5	0	13.3	6.7	290.9	48.0
(rounded) %	0.2	31.9	22.5	0	1.7	27.5	2.9	0	5.0	2.3		
Route B												
Acres	78.8	125.4	47.9	7.9	10.3	3.0	5.5	1.2	0	2.4	293.3	48.4
(rounded) %	26.8	42.9	16.3	2.7	3.5	1.0	1.9	0.4	0	0.8		

[1]Acreage calculations based on a 50-foot right-of-way.

3.5.2.2 Route A With Deviation. Construction along Route A with the deviation would affect similar cover types (see Table 3-3). No threatened and/or endangered species are likely to occur along the deviation.

3.5.2.3 Route B. Eight vegetation types occur along the 48.4 miles of Route B. Sagebrush and grasslands are the dominant types (43 and 27 percent) followed by pinyon-juniper, mixed brush, aspen, and agricultural areas (17, 4, 3, and 2 percent). Route B does not affect any riparian areas but does cross some areas covered with Douglas fir (less than 1 percent). The sagebrush is usually the shorter upland variety of big sagebrush and occurs on coarse well drained soils with stands of mixed brush, Douglas-fir and aspen, without greasewood. Route B also differs from A in crossing several "grassy balds" on windswept slopes along the Cathedral Bluffs Road. The pinyon-juniper type occurs primarily along Big Ridge. Populations of rare plant species occur near the R-O-W. These include populations of Astragalus lutosus (dragon milkvetch), Aquilegia barnebyi (Barneby's columbine), and Sullivantia purpusii (sullivantia) (Map 5).

3.5.3 La Sal Pipeline Routes

3.5.3.1 Route 1 (Route Segment 1 Only). The six vegetation types occurring along Route 1 are plateau sagebrush (40 percent), plateau mixed shrub (11 percent), pinyon-juniper (36 percent), aspen (9 percent), grassland (3 percent), and agricultural lands (1 percent). Numbers of acres to be disturbed are shown in Table 3-4. No populations of rare plants have been documented along or adjacent to the pipeline corridor of Route 1. The habitats along this route are not conducive to the rare plant populations known to occur in the Roan Plateau area between Clear Creek and Piceance Creek.

3.5.3.2 Route 1A (Route Segments 1-1A-1). Six vegetation types occur along this pipeline corridor. These include plateau sagebrush, pinyon-juniper, aspen, plateau riparian, grassland, and agricultural lands. The most significant differences between the plant communities

TABLE 3-4

ACRES OF VEGETATION TO BE DISTURBED BY PIPELINE CONSTRUCTION[1]

Vegatation Type	Route					
	1	1A	2	2A	2B	2C
Plateau Sagebrush	65	65[2]	110	107	73	112
Plateau Mixed Shrub	19		21	20	20	23
Aspen	14	9	21	21	5	17
Pinyon-Juniper	58	24				
Grassland	5	1	2	1	1	5
Plateau Riparian		39	1	1		
Conifer					2	
Valley, Dry-Slope Mixed, Shrub					2	
Saltbush					7	
Valley Sagebrush					20	
Valley Riparian					38	
Agriculture	2	25			1	
Barren					1	
Total	163	163	155	150	170	157

[1]Acreage calculations based on a 50-foot right-of-way

[2]Sagebrush primarily found adjacent to plateau riparian type, resulting in taller, more productive sagebrush.

along Route 1A and Route 1 exist in the plateau sagebrush productivity levels and in the total acreages of the pinyon-juniper, plateau riparian, and agricultural types. Map 6 displays vegetation types occurring along the route.

3.5.3.3 Route 2 (Route Segments 1-2). The five vegetation types occurring along this pipeline corridor are plateau sagebrush (71 percent), plateau mixed shrub (13 percent), aspen (13 percent), plateau riparian (1 percent), and grassland (2 percent). A known population of Festuca dasyclada, a Category Two candidate species, would be intersected by the pipeline Route 2 for a distance of approximately 2 miles (mile 10.5 to 12.5) (see Map 7). This population occurs along the West Fork of Parachute Creek including the adjacent plateau sagebrush communities (BLM 1980).

3.5.3.4 Route 2A (Route Segments 1-2-2A-2). Five vegetation types occur along pipeline Route 2A: plateau sagebrush, plateau mixed shrub, aspen, plateau riparian, and grassland. These are the same vegetation types occurring along Route 2. The riparian vegetation type occurring along Route 2A at the West Fork of Parachute Creek contains scattered willows along the streambanks and can be important to wildlife communities. The population of fescue described for Route 2 will be disturbed along approximately 2 miles (miles 4.5 to 6.5) of the pipeline Route 2A.

3.5.3.5 Route 2B (Route Segments 2B-2A-2B-2). The ten vegetation types occurring along the pipeline corridor are plateau sagebrush (43 percent), plateau mixed shrub (12 percent), aspen (3 percent), grassland (1 percent), conifer (1 percent), valley mixed shrub (dry-slope) (1 percent), saltbush (4 percent), valley sagebrush (11 percent), valley riparian (22 percent), and agricultural lands (1 percent). The same population of fescue grass intersected by both pipeline routes 2 and 2A will also be disturbed along approximately 3.5 miles (mile 19 to 22.5) of Route 2B. Potential habitat for Barneby's columbine (Aquilegia barnebyi) and sullivantia (Sullivantia purpusii) occurs near mile 11 of Route 2B along the steep cliff area of Buck Gulch. Barneby's columbine is listed as a Category Two candidate species and sullivantia is included on the Colorado Natural Heritage Inventory working rare plant list.

3.5.3.6 Route 2C (Route Segments 1-2-2C-2). The four vegetation types that occur along pipeline Route 2C include plateau sagebrush, plateau mixed shrub, aspen, and grassland. The impacts discussed previously for Route 2 would apply to Route 2C with variation in total acreage disturbed (164 ac) and acreage disturbed for each vegetation type (Table 3-4). Pipeline Route 2C would extend for approximately one mile along the outer edge of the population of Festuca dasyclada described previously.

3.6 Wildlife

3.6.1 Regional Setting

A variety of wildlife species occurs on the many habitat types crossed by the alternative pipeline routes. Habitat types are described above in the vegetation section. Limited data are available for wildlife populations near the study corridors with most information being available on important game species.

The mule deer is the most important big game species in the region. Winter range is typically below 7,400 feet elevation on sagebrush and pinyon-juniper habitats (BLM 1980). Summer range is generally above 6,800 feet in sagebrush, mountain shrub, aspen, and spruce-fir habitats. Elk are fewer in number in the region than mule deer but have been steadily increasing in recent years. Both summer and winter range occur above 7,000 feet elevation, with spruce-fir and aspen used as cover from spring through fall and mountain shrub and pinyon-juniper used in winter.

Other mammals occurring in the region total approximately 75 species. Predators include black bear, mountain lion, coyote, bobcat, gray fox, and long-tailed weasel. Medium-sized mammals such as desert and Nuttall's cottontail, white-tailed jackrabbit, beaver, yellow-bellied marmot, and porcupine inhabit various habitats throughout the region. Small mammals are numerous and include deer mouse, least chipmunk, and golden-mantled ground squirrel as dominant species. Also occurring are Colorado chipmunk, rock squirrel, northern pocket gopher, and bushy-tailed woodrat. The abundant small mammals provide an important prey base for avian and mammalian predators.

Four game bird species occur in the region including sage grouse, blue grouse, mourning dove, and chukar. Sage grouse occur in the plateau areas in sagebrush habitats where sagebrush provides food and cover year round. Populations are stable in the region and are dependent on good nesting, brooding, and winter habitat conditions (BLM 1980). Cathedral Bluffs is year round habitat for sage grouse; several strutting ground and winter concentration areas have been mapped by the CDOW (Map 8). Blue grouse inhabot mountain shrub and aspen habitats during the breeding season and move to heavily timbered areas during winter. Populations are small and scattered and sustain light hunting pressure incidental to hunting of other game species. The mourning dove is a common summer resident in all habitats in the region. Nesting usually occurs in trees at edges between habitat types. The chukar, an exotic game bird introduced into the area, inhabits rocky areas in sagebrush, greasewood, and rabbitbrush. Populations are sparse and hunting pressure is probably minimal.

Songbird communities in the various habitats of the region are typified by summer residents that breed in the area and migrate to wintering grounds. Species diversity varies with vegetational structure and diversity within each habitat type. Raptor species such as golden eagle and red-tailed hawk are common in the region, preying on various avian and mammalian species. Waterfowl are uncommon because of the lack of suitable habitat.

Threatened & Endangered Species

No federal- or state-listed threatened species are likely to occur within the study region. Two endangered species, the bald eagle and the peregrine falcon, are potential inhabitants of the region. The bald eagle winters each year along the White River but is unlikely to occur along the study corridors (BLM 1980). Peregrines have been observed performing courtship activities in Parachute Creek Canyon (Smith 1974), and the CDOW has designated the upper portion of Parachute Creek Canyon and its main forks as potential nesting habitat (CDOW Wildlife Resources Information). Similar habitat exists in the upper portion of Clear Creek Canyon. The nearest known peregrine eyrie occurs in DeBeque Canyon near Cameo. This nest was last active in 1977 (Craig 1980,

personal communication). No peregrine nests are known for either Clear Creek or Parachute Creek Canyons, and during 1980 and 1981 field studies on the Clear Creek property, no peregrine nesting activity or peregrines were observed in Clear Creek Canyon (ERT 1981b). Since nest sites preferred by peregrines are high cliff ledges, usually near water, the potential for their nesting within the pipeline corridor is very low.

Black-footed ferrets, although not reported in the area, may occur wherever prairie dog towns are present. However, prairie dog towns were not observed during the aerial reconnaissance of the proposed pipeline corridors. Whooping cranes may occasionally fly over the region during spring and fall migration. A whooping crane was reported along Duck Creek, a tributary of Piceance Creek, in 1977. Whooping crane use of the region is expected to be infrequent and minimal.

3.6.2 Rangely Pipeline Routes

3.6.2.1 Route A. A critical mule deer winter range or concentration area occurs in the area south of the confluence of Douglas and Cathedral Creeks. Another small critical winter range or concentration area occurs in Gillam Draw (Map 8). The Douglas Creek deer herd includes approximately 2,868 deer on summer range, 1,843 on winter range, and 670 on critical winter range (BLM 1980; 1978 population estimates). Elk also concentrate in winter south of the confluence of Douglas and Cathedral Creek and are year round residents along Cathedral Bluffs. Oil and gas development along Douglas Creek may currently or in the near future limit the size of the Douglas Creek elk herd (BLM 1980). Other general wildlife conditions are described in the regional setting. Wintering bald eagles could occur where Route A crosses the White River.

3.6.2.2 Route A with Deviation. Conditions would be similar to those described for Route A.

3.6.2.3 Route B. Conditions for to wildlife along Route B would be similar to those described for Route A. Route B also crosses a mule deer critical winter range area in Gillam Draw. No figures on the size of the wintering herd are available. A few sage grouse strutting grounds

are present along the bluffs near the pipeline route (Map 8). Wintering eagles could potentially occur where the route crosses the White River.

3.6.3 La Sal Pipeline Routes

3.6.3.1 Route 1 (Route Segments 1 Only). Route 1 has a moderate rating for wildlife habitat. This route is comprised of pinyon-juniper woodland, upland sagebrush with rabbitbrush in disturbed areas, and mixed brush and aspen over the remainder. Pinyon-juniper woodland provides habitat for nesting songbirds and possibly a few raptors. The understory below the tree canopy has very limited, sparse vegetation available as forage. The sagebrush steppe is summer range for big game (primarily mule deer) and is habitat for sage grouse. Approximately 7 miles of the route pass through mule deer critical winter range. A sage grouse strutting ground is at the beginning of Route 1 (ERT 1981b). This route crosses good wildlife habitat at Piceance Creek, where the riparian zone and irrigated hayfields provide food, especially in winter, for deer and elk. A herd of about 140 wild horses range along Cathedral Bluff and the drainages leading to Piceance Creek (Gring 1981).

3.6.3.2 Route 1A (Route Segments 1-1A-1). Route 1A has good wildlife habitat over 80 percent of its length and received a high wildlife habitat rating. Sixty percent of the route is riparian, aspen, and mixed shrub communities along East Fawn Creek. About 20 percent of the route (from mile 0 to East Fawn Creek) is aspen and mixed shrub. The remaining 20 percent is sagebrush and greasewood, which are of limited value as big game habitats. However, this habitat is good for small mammals (especially rabbits) which are important prey species. A portion of Route 1A (common with Route 1 at Piceance Creek) crosses mule deer critical winter range (Map 9).

3.6.3.3 Route 2 (Route Segments 1-2). Route 2 received a moderate rating for wildlife habitat quality. Sagebrush steppes provide summer range for big game and sage grouse, and habitat for songbirds and small mammals. Upland sagebrush communities are common in the region and generally are not as important to wildlife as habitats which have more

structural features and components and greater diversity such as the aspen, mixed brush, or riparian habitats. This route also follows an area of disturbance in the form of an existing road.

Good to excellent habitat is present at the confluence of Wet Fork and West Fork Parachute Creek. Here the route drops into the valley bottom where a spring-fed stock pond and surrounding meadows provide good habitat for wildlife. Although the pond is less than 1 acre, it is permanent and provides water for big game and waterfowl. The lush meadows surrounding the pond provide forage for big game and hunting habitat for predators. Suitable nesting habitat is present for raptors, primarily red-tailed hawks, in the Douglas fir and aspen stands on the hillsides next to the meadow. Two stream crossings associated with the Route 2 pipeline corrider are proposed between mile 10 and 11, and at mile 11.3, both along West Fork Parachute Creek.

3.6.3.4 Route 2A (Route Segments 1-2-2A-2). Affected habitats would include sagebrush, aspen, mixed brush, and riparian vegetation. This route received a high rating for wildlife habitat because excellent habitat is present between miles 5 and 7 where the route follows Wolf Creek to its confluence with West Fork Parachute Creek. At the confluence of the two creeks, a permanent pond is present providing water for big game and waterfowl. The permanent free water, wet meadows and aspen stands on the adjacent hillsides provide structural diversity and habitat components important to big game and other wildlife species such as sage grouse, small mammals, and raptors. More riparian vegetation occurs along Route 2A than Route 2 because Route 2A follows Wolf Creek.

3.6.3.5 Route 2B (Route Segments 2B-2A-2B-2). Route 2B received a high wildlife rating. This route crosses good wildlife habitat in the Clear Creek Valley, where it intersects primarily sagebrush and riparian vegetation types. Affected habitats include plateau sagebrush, riparian, mixed brush, valley sagebrush, saltbush, and aspen. This area is critical winter range for elk; both mule deer and elk concentrate in winter along the valley floor and south facing pinyon-juniper slopes of the canyon (CDOW 1978). The canyon walls are potential nesting habitat for the endangered peregrine falcon (BLM 1981c); however, no sitings of the

peregrine have been reported for the area during extensive raptor surveys conducted by ERT (ERT 1981b). Several raptor nests and a golden eagle perch site are reported for the canyon (ERT 1981b). Black bear and mountain lion may occasionally wander into the upper reaches of Clear Creek. Beaver are also present in the upper reaches of Clear Creek. In addition to being of critical importance to big game, the riparian zone provides habitat for many species of wildlife and contains the greatest diversity of both plant and animal species of any habitats or communities in the region (BLM 1980).

3.6.3.6 Route 2C (Route Segments 1-2-2C-2). Wildlife useage along Route 2C is the same as along Route 2 except for the portion of the route that continues to follow Ridge Road rather than following Wet Fork. The majority of Route 2C traverses upland sagebrush. This route eliminates the disturbance of habitat rated as good to excellent along Wet Fork and one stream crossing of the West Fork of Parachute Creek.

3.7 Aquatic Ecology

3.7.1 Regional Overview

A regional overview of the biological communities in the four major streams considered in this study (Willow Creek, Piceance Creek, West Fork Parachute Creek, and Clear Creek) shows rather diverse structure. Two of the streams located on top of the Roan Plateau, Willow Creek and West Fork Parachute Creek, support trout populations consisting of rainbow trout and cutthroat trout, respectively. Piceance Creek contains mainly coldwater nongame fish species such as mountain sucker and speckled dace, while Clear Creek exhibits no fish in the sections proposed for pipeline crossings. The only endangered fish species found in any of the streams crossed by a pipeline route is the Colorado River squawfish found in the White River. This species is discussed further in Section 3.7.2.1 and is not found along the La Sal routes. Benthic macroinvertebrates and periphyton communities in these creeks are indicative of streams that undergo extreme fluctuations in some physical and chemical conditions. More detailed information is presented for each of these streams in the appropriate section of the Clear Creek baseline report (ERT 1981a).

3.7.2 Rangely Pipeline Routes

3.7.2.1 Route A.

Soldier Creek

Fish populations in Soldier Creek are composed of cutthroat trout (Salmo clarki). Surveys conducted by ERT biologists at one location in the creek yielded eight specimens ranging in length from 4 to 6 inches. Previous surveys in Soldier Creek by BLM (1980) listed cutthroat trout and brook trout (Salvelinus fontinalis). The Colorado River cutthroat (Salmo clarki pleuriticus) is listed as threatened in Colorado and is known to occur in the Colorado River Basin (Behnke and Benson 1980). Based on five specimens collected in Soldier Creek in 1977 (Behnke 1977), the population showed hybridization between rainbows and cutthroats but resultant characteristics were closer to the Colorado River cutthroat.

Fish habitat in Soldier Creek is marginal, with few pools, undercut banks, or debris to provide adequate cover. The small size and low flows of the stream probably account for the small-sized fish (BLM 1980). Benthic macroinvertebrate numbers were extremely low in October 1980, with mayflies, caddisflies, and stoneflies comprising the collection. Public fishing is limited in Soldier Creek because no public access exists.

Lake Creek

Lake Creek is classified as a Class I water by the CDOW, indicating that it contains a high quality cold water fishery. Fish populations in Lake Creek are composed of cutthroat trout, rainbow trout, and speckled dace (Rhinichthys osculus). Surveys conducted by ERT biologists yielded 1 cutthroat, 1 rainbow, and approximately 400 speckled dace in a 400 m transect. The status of the cutthroat population is similar to the situation in Soldier Creek; the specimens exhibit Colorado River cutthroat characteristics but hybridization with rainbow trout has occurred. Habitat is moderately good in the stream, as adequate cover is provided by debris-jams, overhanging vegetation, and numerous pools at stream bends. To protect the cutthroat and rainbow trout populations in Lake and Soldier Creeks, the BLM will implement a stream improvement program

in 1982-1983 aimed at reducing impacts of cattle grazing in the surrounding area (Getman 1982, personal communication).

Cathedral Creek

General stream conditions in Cathedral Creek suggest marginal habitat for aquatic organisms. The stream is extremely turbid at times and channelized as a result of erosion. The bottom substrate is composed mainly of silt and gravel in riffle areas with no visible periphyton growth. Benthic macroinvertebrate numbers were low with only 8 taxa present in October 1980 (Appendix D). The only fish collected by ERT biologists were speckled dace. Fish habitat is considered poor with minimal cover and few pools.

East Douglas Creek

Habitat characteristics in East Douglas Creek are slightly improved over conditions in Cathedral Creek. Of the four streams surveyed in the study area, benthic macroinvertebrate numbers were highest in East Douglas Creek, largely due to increased numbers of caddisflies. Fish populations in East Douglas Creek are composed of low numbers of cutthroat trout (hybrid) and speckled dace. Numerous small pools are present at bends in the stream and minimal cover is provided by undercut banks and debris-jams.

Douglas Creek

Douglas Creek is a rather poor quality stream in terms of aquatic resources. The extremely high silt loads in the stream limit periphyton and benthic macroinvertebrate development. The bottom substrate consists predominantly of silt with small amounts of gravel and cobble. In addition, the stream is channelized in most sections from its confluence with the East Fork of Douglas Creek to its entrance to the White River. Fish habitat is poor with few pools and minimal cover. Silt loads probably limit the use of this stream by trout. The only fish species collected in surveys conducted by ERT was speckled dace.

White River

The quality of aquatic habitat in the White River near Rangely, Colorado is poor. Although no published studies exist for the river segment near Rangely, studies conducted by the CDOW upriver showed degradation of habitat below Piceance Creek (Carlson et al. 1979). The river changes to a wide, shallow stream with extremely low summer flows, relatively high summer temperatures, and increased salinity and sediment levels. Fishery habitat is minimal with few deep pools and a general lack of cover.

Surveys conducted in the White River northeast of Rangely found fish communities composed of warmwater species such as carp (Cyprinus carpio), roundtail chub (Gila robusta), red shiner (Notropis lutrensis), fathead minnow (Pimephales promelas), speckled dace (Rhinichthys osculus), bluehead sucker (Catostomus discobolus), flannelmouth sucker (C. latipinnis), and mottled sculpin (Cottus bairdi) (Carlson et al. 1979). No recreationally important species are expected in this section of the river. However, a potential concern is the occurrence of Colorado River squawfish (Ptychocheilus lucius), which is listed as endangered by the federal and state governments (Behnke and Benson 1980). In 1978, squawfish were collected about 20 miles upstream of Rangely and upstream of the confluence with the Green River in Utah.

3.7.2.2 Route A with Deviation. No additional streams are crossed by the deviation; conditions would be the same as those described above.

3.7.2.3 Route B. Route B would cross only the White River; conditions would be the same as those described above.

3.7.3 La Sal Pipeline Routes

3.7.3.1 The following section describes aquatic communities in the streams with proposed crossings. This information is based largely upon existing literature and surveys conducted by ERT during 1980. Of the three Clear Creek tributaries (Willow, Mud Springs, and No Name Creeks), fishery resources are present only in Willow Creek. The fishery in Willow Creek consists of rainbow trout (Salmo gairdneri), which occur

throughout the mainstem section and West Fork Willow Creek. Although the original source of these trout is unknown, stocking probably occurred in the late 1970's (Sealing 1980, personal communication). The number of fish present in the stream is considered moderate to high for small mountain streams with estimates ranging between 14 and 54 per 1,000-foot-section (ERT 1981a). The rather consistent small size range (8 to 10 in) and lack of young-of-the-year suggests that growth and reproduction are limited in this stream.

In general, fish habitat characteristics in Willow Creek are adequate to support a healthy trout population with numerous pools, abundant overhanging vegetation, and undercut banks providing adequate cover. However, some sections of the stream represent marginal habitat during low flow conditions when dense periphyton growths, high water temperatures, shallow depths, and general lack of cover can stress fish populations.

Benthic macroinvertebrate communities in Willow Creek are quite diverse and abundant, providing an adequate food source for the existing trout population. Dominant organisms consist mainly of baetid mayflies, hydropsychid caddisflies, nemourid stoneflies, simulid blackflies, and midge larvae (ERT 1981a). Of the three surveys conducted in 1980 by ERT, maximum numbers occurred in August when densities ranged between 1,500 and 2,000 organisms/square foot. Minimum numbers occurred in the spring and late fall, as a result of scour from spring runoff and seasonal development (hatching). Information on other aquatic communities in Willow Creek is lacking. However, observations made during aquatic surveys conducted by ERT in 1980 showed that filamentous algal growth in the stream is extensive in late summer and fall.

Aquatic resources in Mud Spring and No Name Creeks are limited because of their small size and intermittent flows. No fish occur in either of these streams. Benthic macroinvertebrate and periphyton communities probably are similar to those found in Willow Creek.

Fish communities in lower Piceance Creek are mainly comprised of mountain sucker (Catostomus platyrhynchus) and speckled dace (Rhinichthys osculus) (Quality Development Associates 1977). Although both of these species can be an important part of the food chain, they are not recreationally important species. The only game fish that has been

collected in this section of the stream, but in low numbers, is brook trout (Salmo fontinalis). This species is a fall spawner that migrates upstream to gravelly bottom areas (Baxter and Simon 1970). Nine additional fish species have been collected in other sections of Piceance Creek, some of which may occasionally occur in the vicinity of the proposed crossing (Table 3-5).

General habitat characteristics in this section of Piceance Creek suggest an environment that is adequate for nongame species such as suckers and minnows but marginal for trout. Minimal cover for fish is available, as shoreline vegetation only partially covers the stream; pools and undercut banks are few. Bottom substrate in this section of the stream consists of mud, compacted clay, and some unstable gravel (Quality Development Associates, Inc. 1977; Gray and Ward 1978). High sediment loads and large seasonal and yearly fluctuations in flows and water levels also limit the development of an abundant game fishery.

Benthic macroinvertebrate communities in this section of Piceance Creek may be indicative of rather high silt conditions, and warm summer temperatures, as found in the Green River (Edmunds and Musser 1960). Dominant organisms include tubificid oligochaetes (Limnodrilus hoffmeisteri and Tubifex tubifex), chironomids, and mayflies (Baetis spp., Tricorythodes minutus and Ophiogomphus severus) (Gray and Ward 1978). Macroinvertebrate densities and biomass in the lower sections of Piceance Creek are relatively low compared to upstream sections (above Willow Creek) (Gray and Ward 1978). The lowest density and biomass values usually occur at the onset of winter, while maximum values are found in May, July, and October.

Information describing periphyton communities in Piceance Creek is generally lacking. Extensive filamentous algal growths such as Cladophora and Enteromorpha spp. occur in the summer and fall (Gray and Ward 1978). Thirty-six diatom species have been identified in Piceance Creek but quantitative data are lacking (Gray and Ward 1978).

Stream crossings associated with the Route 1 pipeline corridor are proposed at the following mile markers (approximate distance from pipeline origin): Willow Creek (mile 2.5), No Name Creek (mile 4.2), Mud Spring Creek (mile 5.8), and Piceance Creek (mile 21.7). The streams are part of two major drainages; Roan Creek and the White River. Willow Creek, Mud Spring Creek, and No Name Creek drain into Clear Creek, which enters Roan Creek approximately 10 miles north of DeBeque, Colorado.

TABLE 3-5

FISH SPECIES REPORTED BY VARIOUS INVESTIGATORS, PICEANCE CREEK, COLORADO

Scientific Name	Common Name	Goettl and Edde	Everhart and May	Tract C-b[1] Environmental Baseline	Pettus
Prosopium williamsoni	Mountain whitefish		x		
Salmo gairdneri	Rainbow trout	x	x	x	x
Salmo trutta	Brown trout	x		x	
Salvelinus fontinalis	Brook trout	x	x	x	
Gila robusta	Roundtail chub		x		
Ictalurus melas	Black bullhead		x		
Notropis lutrensis	Red shiner	x	x		
Pimephales promelas	Fathead minnow				x
Rhinichthys osculus	Speckled dace	x	x	x	x
Catostomus commersoni	White sucker				x
Catostomus platyrhynchus	Flannelmouth sucker	x	x	x	
Catostomus platyrhynchus	Mountain sucker	x	x	x	x
Cottus bairdi	Mottled sculpin	x	x		

[1]Ashland Oil Shale and Occidental Oil Shale Inc., 1976

3.7.3.2 Route 1A (Route Segments 1-1A-1). Stream crossings associated with the Route 1A corridor are proposed at the following locations (approximate distance from pipeline origin): East Fawn Creek (several crossings between mile 1 and 7), Fawn Creek (several crossings between mile 10 and 13), Black Sulphur Creek (mile 14.6), McKee Gulch (mile 16.7), and Piceance Creek (mile 15.9). All of these streams are tributaries of Piceance Creek which ultimately empties into the White River. Aquatic ecology characteristics of Piceance Creek are presented in Section 3.7.3.1. The following section characterizes biotic communities in the other stream.

General habitat characteristics in Black Sulphur Creek are similar to those observed in the middle section of Piceance Creek (Gray and Ward 1978). Mean depth and width in Black Sulphur Creek are 10 and 3.1 feet, respectively. Stream bottom substrate consists primarily of rubble and gravel. Fish cover in the stream is generally lacking except for occasional pools and debris accumulations. The only aquatic community which has been studied in Black Sulphur Creek is benthic macroinvertebrates. Macroinvertebrates composition in Black Sulphur Creek is similar to Piceance Creek with chironomids and mayflies dominating both the densities and biomass.

Information describing biotic communities in McKee Gulch, East Fawn Creek, and Fawn Creek is lacking. All of these are small tributaries which exhibit shallow depths during low flow conditions. No fish are expected to occur in these streams.

3.7.3.3 Route 2 (Route Segments 1-2). Based on available literature, there appears to be no information describing aquatic biology resources in West Fork Parachute Creek on top of the Roan Plateau. Although quantative data are not available, cutthroat trout and other fish species reportedly exist above West Fork falls (Jim Clark, Colorado Division of Wildlife, personal communication as cited in Bechtel Corporation and Ecology Consultants, Inc. 1975). Periphyton and benthic macroinvertebrate communities above West Fork falls probably are similar to those described for a section of the stream just below the falls. Of 34 periphyton taxa identified from West Fork Parachute Creek below the falls, 29 were diatoms (Bechtel Corporation and Ecology Consultants, Inc. 1975). The

only nondiatom species which was abundant was the filamentous green alga, Rhizoclonium hookeri. Benthic macroinvertebrates consisted mainly of blackfly larvae (Family Simuliidae) and baetid mayflies. Blackfly larvae were most abundant in riffles while mayflies were common in both riffles and pools.

3.7.3.4 Route 2A (Route Segments 1-2-2A-2). Stream crossings associated with Route 2A are proposed for the West Fork of Parachute Creek at mile 5.4 and Wolf Creek between miles 3 and 5. A discussion of aquatic resources in West Fort Parachute Creek is presented previously. No information is available for Wolf Creek, but it is expected that no fish occur in this stream.

3.7.3.5 Route 2B (Route Segments 2B-2A-2B-2). Stream crossings associated with the Route 2B pipeline corridor are proposed at the following locations: Clear Creek (several crossings between mile 1.5 and 9), Wiesse Creek (one crossing, between mile 9.2 and 14), and West Fork Parachute Creek (Mile 22). A discussion of aquatic resources in West Fork Parachute Creek is presented in Section 3.7.3.3. No information is available for Wiesse Creek, but no fish are likely to occur in this stream.

Stream crossings are proposed in a section of Clear Creek situated below the falls at the canyon rim. This section of Clear Creek is a small, steep-gradient stream with a bottom consisting primarily of boulder, rubble, and cobble. No fish are known to occur in this section of Clear Creek. Although mottled sculpin (Cottus bairdi), rainbow trout (Salmo gairdneri), and cutthroat trout (S. clarki) have been collected in sections of Clear Creek about 5 to 10 miles downstream, several irrigation diversions exist which limit any upstream movement.

Thirty-two macroinvertebrate taxa have been identified by ERT from the upper section of Clear Creek. Based on three surveys conducted in 1981, the highest macroinvertebrate densities occurred in August and October with values of 104 and 153 organisms/square foot, respectively. Total macroinvertebrate densities in June were much lower with a value of 12 organisms/square foot. The dominant taxa in August were blackflies, represented by the genera Simulium and Prosimulium. Species composition was different in October when stoneflies (Families Nemouridae and Perlidae)

and caddisflies (Family Hydropsychidae) were dominant. During June mayflies (Families Baetidae and Heptageniidae), aquatic caterpillars (Family Noctuidae), and blackflies (Simulium) were the most abundant organisms.

3.7.3.6 Route 2C (Route Segments 1-2-2C-2). Aquatic communities affected along this route would be the same as described for Route 2, except that the disturbance along Wet Fork would be minimized.

3.8 Cultural Resources

3.8.1 Regional Setting

Little cultural resource work has been conducted along any of the proposed routes with the exception of the Clear Creek Property areas (LaPoint and Aivazian 1981). Documentation of resources outside of this property has been compiled mostly from small survey investigations conducted in response to energy mineral development (Keen et al. 1980; Black 1981). Table 3-6 lists known cultural resources along the proposed routes. The varying levels of survey intensity may be an explanation for the low number of previously recorded sites along the routes in contrast to the high number of sites found on the Clear Creek Property and elsewhere in the Piceance Basin (Weber et al. 1977; Olson et al. 1975).

No reliable measure of the prehistoric resources in the corridors can be obtained without an on-ground inventory. The evaluations of the routes have been based on studies of settlement patterns and regional chronology elsewhere in the Piceance Basin (Hurlbutt 1976; Jennings 1974; Weber et al. 1977) and on the Roan Plateau (Grady 1980; Kane 1973; LaPoint and Aivazian 1981). The known prehistoric resources in the study area reveal diversified and extensive occupation. From these previous investigations in the vicinity of the proposed route, several periods of prehistoric occupation have been established for the area. An Archaic period is suggested to begin perhaps as early as 7000 B.C. (Olson et al. 1975). Following the Archaic, at approximately A.D. 500, a Fremont Culture period is proposed, and then a Ute occupation period from about A.D. 1500 to A.D. 1800 (Jennings 1974b). These cultural types include several subsistence strategies, including hunting and gathering, semi-sedentary horticulture, and horse-based nomadism. It can be concluded from studies conducted thus far that aboriginal

TABLE 3-6

KNOWN CULTURAL RESOURCES ALONG PROPOSED ROUTES, 1981

	Site Number	Recording Agency	Function or Type	Nature of Impact	NRHP Recommendation
All except Route 2B (1, 1A, 2, 2A, & 2C)	5GF646	LOPA	Open Prehistoric Camp	Indirect	Likely to be Eligible
	5GF650	LOPA	Open Lithic	Indirect	Not Eligible
	5GF651	LOPA	Open Lithic	Indirect	Likely to be Eligible
	5GF655	LOPA	Historic	Indirect	Not Eligible
	1F46GF	LOPA	Isolated Find	Indirect	Not Eligible
	1F47GF	LOPA	Isolated Find	Indirect	Not Eligible
	1F50GF	LOPA	Isolated Find	Indirect	Not Eligible
	1F61GF	LOPA	Isolated Find	Indirect	Not Eligible
	1F62GF	LOPA	Isolated Find	Indirect	Not Eligible
	1F63GF	LOPA	Isolated Find	Indirect	Not Eligible
Route 1	5RB1472	G & K	Isolated Find	Indirect	Not Eligible
	5RB1473	G & K	Isolated Find	Indirect	Not Eligible
	5RB1474	G & K	Isolated Find	Direct	Not Eligible
	5RB1475	G & K	Isolated Find	Indirect	Not Eligible
	5RB1478	G & K	Isolated Find	Indirect	Not Eligible
	5RB1592	G & K	Isolated Find	Indirect	Not Eligible
	5RB1609	G & K	Isolated Find	Indirect	Not Eligible
Route 1A	5RB2168	M & Z	Historic	Direct	Not Eligible
	--	unrecorded	Historic	Direct	
	--	unrecorded	Historic	Direct	
	--	unrecorded	Historic	Direct	
	--	unrecorded	Historic	Direct	
	--	unrecorded	Historic	Direct	
Route 2B	5GF652	LOPA	Open Lithic	Indirect	Not Eligible
	5GF665	LOPA	Historic	Direct	Not Eligible
	1F616F	LOPA	Isolated Find	Indirect	Not Eligible

G & K - Gordon and Kranzusch, Inc. (Keen et al. 1980)
M & Z - Metcalf and Zier (Black 1981)

exploration of the area was continuous for many centuries up to the twentieth century.

Site locational analyses have suggested that recurrently used prehistoric camp sites tend to be situated vertically and horizontally close to a reliable water source in lowland areas such as floodplains and finger ridges overlooking drainages. These areas often provide easy access to a variety of local food resources as well as protection from the elements. Exposed ridgetop locations along drainage divides far from water are often places where small, disassociated, one-time or short-term sites may be found. These sites are often specialized task loci related to hunting or gathering work and are peripheral to camp sites. Areas of steep slope are considered poor places for prehistoric occupation.

Historic occupation and exploration began in the 1800's in the form of homesteading and cattle ranching. The area is now being extensively developed for oil shale, natural gas, and oil. As indicated from the established ranches in the area, settlements have a strong tendency to be on major drainages at lower elevations, areas not subject to such severe weather conditions as the ridgetops. These areas also provide permanent water sources and land suitable for farming.

3.8.2 Rangely Pipeline Routes

3.8.2.1 Route A. A considerable amount of cultural resource research has been conducted along the Route A corridor. An abundance of prehistoric and historic sites are on record for Rio Blanco County although no sites have been recorded along the portion of the route within Garfield County (Appendix B). Documentation of these resources has been compiled mostly from small survey investigations conducted in response to energy and mineral development.

Prehistoric utilization along the central portion of the proposed route has been primarily documented as a result of a LOPA cultural resource inventory of the Canyon Pintado Historic District. Located in the Douglas Creek Drainage, the district's southern boundary begins at the confluence of East and West Douglas Creeks and includes approximately 1 mile of either side of the creek north to Sec. 7, T1N, R10W (Map 8). A total of 179 prehistoric and historic sites was recorded in the district,

and test excavations of two sites were performed. Of the 179 sites, 31 sites would be affected by Route A.

Several additional surveys have been conducted along East Douglas Creek and Cathedral Creek (Jennings 1974a, 1975; Jennings and Hall 1976; Jennings and Spitzer 1976; Wenger 1956; Gordon and Kranzusch 1977), and one survey has been conducted in Soldier Creek (Daniels et al. 1980). Within these drainage areas, 27 sites have been recorded, of which 20 would be affected by the construction of the proposed route.

The level of intensity of archaeological investigation has varied substantially throughout the region. The greater number of sites within the district compared to the low number recorded outside the district may be more a reflection of the varying levels of intensity of surveys in the two areas, rather than necessarily reflecting less intensive prehistoric activity outside of the Douglas Creek mainstem.

A general overview of the cultural sequence along the Route A corridor can be outlined as follows. The late Desert Archaic is the first well documented occupation of Douglas Creek. Radiocarbon dates indicate that the occupation began around 4100 B.P. (Creasman 1981). Dated sites from this period are buried in the alluvial fill of Douglas Creek at depths as great as 4 m. The early inhabitants followed a generalized hunting and gathering subsistence strategy. Habitation sites recognized as Late Archaic are found as open camp sites on the floodplain and sheltered camps along the edge of the floodplain (Creasman 1981).

A later localized variant of the Fremont Culture may have developed from this Desert Archaic Tradition within Douglas Creek. Fremont people were semi-sedentary horticulturalists who supplemented their subsistence through hunting and gathering activities. Floodplain campsites occupied earlier during the Archaic times continued to be used throughout Fremont times. Rock shelters were also utilized. The development of a horticultural subsistence pattern in Douglas Creek began around 1575 B.P. and continued until 740 B.P. Canyon Pintado was most intensively occupied during this period. This occupation is evidenced by the presence of Turner Gray (Cisco variety) pottery, dry-laid masonry architecture, maize horticulture, rock art, and certain projectile points (Creasman 1981).

By A.D. 1200, the Fremont groups were on the decline in northwestern Colorado and were either replaced or joined by early Ute and Shoshonean

groups. Only limited evidence of this subsequent occupation of the canyon has been recovered. It is presumed that these groups were nomadic hunters and gatherers and that their presence persisted into historic times until the forced abandonment of the area by the Utes following the Meeker massacre in 1879.

This later occupation of the canyon is indicated by the occurrence of Shoshonean pottery and equestrian rock art motifs which point to aboriginal activity in the area following Spanish contact in the American Southwest. The settlement pattern of these groups may have deviated slightly from that of the Late Archaic and Fremont times with campsites appearing on the benches along the cliff walls. A bison hunting scene depicted at Dripping Brow Cave suggests that bison became part of the economic base after the introduction of the horse (Creasman 1981).

The first record of Euro-American presence in the area was the Dominguez-Escalante expedition of 1776. They described a number of pictographs and petroglyphs and named the canyon "Canyon Pintado", or painted canyon.

Homesteading in the area began in the late 1880's and early 1900's upon the Ute removal. Most of the homesteads were located on floodplains of major drainages where water was plentiful, ground was easily cleared for farming, and transportation to nearby towns was possible along the drainage corridor (Gordon and Kranzusch 1979). Sheep and cattle operations were established in the 1800s, fomenting conflicts between the two which erupted into range wars. Fossil fuel and oil shale potential in the area was recognized in the early twentieth century, precipitating present-day energy development.

3.8.2.2 Route A With Deviation. Conditions would be similar to those described for Route A.

3.8.2.3 Route B. Far less cultural resource work has been conducted along the Route B pipeline corridor. According to the LOPA records, only one survey has been conducted for cultural resources along Route B. This survey was conducted in 1975 by LOPA for a small gas-gathering pipeline near the mouth of Douglas Creek (Appendix B). Two rock shelters and a Fremont rock art site were recorded (Jennings

and Ritchie 1975). Subsequent surveillance during the construction of the pipeline revealed an Archaic type McKean-Pinto style projectile point and a radiocarbon date of 3510 ±150 B.P. (1560 B.C.) in the same cultural levels (Conners and Alexander n.d.).

On the east side of the Cathedral Bluffs, two archaeological surveys were conducted in the general vicinity of the proposed route. One survey, conducted in the oil shale C-a tract by Dr. Alan Olson in 1975 and 1976, revealed 196 sites. The second survey, conducted for a pipeline R-O-W in 1978 (Bridge et al.), revealed two sites. These sites include evidences of Archaic, Fremont, and Ute affiliations with material inventories including groundstone, pottery, a wide range of lithic stone tools, and wickiup structures.

The known prehistoric resources of the Piceance Basin reveal diversified and extensive occupation. From these earlier investigations in the immediate vicinity of the proposed route, several periods of prehistoric occupation have been established for the area. An Archaic period is suggested by Olsen beginning perhaps as early as 7000 B.C. (Olsen et al. 1975). Following the Archaic at approximately A.D. 500, a Fremont Culture Period is proposed, followed by a Ute occupation period from about A.D. 1500 to A.D. 1800 (Jennings 1974b). These cultural types span several occupational groups, including hunting and gathering peoples, semi-sedentary horticulturalists, and nomadic peoples. Studies conducted thus far indicate that aboriginal exploration of the area was continuous for many centuries up to and including the twentieth century.

Historic occupation and exploration began in the 1800s in the form of homesteading and cattle ranching. Currently, the area is being extensively developed for oil shale, natural gas, and petroleum.

3.8.3 La Sal Pipeline Routes

3.8.3.1 Route 1 (Route Segment 1 Only). Two cultural resource surveys have been conducted along this route (see Map 10). The segment from mile 0 to mile 5 is within the Clear Creek study area inventoried by LOPA for Chevron in 1980 (LaPoint and Aivazian 1981). The majority of archaeological sites were located along the drainages and lower ridges overlooking No Name, East and West Willow, and Mud Springs Creeks. This segment, common to all proposed routes except 2B, crosses East and

West Willow and No Name Creeks where archaeological sites could be located. These sites are located between miles 3 to 4 and 5 to 6 of Route 1.

From mile 5 to mile 9 the route crosses one drainage divide, drops into a tributary drainage to West Hunter Creek, then climbs to another ridgetop. This segment is considered to have a good potential for cultural resources because it is close to water and in a protected location.

From mile 9 to mile 18 the route follows the divide of an interfluvial ridge flanked by West Hunter Creek to the east and East Fawn Creek to the west. A cultural resource survey conducted by Keen et al. (1980) revealed seven isolated finds of prehistoric origin along this ridgetop; none of these were deemed eligible for nomination to the National Register of Historic Places (NRHP). The ridgetop appears to be an area where single use localities rather than open prehistoric camp sites occur. Site density is believed to be low.

As the route drops off the ridge it enters an area from miles 18 to 25 known to be ideal for site locations. High site densities have been recorded along Piceance Creek (Weber et al. 1977; Olson et al. 1975). The area surrounding the terminus of Route 1 (miles 25 to 26) has been extensively surveyed in the past by a number of archaeologists and no cultural resources have been found along this portion of the route.

3.8.3.2 Route 1A (Route Segments 1-1A-1). The majority of the route follows the Fawn Creek drainage to the north of Piceance Creek, where it joins Route 1 at mile 18. The first segment of the route (miles 0-5) has been discussed under pipeline Route 1. Only one small archaeological survey in Section 11, T.3S., R 98W. has been conducted along the remainder of this route (Black 1981). One historic water diversion site was recorded, 5RB2168, and is believed to be related to the Butner Homestead just north of the site. The site is not considered eligible for nomination to the NRHP. Five other unrecorded historic sites along Fawn Creek are shown on USGS maps.

The route passes through drainages and lower ridges considered to be ideal locations for prehistoric occupation. These areas provide protection, water, and easy access to a variety of exploitable resources.

Alluvial fill within the drainages and floodplains may mask the presence of buried cultural resources. Except for a small segment of the route between miles 0 and 1, the entire route is expected to yield high site densities.

3.8.3.3 Route 2 (Route Segments 1-2). No cultural resource surveys have been conducted along this route other than the Clear Creek survey along miles 1 to 5. As a result, site density, settlement pattern, and length and nature of occupation remain unknown. Judging from work conducted by LOPA in adjacent areas of Parachute and Clear Creeks, few occupation sites would be expected to occur along the ridgetop segments of this route.

The route generally follows the Ridge Road along the drainage divide between Piceance Creek on the north and Clear and Parachute Creeks on the south. This ridgetop is exposed to severe weather and is generally far from water. Between miles 8 and 13 the route drops into the Wet Fork drainage which in turn empties into the West Fork of Parachute Creek. Similar topographic situations on Chevron's Parachute property revealed a high incidence of open camp sites along such drainages, with a potential for deep cultural deposits due to the alluvial nature of these canyons.

3.8.3.4 Route 2A (Route Segments 1-2-2A-2). The segment of Route 2A along Wolf Creek is located in an area considered conducive to prehistoric occupation. The area is well watered, being a tributary to a major creek in the area. Deep alluvium, which may have buried sites, is also present. Sites found in this area would most probably be base camps that were reused season after season; these could contain potentially great cultural depth. This type of site is considered eligible for nomination to the NRHP. The pipeline also crosses West Fork Parachute Creek. The confluence of West Fork Creek with Wolf Creek is an area ideal for site locations, as well as the entire West Fork of the Parachute Creek floodplain.

3.8.3.5 Route 2B (Route Segments 2B-2A-2B-2). Seven miles of this route have been surveyed for cultural resources by LOPA during the

reconnaissance for the Clear Creek Properties. Miles 1 through 7 revealed one prehistoric site 5GF652 and one historic site, 5GF665, neither considered eligible for the NRHP. From miles 7 to 11 the route remains in the Clear Creek Canyon, then climbs out at Buck Gulch and continues north along Wiesse Creek. This 4-mile segment will probably reveal a low site density, based on the results of the Clear Creek Canyon survey. From mile 11 to 14, however, the route enters a well-watered valley that affords protection and easy access to a variety of resources. This area is considered ideal for prehistoric and historic site location. One possible homestead is located along this portion of the route at mile 14.

The next leg of the pipeline route, between mile 14 and mile 21, follows the ridgetop divide between Parachute and Clear Creeks. The area is exposed with shallow soils and is far from water. It is not considered ideal for long term prehistoric occupation. Site density, based on LOPA experience just south of the route on the Parachute properties, would be very low and consist of small, single-use localities not generally considered for long-term prehistoric site location.

3.8.3.6 Route 2C (Route Segments 1-2-2C-2). Cultural Resources for Route 2C are the same as for Route 2 except for the portion of the route that follows Ridge Road rather than Wet Fork. Less potential for finding open campsites or deep cultural deposits exists along Route 2C.

3.9 Visual Resources

3.9.1 Regional Setting

The proposed pipeline corridors are characterized by rugged, arid topography with steep, eroded cliffs and gently sloping to rolling plateaus. Vegetation consists of occasional stands of aspen and Douglas fir, sagebrush, mixed shrub communities, and mixtures of grasses and forbs. Water is generally associated with deep canyons exhibiting flat canyon floors. Water is not abundant on the plateaus or in the washes.

Significant natural visual features in the region include the Roan Plateau, which defines the southern boundary of the Piceance Basin at an average elevation of 8,400 ft; the 750,000 ac Piceance Basin covering about 1,600 sq mi; the Roan Cliffs at the southern edge of the Roan Plateau; Colorado River; Grand Hogback north of Rifle; and Cathedral

Bluffs northeast of Douglas Pass. Significant man-made visual features in the region include the communities of DeBeque, Parachute, and Battlement Mesa; developments at the Cathedral Bluffs Oil Shale Project (Tract C-b), Union Oil Project, Colony Project, and Occidental Logan Wash Project; and Interstate 70.

The BLM has implemented a visual inventory and evaluation process to provide for a systematic interdisciplinary approach to the management of visual values on public lands. The VRM system inventories existing landscape character and assigns visual management classifications based upon the combination of visual qualities, visual sensitivities of viewers, and visual distances in the landscape (see Methods Section). The affected environment is identified as the area which might potentially be influenced by the proposed syncrude pipeline routes and/or alternatives.

The environment's visual characteristics, qualities, and management classes were defined by the BLM, Craig District Office and Grand Junction District Office in Colorado. Detailed descriptions of the visual environment can be found on file in these offices.

3.9.2 Rangely Pipeline Routes

The BLM has established five VRM classifications for nation-wide application to provide guidance in ascertaining the degree of modification acceptable by the landscape affected by proposed management activities (Table 3-7). Of the five national classes, three exist in the Rangely study area. These include: (1) Class II, in the White River area near Rangely and in the Cathedral Mountain area above Soldier Creek; (2) Class III, along the majority of the Cathedral Bluffs, upper Cathedral Creek, the Big Ridge area, and the area just southwest of Rangely; and (3) Class IV, along Skinner Ridge, lower Cathedral Creek, Douglas Creek to Rangely, and the remaining area north of Big Ridge to Rangely. The accompanying Environmental Constraints Map, Map 8 demonstrates VRM classes in the pipeline corridor.

The most critical visual environment is located on the Class II area along the White River, and at the southern end of the Cathedral Bluffs. The most critical viewer locations are along Colorado Route 139 where the proposed syncrude pipeline would be seen in the foreground view. Other critical areas occur along the Cathedral Bluffs ridge road, commonly used by hunters and campers.

TABLE 3-7

VISUAL RESOURCE MANAGEMENT CLASSES

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.

Areas of Critical Environmental Concern for Scenic Values. The ACEC for scenic values are lands of high scenic value of relative scarcity. For this reason, priority identification must be made for presentation in the management framework process. Conformance with VRM Class II objectives constitutes interim management.

Class II. [1] 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.

Class III. [1] 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.

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.

Class V. Change is needed or change may add acceptable visual variety to an area. This class applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding landscape. This class would apply to areas identified in the scenic evaluation where the quality class has been reduced because of unacceptable cultural modification. The contrast is inharmonious with the characteristic landscape. It may also be applied to areas that have the potential for enhancement, i.e., add acceptable visual variety to an area/site. It should be considered an interim or short-term classification until one of the other VRM class objectives can be reached through rehabilitation or enhancement. The desired visual resource management class should be identified.

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[1]Structures located in the foreground distance zone (0-1/2 mile) often create a contrast that exceed the VRM class, even when designed to harmonize and blend with the characteristic landscape. This may be especially true when a distinctive architectural motif or style is designed. Approval by the District Manager is required on a case-by-case basis to determine whether the structure(s) meet the acceptable VRM class standards, and, if not, whether they add acceptable visual variety to the landscape.

3.9.3 La Sal Pipeline Routes

3.9.3.1 Route 1 (Route Segment 1 Only). Significant natural features along this corridor include the major ridge west of Hunter Creek and Piceance Creek. Significant man-made visual features include jeep roads and pack trails on the ridges and the paved Piceance Creek road. The Route 1 corridor extends through two distinct landscape character types--the Mountain Brush Highlands and the Piceance Creek Floodplain.

Mountain brush highlands landform is characterized by steep to rolling slopes with frequent occurrences of small rocky outcrops. Lines are typically curvilinear. Colors range from gray to yellow, tan, and brown where soil or rock is exposed; textures are insignificant. Vegetation consists primarily of sagebrush on south slopes and mountain brush on north slopes, with stands of pinyon pine and juniper occurring frequently at higher elevations. Lines are infrequent, occurring primarily between vegetation types. Colors range from mottled gray to light green, dark green, and yellow, depending upon season and available ground moisture. Textures are typically moderately coarse to coarse; forms are insignificant. Jeep roads and pack trails delineate horizontal and curvilinear lines in the landscape. Infrequent and scattered structures delineate strong vertical lines and block forms. Colors in the tan to brown range create contrast with the surrounding landscape, except in areas where soil or rock is exposed; forms and textures are insignificant. Water is not a significant visual element in this area.

The Piceance Creek floodplain landform is typically flat to gently sloping; lines are curvilinear or straight. Colors range from tan to brown where the landform material is exposed; textures are insignificant. The dominant vegetation on the floodplain consists of grasses in small pastures, with areas of sagebrush. The infrequent riparian vegetation creates highly contrasting conical forms and green colors. The dominant forms are rounded. Colors range from grays to greens, yellows and browns, depending upon the season. Breaks between vegetation types create some vertical and horizontal lines; textures are insignificant. The floodplain is characteristically dominated by the strong lines of the Piceance Creek Road, primitive roads, and fencelines. Colors are insignificant, with the exception of the gray-black asphalt of the major

roadway. The occasional farmhouses or outbuildings create blocky forms in the landscape, and strong vertical and diagonal lines. Color and texture are insignificant. Flowing water is present, but does not dominate the landscape, creating mild curvilinear lines which are subordinate to those of the major roadway and fencelines. Forms, colors, and textures associated with water are insignificant.

Cultural modifications are few within the Route 1 corridor, with the majority occurring in the floodplain area. Moderate to high levels of contrast are caused by roads, fencelines, farm buildings, and related structures. Low to moderate levels of contrast are caused by roads, pack trails, and infrequent stock-watering structures in the higher elevations.

Based upon the estimations of scenery quality, viewer sensitivity, and distance zones, the BLM has concluded that three Visual Resource Management Classes exist in the Route 1 corridor (see Map 11). These include: (1) Class II (1 mile), within the Piceance Creek floodplain area; (2) Class III (1 mile), in the plateau area surrounding the destination point with the La Sal Pipeline; and (3) Class IV (24 miles), in the remainder of the corridor. The Class II area consists of Class B Scenery, High Viewer Sensitivity, and the Foreground/ Middleground Distance Zone. The Class III area consists of Class B Scenery, High Viewer Sensitivity, and the Background Distance Zone. The Class IV area consists of Class B Scenery, Low Viewer Sensitivity, and the Seldom Seen Distance Zone.

3.9.3.2 Route 1A (Route Segments 1-1A-1). Significant natural visual features include the Black Sulphur and Piceance Creeks. Significant man-made visual features include the jeep and pack trails on the ridges; the Piceance Creek Road; and the agricultural developments in the Piceance Creek floodplain. The Route 1A corridor passes through two distinct landscape character types: the Mountain Brush Highlands; and the Valley Bottom type of Fawn Creek and the Piceance Creek floodplain described previously. Cultural modifications are infrequent along the Route 1A corridor, the majority occurring in the Piceance Creek floodplain and Fawn Creek valley floor. Moderate to high levels of contrast are caused by roads, fencelines, farm buildings, and related structures in these areas. Low to moderate levels of contrast are caused by roads and

pack trails along the ridgelines and drainages in the remainder of the areas at higher elevations. Based upon the estimations of scenery quality, viewer sensitivity, and distance zones, the BLM has determined that three Visual Resource Management Classes exist in the Route 1A corridor. These include: (1) Class II (1 mile), within the Piceance Creek valley floor; (2) Class III (9 miles), within the Fawn Creek drainage; and (3) Class IV (8 miles), in the upper elevations.

The Class II area consists of Class B Scenery, High Viewer Sensitivity, and the Foreground/Middleground Distance Zone. The Class III area consists of Class B Scenery, Medium Viewer Sensitivity, and Foreground/Middleground Distance Zone. The Class IV area consists of Class B Scenery, Low Viewer Sensitivity, and the Seldom Seen Distance Zone.

3.9.3.3 Route 2 (Route Segments 1-2). The Route 2 corridor extends along the Roan Plateau ridge from its origin at Route 1 to the La Sal Pipeline destination. This area displays the Mountain Brush Highland landscape character type described previously. Based upon the estimations of scenery quality, viewer sensitivity, and distance zones, BLM has concluded that two Visual Resource Management Classes exist in the Route 2 corridor. These include about 6 miles of Class II in the Davis Point area, away from the centerline of the pipeline (insignificant area); and about 19 miles of Class IV, for the remainder of the corridor and all of the centerline.

The Class II area consists of Class A Scenery, Medium Viewer Sensitivity, and the Background Distance Zone. The Class IV area consists of Class B Scenery, Low Viewer Sensitivity and the Seldom Seen Distance Zone.

3.9.3.4 Route 2A (Route Segments 1-2-2A-2). No significant natural visual features exist within the Route 2A corridor. Significant man-made visual features include the jeep road extending down Wolf Creek. The Route 2A corridor exists within the Mountain Brush Highland character type. The jeep road following Hunter Creek delineates curvilinear lines in the landscape. Colors range from tan to gold and brown within the roadway and in areas disturbed by cuts and fills. Forms and textures are insignificant.

Moderate to high levels of contrast are caused by the jeep trail near the centerline of the corridor. Pack trails and other man-made visual features are not significant visual elements in this landscape. Based upon the estimations of scenery quality, viewer sensitivity, and distance zones, the BLM has determined that one Visual Resource Management Class exists in the corridor. The Class IV designation is based upon Class B Scenery, Low Viewer Sensitivity, and the Seldom Seen Distance Zone.

3.9.3.5 Route 2B (Route Segments 2B-2A-2B-2). Significant natural visual features on Route 2B include the Roan Cliffs along Clear Creek and the accompanying riparian habitat, the Buck Gulch cliffs, and Jackrabbit Ridge. Significant man-made visual features include the materials storage flats on the floor of Clear Creek Canyon and the jeep roads and pack trails along the canyon floor and ridges. The Route 2B corridor extends through two types of landscape character. These include the Mountain Brush Highlands (described previously) and the Canyon Cliffs and Floor.

The Canyon Cliffs and Floor Type is characterized by cliffs, steep talus slopes, and canyon floor which create distinct vertical, diagonal, and horizontal lines in the corresponding segments of the Route 2B corridor. Colors in the rich yellow, gold, tan, brown, and black spectrum form somewhat less distinct horizontal and diagonal lines across cliff walls and along the edges between cliff and talus. Textures range from coarse to extremely fine, depending on the distance from the observer, the angle of the sun in relation to the observer, and relative amount of polish caused by wind and water. Forms are distinctly pyramidal and planar. Vegetation is extremely sparse along the cliffs. However, the occasional aspen and conifers provide highly contrasting yellows, light greens, and dark greens. Shrubs and grasses, grey-green and tan in color, may be found in scattered clumps on the talus slopes. Riparian vegetation on the canyon floor creates highly contrasting forms, colors, and textures in this typically arid landscape. Rich yellows, greens, oranges, and reds give this area significant visual character. Forms are strongly spherical and conical. Textures range from coarse to extremely fine, depending on the season. Lines are not significant.

Roads, stock trails, stock tanks and related structures, and materials and equipment storage flats exist on the canyon floor. Forms are typically planar and rectilinear. Lines and textures are insignificant. Diverse colors related to equipment and materials storage flats may be significant and dominant in contrast to the surrounding landscape within the corridor.

Clear Creek, with its variety of subtle flows, pools, and rapids, creates significant visual variety in the corridor. Several of the Clear Creek tributaries located within the corridor contribute to the scenery through their visually interesting waterfalls and flow characteristics.

Cultural modifications are few within the canyon cliffs and floor area of the Route 2B corridor. Low levels of contrast result from roads, stock trails, stock tanks, and related structures in the area. Moderate to high contrasts result from roads, parking areas, and storage areas on the talus slopes and lower areas.

Based upon the estimation of scenery quality, viewer sensitivity, and distance zones, ERT has concluded (with concurrence from the BLM/ Grand Junction District) that one Visual Resource Management Class exists in the cliff and canyon floor area of the corridor. The Class II area (11 miles of the corridor) consists of Class A Scenery, Medium Viewer Sensitivity, and the Foreground/Middleground and Background Distance Zones. Remaining portions of the Route 2B corridor exist within the Visual Resource Management Class IV area. The Class IV area (12 miles of the corridor), consists of Class B Scenery, Low Viewer Sensitivity, and the Seldom Seen Distance Zone.

3.9.3.6 Route 2C (Route Segments 1-2-2C-2). Visual Resource characteristics for Route 2C are the same as those for Route 2.

3.10 Land Use and Transportation

3.10.1 Regional Setting

Grazing by livestock and wildlife is the primary land use within the areas traversed by all of the alternative synfuel pipeline routes. Private ranching operations have evolved around the use of public lands and intermingled private and state lands. In many cases ranchers are

very dependent on BLM land because of the small size or seasonal use constraints on their own properties. Hay is typically produced on private land to feed livestock during the winter.

The earliest that grazing is allowed on BLM land in spring is March 1, but it can be as late as June 1 depending on elevation (BLM 1978 and 1980). When available forage is depleted, grazing ceases and cattle or sheep are moved to higher elevation rangeland. Permit grazing in the study area is done primarily by cattle with a few sheep allotments. Range suitability is a major problem in the area because livestock distribution is often severely hampered by steep rugged terrain and by poor availability of water supplies.

Grazing on public lands is managed by the BLM through a series of Allotment Management Plans (AMP's). An AMP is an agreement between the agency and ranchers operating in a specific geographic area, an allotment, which describes (1) the manner in which grazing activity will be conducted, (2) the extent of use, (3) what range improvements will be installed and how they will be managed, and (4) approved levels of forage use. Vegetation allocations are described in Animal Unit Months (AUM's), which is defined as the amount of forage required to support one cow and calf for one month. The number of AUM's available in an area depends on many variables, such as climate, soil, and past land use which influence current vegetation conditions.

Backcountry roads are the principal transporation routes crossed by all the proposed pipeline routes, except where noted. Most of these roads are single-lane, low-use facilities with only occasional grading and seldom with a gravel surface. During periods of rain or snow surfaces can become impassable to everything but four-wheel drive vehicles. Portions passing through large tracts of private land are often closed to public entry. Ranchers and mineral exploration crews are the principal year-round users of these roads, but hunters use them extensively in the fall months.

Recreational resources in the region include hunting and fishing. Big game species include mule deer and elk; huntable populations also exist for small game and upland game birds. The greatest, and probably only important, recreational use in the study area is big game hunting during the fall. The Piceance Basin contains one of the largest mule deer herds in the West in addition to large numbers of elk. Hunting for

these animals draws recreationists from all over the country and is an important economic benefit to the area.

The Bluff Road provides access to the Cathedral Bluffs where hikers, campers, and sight-seers may view wildlife species and geologic formations. Heavy vehicular use of dirt roads along Douglas Creek may preclude use of the study corridor by hunters and sight-seers because of high noise and dust levels. Fishing pressure along Douglas Creek and its tributaries is probably light (BLM 1980) because the smaller trout streams do not contain populations large enough to sustain much fishing pressure. Cutthroat trout occur in Douglas Creek and various tributaries.

3.10.2 Rangely Pipeline Routes

3.10.2.1 Route A. This proposed pipeline route to Rangely crosses primarily public and private lands leased for oil and gas drilling or in agricultural production. Farming is limited to primarily forage production for livestock. Farms and ranches in the region have generally become fewer and larger and are present along valleys where ground or surface water is available for irrigation. Much of the Douglas Creek Valley is irrigated hay meadow. Oil and gas exploration and development have been present along Route A (Douglas Creek) for about 40 years but have increased significantly in recent years.

3.10.2.2 Route A with Deviation. The Route A deviation would affect similar land use, primarily oil and gas development and farming, as described for Route A.

3.10.2.3 Route B. Route B crosses public lands primarily used for livestock grazing and recreational hunting. Most of these lands are used by local ranchers for summer grazing. Some oil and gas activity occurs in Gillam Draw near the northern end of Route B.

3.10.3 La Sal Pipeline Routes

3.10.3.1 Route 1 (Route Segment 1 Only). Land uses along miles 0 to 5 in Garfield County are primarily livestock and wildlife grazing. This route segment receives little use because of the lack of maintained roads and its isolation from population centers. Several four-wheel

drive roads traversed by the route provide access to rangeland and to several abandoned mineral prospects, but they receive only occasional use. Roadway access to these secondary roads is from East Douglas Creek. There are no other major land uses in this area. From mile 5 to mile 21.5, Route 1 crosses into Rio Blanco County and to Piceance Creek along the northeastward-trending ridgelines. Grazing is the only major land use in this area.

Near mile 21.5 the proposed route would cross Piceance Creek and an improved road of the same name. Hay is grown in pastures on the valley floor using irrigation water diverted from the creek. Grazing, mostly during winter and spring months, occurs on nearby unirrigated lowlands. The Piceance Creek Road is the principal transportation artery between State Highway 64 and 789 for residents of the Piceance Basin. Local ranch traffic as well as commercial trucking related to oil shale development are the primary highway users, except during fall when the entire area is heavily used by big game hunters.

The route's remaining 4.5 miles ascend the northeastern side of the valley to the proposed terminus with the La Sal Pipeline. Grazing is the principal land use in the vicinity. Only one little-used unimproved road would be crossed.

3.10.3.2 Route 1A (Route Segments 1-2). Route 1A from its junction with alternative Route 1 to mile 15.7 descends the sloping terrain to the Piceance Basin floor. The course follows East Fawn Creek and a ranch access road of the same name. Irrigated hayland lies along the creek bottom for about 6 miles beginning near the junction of the east and west forks. These crops are used primarily for livestock feed during winter months and in spring before surrounding rangeland is free of snow. There are four ranches along the creek to its junction with Black Sulphur Creek.

The valley widens at the junction of Fawn and Black Sulphur Creeks and the bottomlands contain extensive areas of irrigated hayland along the 1.2 miles to Piceance Creek. Here the pipeline would cross Piceance Creek and the adjoining road near the Rock School. This small rural grade school along with six other residences would be within one-quarter mile of the proposed route. The valley floor on this area has extensive

irrigated agriculture. The remaining 2 miles of Route 1A ascend the northeast side of the valley to a junction with Route 1. Grazing is the principal use along this corridor.

3.10.3.3 Route 2 (Route Segments 1-2). Route 2 generally follows a path along the top of the Roan Plateau over a series of ridgetops and saddles. Elevations range from 8,500 feet near the junction with alternative Route 1 to 8,700 feet near mile 8. This high rugged terrain has mixed aspen-conifer vegetation with numerous open meadows and is particularly useful for summer livestock pasture and wildlife habitat. This area is used by hunters in the fall because of the presence of big game species and numerous four-wheel drive access roads. The roads also provide vehicle access for ranchers.

The proposed route descends the Wet Fork to the West Fork of Parachute Creek before rising again to terminate near Davis Point. The Wet Fork is a very small stream paralleled by a secondary road. There are no residences in the area. After ascending the northern side of the Wet Fork Canyon, similar terrain and vegetation are encountered to the end of the route's first 8 miles. Grazing is the principal land use in this area also. All routing alternatives avoid the BLM wild horse management units that are north of Yellow Creek.

3.10.3.4 Route 2A (Route Segments 1-2-2A-2). Wolf Creek is a very small ephemeral stream with a four-wheel drive road paralleling the stream course. There are no residences or ranch structures in the vicinity. Summer grazing is the only major use of the area, except for limited hunting during the fall.

3.10.3.5 Route 2B (Route Segments 2B-2A-2B-2). Route 2B from its beginning near Red Point drops considerably through the unstable Green River Formation to the bottom of Clear Creek Canyon. On the floor its path follows the creek, crossing it several times before it turns northeast near mile 9 to ascend the canyon and eventually join Route 2A. There are no ranches or irrigated acreage along this area of Clear Creek, but it is good spring and summer grazing land and has received considerable use in the past. The pipeline would be placed alongside

the existing Chevron project access road and would cross it in several places. Upon reaching the plateau, this route would go through a ranch and associated irrigated hay fields at about mile 14.

3.10.3.6 Route 2C (Route Segments 1-2-2C-2). Land use and transportation conditions for Route 2C are the same as Route 2 except for the portion of the route which traverses along Ridge Road rather than Wet Fork.

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5.0 GLOSSARY OF SELECTED TERMS

Geohydrology

Air lift pumping
A method of pumping a well with air flow. An air line is lowered into the well and air is circulated. The air lifts the water out of the well and flow begins toward the lowered head in the well. Water which enters the well is then entrained in the air flow and removed.

Alkalinity
The capacity of water to neutralize acid to a specific pH.

Anisotropy
Having different material properties in different directions.

Anticline
A geologic structural fold which is convex upward.

Bailer
A section of pipe fitted with a check valve on the bottom and a bail on the top to remove water from a drill hole.

Cation-anion balance
A check on analytical accuracy computed by expressing the difference between the sum of the cations and the sum of the anions as a percentage of the sum of the 2 sums, all in milliequivalents per liter.

Conductivity
The ability of a material to conduct an electrical current. In water, it is roughly proportional to dissolved ionic concentrations and to temperature.

Conductivity probe
A device used to measure the depth to water in wells that uses the conductivity of the water in the hole to complete a circuit through the two downhole leads which is indicated by a needle deflection at the surface. The two wire conductor is marked with depth indicators to determine the depth where the circuit is completed.

Conformable contact
A surface between two rock strata showing no evidence of disturbance.

En echelon
Parallel structural features.

Eocene
The second epoch of the Tertiary period, spanning from approximately 36 to 58 million years ago.

Evaporation
: Conversion of water to the vapor state.

Evapotranspiration
: The cumulative loss of water to the atmosphere from both the surface and groundwater systems through evaporation and transpiration by plants.

Finite element analysis
: An analytical procedure for solving the governing equations for any system over volumes (finite sized elements) which are small enough that the solution can be assured to vary in some simple manner (usually linearly).

Flowing artesian
: A well which flows without assistance because the piezometric head in the zone of completion is sufficient to cause the water level in the well to rise above the ground surface (or top of the casing).

Gaining reach
: A stretch of stream which is recharged by flow from the groundwater system.

Geohydrology
: The science dealing with the chemistry and physics of water in geologic media.

Geophysical logging
: Indirect observation of downhole conditions using probes of various kinds.

Geothermal gradient
: The change in temperature of the earth with depth.

Groundwater
: Water beneath the ground surface in a geologic media, at or above atmospheric pressure.

Groundwater discharge
: The return of groundwater to the surface.

Groundwater system
: The entire interconnected system of groundwater flow and chemistry, considering directions, quantities, sources and sinks, the material which provides the matrix for the flow and any interactions between these components.

Head conditions
: The distribution of groundwater potentials, which is indicative of potential flow directions.

Hydraulic conductivity
: The measure of the capacity of the geologic material to transmit water.

Hydraulic gradient
: The rate of change of pressure head with distance along a flow path.

Hydrogeochemistry
: The chemistry of groundwater, including consideration of chemical equilibria between the water and the geologic materials.

Hydrostatic conditions
: The pressure distribution characteristic of a body of water at rest, where the pressure is everywhere directly proportional to the depth of the point below the water surface.

Joint
: A fracture or discontinuity in a rock mass upon which major displacement has not occurred.

In situ
: In its natural, undisturbed state.

Infiltration
: The flow of water from the surface into groundwater system.

Intermittent
: A stream that does not flow continuously throughout the year or throughout its length.

Losing reach
: A stretch of stream from which flow is lost to the groundwater system.

Open hole
: An unstabilized drill hole, the integrity of which is maintained by the geologic materials alone.

Parallel drainage
: A stream pattern in which the streams are parallel.

Perennial
: A stream that flows throughout the year.

Permeability
: The property of material which allows fluid flow through it. Used in this study in a generic sense (see hydraulic conductivity).

pH
: The hydrogen ion activity in moles per liter, expressed as the negative of the logarithm to the base 10.

Piezometer
: An instrument for measuring the change of pressure of a material subjected to hydrostatic pressure.

Piezometric conditions
: The distribution of groundwater pressures in a specific horizon (cf. head conditions).

Piezometric surface
: A conceptual surface formed by contouring the pressure heads from a single horizon.

Priority pollutants
: A list of 129 pollutants given special designation by the U.S. Environmental Protection Agency because there is no conventional control technology for these pollutants.

Quaternary
: The time from the end of the Tertiary Period (approximately 2 million years ago) to the present.

Recharge
: The process by which water is added to the groundwater or surface water systems.

Recovery test
: A method of field testing for hydraulic conductivity and estimating the storage coefficient (both hydraulic material properties of geologic material providing the matrix for groundwater flow) by ceasing pumping from the groundwater and monitoring the rate of return to undisturbed conditions.

Representative sample
: A small portion of the total populations having the average properties of the total population.

Riser pipe
: The pipe on which a submersible well pump is suspended and through which the water is brought to the surface.

Seep
: A point of groundwater discharge without measurable flow.

Spring
: A point of groundwater discharge with measurable flow.

Standard deviation
: The positive square root of the expected value of the square of the difference between a random variable and its mean.

Steppe
: The type of climate in which precipitation, although slight, is sufficient for growth of short, sparse grass; typical of the steppe regions of south-central Eurasia.

Storage coefficient
: A material property relating the amount of stored water released from a unit column of the geologic material under a unit decline of head. The coefficient is influenced by the compressibility of both the fluid and the geologic material.

Surface water system
: The interconnected whole, including quality, quantity, gains, and losses of water flowing or stored above the surface.

Syncline
: A geologic structural fold which is concave upward.

Transpiration
: The passage of water through plants and loss to the atmosphere as a gas through the plant tissue.

Trellis drainage
: A stream pattern in which tributary streams are nearly at right angles to the master stream.

Volatile organics
: Organic compounds with boiling points of 25°C or less.

Water table
: A surface below which saturated conditions exist and at which pressure is everywhere atmospheric.

Well bore storage
: That volume of water which is required to fill the casing to the static water level.

Well completion
: The materials used to stabilize a drill hole and allow communication with a particular zone.

Well development
: A process to improve the yield of a well intended to remove fines from the wall rock which may be naturally occurring or may have been introduced by drilling.

Soils

Alluvium

1) Locally derived - unconsolidated mineral material deposited on sideslopes and valley floors by unconcentrated downslope runoff, accompanied somewhat by gravitational forces.

2) Streamlain - mineral material that has been subjected to appreciable transport in suspension with concentrated water flow and deposited in highly variable layers.

Available Waterholding Capacity (AWC)

The amount of water available for plant growth that a 60-inch soil column will generally hold. Soil texture is primary among the factors affecting available waterholding capacity; silty clay loams typically hold the most moisture, whereas loamy sands are droughty. AWC classes are low (<6 inches water per 60 inches soil), moderate (6 to 9 inches), and high (>9 inches).

Calcareous

The soil contains sufficient calcium carbonate to effervesce with 10% hydrochloric acid.

Chroma

A measure of the brightness of soil color. Low chromas are grayish or neutral; high chromas exhibit a greater degree of color intensity. See hue, value.

Coarse Fragments

That portion of the soil mineral particles having diameter greater than 2 mm. Gravels are somewhat rounded coarse fragments 2 mm to 3 inches in diameter; cobbles are 3 to 10 inches in diameter; channers are thin, flat fragments less than 6 inches in length. Coarse fragment content is expressed in percent by volume. For example, "gravelly" means 15 to 35 percent gravels. "Very gravelly" means 35 to 60 percent gravels, and "extremely gravelly" means greater than 60 percent.

Coarse loamy

Generally, a soil textural class having less than 18 percent clay by weight in the fine-earth fraction, and 15 percent or more of the soil particles are fine sand or coarser.

Colluvium

A deposit of rock fragments and soil material accumulated at the base of steep slopes as a result of gravitational action.

Cryic

A "cold" soil temperature regime with mean annual soil temperature between 0 to 8°C (32-46°F). Mean summer temperatures are generally lower than 15°C (59°F). Typically cooler than frigid.

Deep
The soil is greater than 40 inches over bedrock.

Effective Rooting Depth
The soil depth to which roots may freely penetrate without obstruction from bedrock or cemented soil horizons.

Epipedon
A surface horizon which is taxonomically diagnostic.

Erosion Hazard
The degree of inherent susceptibility to soil movement by the forces of wind or water. Based primarily on soil texture, aggregation, and organic matter content.

Fine
A soil textural class having 35 to 59 percent clay in the fine-earth fraction, by weight.

Fine-earth Fraction
The soil portion having particles with diameters of less than 2 mm.

Fine loamy
By weight, a textural class in which the fine earth fraction has 18 to 34 percent clay and greater than 15 percent fine sand or coarser.

Frigid
A "cool" soil temperature regime with mean annual soil temperature between (and not including) 0 to 8°C (32 to 46°F). Mean summer temperatures are generally greater than 15°C (59°F).

Genetic horizons
Soil horizons resulting from soil-forming processes such as freezing and thawing, depth of water percolation, wetting and drying, and organic matter accumulation. The presence, arrangement, and physical and chemical characteristics (texture, salts, etc.) of genetic horizons determine a soil's taxonomic classification. See "argillic," "mollic," and "ochric" for examples of genetic horizons.

Horizon
A soil layer.

Horizon Nomenclature
The three major types of soil horizons are identified as A, B, or C. The A horizons are surface layers characterized by organic accumulations and/or leaching losses of clays. The B horizon, or subsoil, is a zone of clay accumulation, or of suspended organic accumulation, as deposited by leach water. B horizons may also form in place by weathering of mineral fractions to form clays. The C horizon, or parent material, consists of highly weathered, unconsolidated rock or other geologically-deposited material which is relatively unaffected by the more active soil genetic processes

taking place higher in the profile. Transitional horizons such as an AC or B1 exhibit characteristics of both the over- and underlying major horizons.

Hue

A factor of soil color. Hue is the basic color (red, brown, olive) which a soil exhibits. Hues are identified by number and letter codes; e.g., 10R is red, 7.5 YR is reddish-yellow, 10YR is brownish, 5Y is yellow-green.

Internal Drainage

The degree of soil aeration, related also to the rate of water movement through a profile. Internal drainage classes are determined mainly by soil texture, porosity, and depth to a permanent or intermittent water table. Examples of drainage classes are: somewhat poorly drained, where a water table exists within 20 to 36 inches of the surface; moderately well drained, where a water table is present at depths of 36 to 72 inches; well drained, the water table is below 6 feet; somewhat excessively drained, the soil is porous and/or shallow or steep; and excessively drained, the soil is very porous, as in sandy and/or rocky, shallow soils.

Moderately Deep

The soil is 20 to 40 inches deep over bedrock.

Mollic Epipedon

A deep, dark, organic-enriched surface horizon.

Ochric Epipedon

A surface soil horizon characterized by light color values, low organic matter, and/or thickness less than that required for a mollic epipedon.

Pachic

A modifier for a mollic epipedon greater than 16 inches thick in a cool temperature regime.

Pedon

A conceptual unit area of soil which represents the nature and variabilities of its horizons and other properties. Comparable to the unit cell of a crystal.

Permeability

The rate at which water moves downward through the most restrictive layer of a saturated soil. Primary factors affecting permeability are soil texture and structural aggregation. Classes are defined from very slow (<0.06 in/hr) through moderate (0.6 to 2.0 in/hr) to very rapid (>20 in/hr). Corresponding textural classes are clays through loams to sands and gravels.

Phase

A subdivision of a soil series based on such factors as slope, surface texture, stoniness, salinity, or internal drainage.

Profile
The sequence of horizons present in a soil.

Reaction Class
The pH range (acidity, alkalinity) of a soil. Acid: 6.5 and less; Neutral: 6.7 - 7.3; Mildly Alkaline: 7.4 - 7.8; Moderately Alkaline: 7.9 - 8.4; Strongly Alkaline: 8.5 - 9.0; Very Strongly Alkaline: greater than 9.0.

Residuum
Unconsolidated material which accumulates by weathering of parent material in place.

Runoff
The relative rate that water flows over the surface of the soil. Examples of classes are "slow" and "rapid". Slow runoff is where surface water flows away so slowly that free water covers the soil for long periods of time, or else enters the profile rapidly and percolates through or evaporates. Rapid runoff is where water moves quickly over the soil surface and only a small part moves through the profile.

Sandy
Texture of the fine earth is sand or loamy sand but not loamy very fine sand or very fine sand; rock fragments make up less than 35 percent by volume.

Series
A level of classification in the soil taxonomic system; somewhat similar to the species category in the Linnaean taxonomic system.

Shallow
The soil is less than 20 inches over bedrock.

Skeletal
The soil profile, at diagnostic depth, is characterized by greater than 35 percent rock fragments by volume.

Soil Survey Orders
The intensity of field investigations based on frequency of profile examinations and size of map scale. Order 2 intensity is generally conducted at scale of 1:6,000 to 1:24,000, with profiles examined in at least 80% of the delineations. Order 3 investigations are conducted on a reconnaissance basis, relying heavily on aerial photointerpretation, relatively wide-spaced profile examinations, and geomorphic interpretations. Scales are commonly 1:15,840 and 1:24,000.

Structural Aggregation
The type of grouping exhibited by soil particles; the shape of soil solids. Examples of soil aggregates are blocky (cube-like), prismatic, and granular.

Texture

The percent by weight of sand, silt, and clay in a soil. Coarse fragment modifiers are used when appropriate as in "gravelly sandy clay."

Typical Profile

That profile which represents the modal concept of a soil's morphology and its physical and chemical characteristics.

Value

The lightness or darkness of a soil color.

Variant

A unique soil which does not occupy enough total acreage to warrant the establishment of a new soil series. Variants are named for the established series which they most closely resemble.

APPENDIX A

SOIL MAPPING UNITS AND SOILS DESCRIPTIONS

TABLE A-1

Map Unit Number	Map Unit Name	Route A (Miles)	Route A Deviation (Miles)	Route B (Miles)	Physical Constraints	Chemical Constraints
2F	Parachute loam, 25-75% slopes	0	0	0.8	Slope, coarse fragments, low AWC, high erosion hazard, can be shallow	
2Ce	Parachute-Rhone loams, 5-30% slopes -Parachute part (55%) -Rhone part (35%)	0	0	1.2	Slope, coarse fragment, low AWC, moderate-high erosion hazard, can be shallow Slope, coarse fragments, moderate to high erosion hazard	
16	Irigul-Parachute complex, 5-30% slopes -Irigul part (60%) -Parachute part (30%)	2.3	2.3	3.0	Slope, coarse fragments, very low AWC, slight-high erosion hazard, very shallow Slope corase fragments, low AWC, moderate-very high erosion hazard, shallow	
26	Rhone loam, 30-75% slopes	0	0	1.1	Slope, coarse fragments, very high (erosion) hazard	
33	Tisworth fine sandy loam, 0-5% slopes	10.2	10.2	0	Slow permeability	Strongly calcareous and alkaline; alkalinity limitation to seeding
38	Havre loam, 0-4% slopes	4.7	4.7	0		Moderately to strongly alkaline (suited to range seeding)
38C	Havre loam, 0-4% slopes	-	-	-		Moderately to strongly alkaline (suited to range seeding)

TABLE A-1 (CONTINUED)

Map Unit Number	Map Unit Name	Route A (Miles)	Route A Deviation (Miles)	Route B (Miles)	Physical Constraints	Chemical Constraints
39	Turley fine sandy loam, 0-3% slopes	0	0	0.4	-	Strongly calcareous, moderately to strongly alkaline, seeding may be limited by salinity and alkalinity
39C	Turley fine sandy loam, 3-8% slopes	0.3	2.1	0.8	Slight to moderate erosion hazard	Suited to range seeding but limited by alkalinity and salinity.
41	Glendive fine sandy loam (nearly level)	0.6	0.6	1.6		Strongly alkaline at depth
46C	Kobar silty clay loam, 3-8% slopes	1.4	.14	0	Some heavy textures, moderate erosion hazard	Strongly alkaline at depth, some free salts
46D	Kobar silty clay loam, 8-15% slopes	0.7	0.7	0	Some heavy textures, moderate to high erosion hazard	Strongly alkaline at depth some free salts
47	Abor clay loam, 5-30% slopes	0	0	6.43	Heavy textures, low AWC, slope high erosion hazard, can be shallow	Some parts strongly alkaline
48	Bulkley channery silty clay loam, 5-30% slopes	0	0 -	0.76	Some heavy textures, coarse fragments, high erosion hazard, slope	Some free lime
50C	Patent loam, 3-8% slopes	2.7	2.7	0		Some free calcium carbonate
50D	Patent loam, 8-15% slopes	-	-	-	High erosion hazard	Some free calcium carbonate

TABLE A-1 (CONTINUED)

Map Unit Number	Map Unit Name	Route A (Miles)	Route A Deviation (Miles)	Route B (Miles)	Physical Constraints	Chemical Constraints
63	Rentsac channery loam, 5-50% slopes	0.2	0	0.1	Slope, coarse fragments, very low AWC, moderate-very high erosion hazard, shallow	Some parts strongly calcareous
65E	Moyerson stoney clay loam, 15-65% slopes	0.9	2.5	0.2	Slope, heavy textures, some coarse fragments, very high erosion hazard, shallow	Some parts strongly alkaline
X38	Billings silty clay loam, 0-5% slopes	0	0.1	0.6	Moderate to high erosion hazard	Some parts strongly alkaline; some possible seeding problems from alkalinity and slight salinity
X39	Nihill channery sandy loam, 5-50% slopes	0	0	0.7	Slope, coarse fragments, low AWC, moderate-very high erosion hazard	Some parts strongly alkaline, some free lime
X48	Blakabin-Rhone-Waybe complex, 5-50% slopes -Blakabin part (45%) -Rhone part (25%) -Waybe part (20%)	0.3	0.3	0	Slope, some heavy textures, moderate-very high erosion hazard -- Slope, some coarse fragments, slight-very high erosion hazard Slope, coarse fragments, moderate-low AWC, moderate-very high erosion hazard, shallow	Some parts strongly alkaline, some free salts -- -- Some parts strongly effervescent
X58	Starman-Vandamore complex, 5-50% slopes -Starman part (50%) -Vandamore part (40%)	0	0	13.0	Slope, coarse fragments, very low AWC, shallow -- Slope, coarse fragments, very low AWC, somewhat shallow	Some parts strongly calcareous and strongly alkaline -- Some free salts
X64	Blazon, moist-Rentsac complex, 8-65% slopes -Blazon part (50%) -Rentsac part (35%)	0.5	0.5	0	Slope, coarse fragments, low AWC, moderate-very high erosion hazard, shallow -- Slope, coarse fragments, low AWC, moderate-very high erosion hazard, shallow	-- -- Some parts strongly calcareous

TABLE A-1 (CONTINUED)

Map Unit Number	Map Unit Name	Route A (Miles)	Route A Deviation (Miles)	Route B (Miles)	Physical Constraints	Chemical Constraints
70	Piceance fine sandy loam, 5-15% slopes	0.4	0	0	Moderately low AWC, moderate-high erosion hazard, can be shallow, coarse fragments	Some free calcium carbonate at depth
72	Chipeta silty clay loam, 3-25% slopes	-	-	-	Slope, low AWC, high erosion hazard, shallow	Some free salts
73	Yamac loam, 2-15% slopes	-	-	-		Some parts strongly alkaline
138	Billings-Torrifluvents complex, gullied, 0-5% slopes -Billings part (55%) -Torrifluvents part (35%)	0.4	0.5	0.5	High erosion hazard -- No Data	Some parts strongly alkaline -- No Data
150	Kinnear fine sandy loam, 1-5% slopes	0.6	1.1	1.1	Susceptable to blowing	Some free calcium carbonate
X5	Northwater loam, 5-50% slopes	0.6	0.6	0.4	Slope, some coarse fragments, moderate-very high erosion hazard	
X6	Irigul channery loam, 5-50% slopes	0	0.2	3.4	Slope, coarse fragments, very low AWC very high erosion hazard, shallow	
X7	Silas loam, 0-8% slopes	1.7	1.7	2.4		
X26	Razorba channery sandy loam, 30-75% slopes	0.9	0.9	0	Slope, coarse fragments, low AWC, very high erosion hazard	Some parts strongly calcareous
X33	Uffens loam, 0-5% slopes	0.1	1.1	0.1	Moderate erosion hazard	Strongly calcareous and strongly to moderately alkaline, seeding limited by salinity and alkalinity

TABLE A-1 (CONTINUED)

Map Unit Number	Map Unit Name	Route A (Miles)	Route A Deviation (Miles)	Route B (Miles)	Physical Constraints	Chemical Constraints
X66	Rentsac-Moyerson-Rock Outcrop complex, 5-65% slopes -Rentsac part (40%) -Moyerson part (25%) -Rock outcrop part (20%)	7.1	6.4	5.1	Slope, coarse fragments, very low AWC, moderate-very high erosion hazard, shallow -- Slope, coarse fragments, low AWC, very high erosion hazard, shallow Slope, lacks soil	Some parts strongly calcareous -- Some parts strongly alkaline
X89	Cliffdown-Cliffdown variant complex, 5-65% slopes -Cliffdown part (60%) -Cliffdown variant part (25%)	0.1	0.2	0.2	Slope, coarse fragments, very low AWC, somewhat excessive drainage -- Slope, coarse fragments, very low AWC, somewhat excessive drainage, moderate to high erosion hazard, shallow	Some parts strongly alkaline, some free salts in variable amounts -- Some parts strongly alkaline
BL	Badlands, [10-65% slopes]	0.1	0.5	0.7	Slope, little soil, very low AWC, very high erosion hazard	Derived from highly calcareous and gypsiferous sources
RT	Torriorthents-Rock Outcrop complex, 15-90% slopes -Torriorthent part (50%) -Rock outcrop part (30%)	2.3	2.4	2.9	Slope, coarse fragments, very low AWC, very high erosion hazard, shallow -- Slope, lacks soil	-- --
R6	Torrifluvents, gullied [0-5% slopes] (Torrifluvents = 35% gullies, and headcuts = 45%)	1.7	1.7	0.1	Soil properties vary, very high erosion hazard	Derived from highly calcareous and gypsiferous sources
RO	Rock Outcrop [50-100% slopes]	0	0.3	0.4	Slope, lacks soil	
4	Colarow sandy loam [nearly level]	0.3	0.3	0.3	Some light soil textures	

TABLE A-2

Map Unit Number	Map Unit Name	Surface Texture (typical)	Subsurface Texture (range)	Permeability
2F	Parachute loam, 25-75% slopes	Loam	Loam-extremely channery loam	Moderate
2Ce	Parachute-Rhone loams, 5-30% slopes			
	- Parachute part (55%)	Loam	Loam-extremely channery sandy loam	Moderate
	- Rhone part (35%)	Loam	Loam-very channery loam	Moderate
4	Colarow sandy loam [nearly level]	Sandy loam	Loamy fine sand-loam	Moderately rapid
16	Irigul-Parachute complex, 5-30% slopes			
	- Irigul part (60%)	Channery loam	Extremely channery loam	Moderate
	- Parachute part (30%)	Loam	Loam-extremely channery sandy loam	Moderate
26	Rhone loam, 30-75% slopes	Loam	Loam-very channery loam	Moderate
33	Tisworth fine sandy loam, 0-5% slopes	Fine sandy loam	Fine sandy loam-clay loam	Slow
38	Havre loam, 0-4% slopes	Loam	Loam-silty clay loam	Moderate
38C	Havre loam, 0-4% slopes	Loam	Loam-silty clay loam	Moderate
39	Turley fine sandy loam, 0-3% slopes	Fine sandy loam	Loam	Moderately slow
39C	Turley fine sandy loam, 3-8% slopes	Fine sandy loam	Loam	Moderately slow
41	Glendive fine sandy loam [nearly level]	Fine sandy loam	Stratified fine sandy loam	Moderately rapid
46C	Kobar silty clay loam, 3-8% slopes	Silty clay loam	Heavy silty clay loam silty clay	Slow
46D	Kobar silty clay loam, 8-15% slopes	Silty clay loam	Silty clay loam-silty clay	Slow
47	Abor clay loam, 5-30% slopes	Clay loam	Silty clay loam-silty clay	Slow-very slow
48	Bulkley channery silty clay loam, 5-30% slopes	Channery silty clay loam	Clay loam-silty clay	Slow
50C	Patent loam, 3-8% slopes	Loam	Very fine sandy loam-loam	Moderate
50D	Patent loam 8-15% slopes	Loam	Very fine sandy loam-loam	Moderate
63	Rentsac channery loam, 5-50% slopes	Channery loam	Very channery light loam-extremely flaggy light loam	Moderately rapid

TABLE A-2 (CONTINUED)

Map Unit Number	Map Unit Name	Surface Texture (typical)	Subsurface Texture (range)	Permeability
65E	Moyerson stoney clay loam, 15-65% slopes	Stoney clay loam	Hesoy clay loam-clay	Slow
70	Piceance fine sandy loam, 5-15% slopes	Fine sandy loam	Loam-channery light loam	Moderate
72	Chipeta silty clay loam, 3-25% slopes	Silty clay loam	Silty clay	Slow
73	Yamac loam, 2-15% slopes	Loam	Loam	Moderate
138	Billings-Torrifluvents complex, gullied 0-5% slopes			
	- Billings part (55%)	Silty clay loam	Light loam-loam silty clay loam	Slow
	- Torrifluvents part (35%)	ND	ND	ND
150	Kinnear fine sandy loam, 1-5% slopes	Fine sandy loam	Light loam-loam	Moderate
X5	Northwater loam, 5-50% slopes	Loam	Loam-very channery sandy clay loam	Moderate
X6	Irigul channery loam, 5-50% slopes	Channery loam	Extremely channery loam	Moderate
X7	Silas loam, 0-8% slopes	Loam	Light loam-light sandy clay loam	Moderate
X26	Razorba channery sandy loam, 30-75% slopes	Channery sandy loam	Channery sandy loam	Moderately rapid
X33	Uffens loam, 0-5% slopes	Loam	Loam-light clay loam	Moderately slow
X38	Billings silty clay loam, 0-5% slopes	Silty clay loam	Silty clay loam	Slow
X39	Nihill channery sandy loam, 5-50% slopes	Channery sandy loam	Very channery sandy loam, very channery loam	Moderately rapid
X48	Blakabin-Rhone-Waybe complex, 5-50% slopes			
	- Blakabin part (45%)	Clay loam	Clay loam-clay	Slow
	- Rhone part (25%)	Loam	Very channery loam	Moderate
	- Waybe part (20%)	Flaggy clay loam	Channery silty clay loam	Slow
X58	Starman-Vandamore complex, 5-50% slopes			
	- Starman part (50%)	Channery loam	Extremely channery loam	Moderate
	- Vandamore part (40%)	Channery-extremely channery loam	Extremely channery loam	Moderate-moderately rapid
X64	Blazon, moist-Rentsac complex, 8-65% slopes			
	- Blazon part (50%)	Channery loam	Channery clay loam-very shaley clay loam	Moderately slow
	- Rentsac part (35%)	Channery loam	Channery light loam-extremely flaggy light loam	Moderately rapid

TABLE A-2 (CONTINUED)

Map Unit Number	Map Unit Name	Surface Texture (typical)	Subsurface Texture (range)	Permeability
X66	Rentsac-Moyerson-Rock Outcrop complex, 5-65% slopes			
	- Rentsac part (40%)	Channery loam	Very channery light loam-extremely flaggy light loam	Moderately rapid
	- Moyerson part (25%)	Stoney clay loam	Clay loam-clay	Slow
	- Rock Outcrop part (20%)	NA	NA	NA
X89	Cliffdown-Cliffdown variant complex, 5-65% slopes			
	- Cliffdown part (60%)	Gravelly loam	Very gravelly sandy loam	Moderately rapid
	- Cliffdown variant part (25%)	Very cobbly loam	Very gravelly loam-gravelly clay loam	Moderately-very slow
BL	Badlands [10-65% slopes]	NA	NA	Very slow
RT	Torriorthents-Rock Outcrop complex, 15-90% slopes			
	- Torriorthents part (50%)	Channery loam	Fine sandy loam-very channery loam	Moderate
	-Rock Outcrop part (30%)	NA	NA	NA
RG	Torrifluvents, gullied [0-5% slopes] (Torrifluvents = 35%, gullies and headcuts = 45%)			Moderately rapid-slow
RO	Rock Outcrop [50-100% slopes]	NA	NA	NA

TABLE A-3

Map Unit Number	Available Water Capacity	Drainage	Runoff	Erosion Hazard (Water)	Effective Rooting Depth (inches)	Capability Subclass Irrigated/ Non-irrigated
2F	Low	Well	Medium	Very high	20-40	NA/VIIe
2Ce	Low	Well	Medium	Moderate-high	20-40	NA/VIe
	High	Well	Medium	Moderate-high	40-60	NA/VIe
4	Moderate	Well	Medium	Slight	60+	IIIe/IVe
16						
	Very low	Well	Medium-rapid	Slight-high	10-20	NA/VIIe
	Low	Well	Medium	Moderate-very high	20-40	NA/VIIe
26	High	Well	Medium	Very high	40-60+	NA/VIIe
33	Moderate	Well	Rapid	Moderate	60+	IVs/VIIs
38	High	Well	Medium	Slight	60+	IIIe/IIIc
38C	High	Well	Medium	Slight	60+	IIIe/IIIc
39	High	Well	Medium	Slight	60+	IIIe/IVe
39C	High	Well	Medium	Slight-moderate	60+	NA/VIe
41	Moderate	Well	Slow	Slight	60+	IIIe/IVe
46C	High	Well	Medium-rapid	Moderate	60+	IVe/IVe
46D	High	Well	Rapid	Moderate-high	60+	IVe/IVe
47	Low	Well	Rapid	High	20-40	NA/VIe
48	Moderate	Well	Rapid	High	40-60	NA/VIe
50C	High	Well	Medium	Moderate	60+	NA/IIIe
50D	Moderate	Well	Medium	High	60+	NA/IVe
63	Very low	Well	Rapid	Moderate-very high	10-20	NA/VIIe
65E	Low	Well	Rapid	Very high	10-20	NA/VIIe
70	Moderately low	Well	Slow-medium	Moderate-high(w)	20-40	NA/VIe
72	Low	Well	Rapid	High	10-20	NA/VIIe
73	Moderate-high	Well	Medium	Slight-moderate	60+	NA/IVe
138	High	Well	Rapid	High	60+	NA/VIIe
	ND	ND	ND	ND	Varies	NA/VIIe
150	High	Well	Medium	Slight	60+	IIIe/IVc
X5	Moderate	Well	Medium	Moderate-very high	40-60	NA/VIIe
X6	Very low	Well	Medium-rapid	Very high	10-20	NA/VIIe
X7	High	Well	Medium	Slight-moderate	60+	NA/VIe

TABLE A-3 (CONTINUED)

Map Unit Number	Available Water Capacity	Drainage	Runoff	Erosion Hazard (Water)	Effective Rooting Depth (inches)	Capability Subclass Irrigated/ Non-irrigated
X26	Low	Well	Medium	Very high	60+	
X33	Moderate	Well	Slow	Moderate	60+	IVs/VIIs
X38	High	Well	Rapid	Moderate-high	60+	IIIe/VIe
X39	Low	Somewhat excessive	Medium	Moderate-very high	60+	NA/VIIe
X48						
	High	Well	Medium-rapid	Moderate-very high	60+	NA/VIIe
	High	Well	Medium	Slight-very high	40-60	NA/VIIe
	Moderate-low	Well	Rapid	Moderate-very high	10-20	NA/VIIe
X58						
	Very low	Well	Medium	Slight	10-20	NA/VIe-VIIe
	Very low	Well	Medium	Slight	20-30	NA/VIe-VIIe
X64						
	Low	Well	Rapid	Moderate-very high	10-20	NA/VIIe
	Low	Well	Rapid	Moderate-very high	10-20	NA/VIIe
X66						
	Very low	Well	Medium	Moderate-very high	10-20	NA/VIIe
	Low	Well	Medium-rapid	Very high	10-20	NA/VIIe
	NA	NA	NA	NA	NA	NA/NA
X89						
	Very low	Somewhat excessive	Medium-slow	Slight-moderate	60+	NA/VIIe
	Very low	Somewhat excessive	Rapid	Moderate-high	10-20	NA/IIIe
BL						
	Very low	NA	Very rapid	Very high	0-10	VIII
RT						
	Very low	Well-somwhat excessive	Very rapid	Very high	16	NA/IIIe
	NA	NA	NA	NA	NA	NA/IIIe
RG	Medium-high	Well-somewhat excessive	Rapid	Very high	60+	NA/VIII
RO	NA	NA	NA	NA	NA	NA/VIII

SOILS DESCRIPTIONS

Introduction

The following discussion presents the baseline data and impact analysis for soil resources. The soils along the routes in Rio Blanco County have been surveyed at an Order 3 level. Consequently, the level of detail is relatively high. In contrast, no soil surveys have been conducted along the route in Garfield County and the detail to which soils can be analyzed is limited. Therefore, the information presented for Garfield County has been taken from "Range Site Descriptions."

RIO BLANCO COUNTY

Map Unit 2F - Parachute loam, 25-75% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 0.8 mi.

This moderately deep soil is located on mountain ridges and was formed in residuum derived primarily from sedimentary rock. The surface layer is typically a loam approximately 4 in thick. The underlying material, to a depth of 38 in, ranges from loam to extremely channery loam. Content of rock fragments ranges from 35 to 85 percent. Depth to sandstone or hard shale ranges from 20 to 40 in. The profile is neutral or mildly alkaline. Available water capacity is low and the erosion hazard is very high. This unit is used primarily for livestock grazing and wildlife habitat and is classified in the "Brushy Loam" range site. Average annual production (air-dry vegetation) is about 2,000 pounds per acre.

Map Unit 2Ce - Parachute-Rhone Loams, 5-30 % slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 1.2 mi.

This unit is present on ridge crests, mountainsides, and upland ridges and sideslopes. The moderately deep Parachute soil was formed in residuum derived primarily from sandstone or hard shale. The surface layer is a loam 4 in thick. The subsurface material ranges from loam to extremely channery sandy loam. Depth to fractured sandstone or hard

shale bedrock is from 20 to 40 in. Content of rock fragments ranges from 35 to 85 percent. The profile is neutral or mildly alkaline. Available water capacity is low and the erosion hazard is moderate to high.

The Rhone part is deep and was formed in residuum and colluvium derived primarily from sandstone or hard shale. The surface layer is a loam about 8 in thick. The underlying material ranges from loam to very channery loam. Depth to bedrock ranges from 40 to 60 in. The profile is noncalcareous and neutral to mildly alkaline. The C horizon may contain 35 to 65 percent rock fragments. The erosion hazard is moderate to high.

The unit is used for livestock grazing and wildlife habitat. The average annual air-dry vegetative production is 1,500 pounds per acre. It is classified in the "Mountain Loam" range site.

Map Unit 4 - Colarow sandy loam (nearly level)

- Route A = 0.3 mi.
- Route A with deviation = 0.3 mi.
- Route B = 0.3 mi.

This deep soil is located on floodplains and low terraces. The surface layer is typically a sandy loam about 5 in thick. The underlying material ranges from loamy fine sand to loam. Bedrock is below 60 in. Water erosion hazard is slight. The unit is used primarily for irrigated hazard pasture, livestock grazing, and wildlife habitat. This soil is well suited to hay and pasture and is a source of topsoil. The main limitation to seeding is low precipitation. The average annual air-dry production is about 1,500 to 2,500 pounds per acre. The unit is in the "Sandy Saltdesert" range site.

Map Unit 16 - Irigul-Parachute complex, 5-30% slopes

- Route A = 2.3 mi.
- Route A with deviation = 2.3 mi.
- Route B = 3 mi.

This complex is present on mountain ridges and on the crests and sides of hills. The shallow Irigul part was formed in residuum derived primarily from sandstone and hard shale. The surface layer, typically, is a channery loam 5 in thick. The underlying material is extremely

channery loam. Hard sandstone or shale bedrock is at a depth of 10 to 20 in. The pedon is noncalcareous and mildly alkaline. The content of channery rock fragments equals or exceeds 30 percent throughout the profile. Available water capacity is very low and runoff is medium to rapid. Erosion hazard is slight to high.

The Parachute part is moderately deep and was formed in residuum derived mainly from sandstone or hard shale. The surface layer is a loam 4 in thick. The underlying material ranges from loam to extremely channery sandy loam. Rock content ranges from 35 to 85 percent in lower horizons. The profile is neutral or mildly alkaline. Available water capacity is low and the erosion hazard is moderate to very high.

The unit is used for livestock grazing and wildlife habitat. The average annual air-dry vegetative production is about 900 (Irigul part) to 1,500 (Parachute part) pounds per acre. The main limitations for seeding are slope, shallow rooting depth, and short growing season. The Irigul soil is classified in the "Loamy Slopes" range site and the Parachute soil is in the "Mountain Loam" range site.

Map Unit 26 - Rhone loam, 30-75% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 1.1 mi.

The Rhone loam is a deep soil that was formed on mountainsides, upland ridges, and valley sides from residuum and colluvium derived primarily from sedimentary rock. The surface layer is typically a loam about 8 in thick. The underlying material to 50 in ranges from loam to very channery loam. The C horizon may contain 35 to 65 percent rock fragments. Depth to fractured sandstone bedrock ranges from 40 to 60 in. The profile is noncalcareous and neutral or mildly alkaline. The erosion hazard is very high. This unit is used primarily for livestock grazing and wildlife habitat. It is in the "Brushy Loam" range site. Average annual air-dry vegetative production is about 2,500 pounds per acre.

Map Unit 33 - Tisworth fine sandy loam, 0-5% slopes

- Route A = 10.2 mi.
- Route A with deviation = 10.2 mi.
- Route B = 0 mi.

This is a deep soil found on valley floors, broad fans, and low uplands. It was formed in alluvium derived primarily from sedimentary rock that contains some gypsum and alkaline salt. Typically, the surface layer is a 4-in thick sandy loam. The underlying material, to a depth of 60 in, ranges from fine sandy loam to clay loam. Saline slickspots are at the surface. The pedon is primarily strongly calcareous and strongly to very strongly alkaline. The C horizon may contain 5 to 25 percent rock fragments (mainly gravel-size) and commonly has fine crystalline deposits of gypsum. Permeability is slow, runoff rapid, and erosion hazard moderate. The unit is used for livestock grazing, irrigated hay and pasture, and wildlife habitat. It is classified in the "Alkaline Slopes" range site. The average annual air-dry vegetative production is 600 pounds per acre. The main limitations to seeding are low precipitation in summer, alkalinity and erosion hazard.

Map Unit 38 - Havre loam, 0-4% slopes

- Route A = 4.7 mi.
- Route A with deviation = 4.7 mi.
- Route B = 0 mi.

The Havre loam is a deep soil located on flood plains, stream terraces, and narrow valley bottoms. It was formed in stratified calcareous alluvium from sedimentary materials. The surface layer is a loam 21 in thick. The subsurface materials range from sandy loam to silty clay loam to a depth of 60 in. The pedon is calcareous and moderately to strongly alkaline. The erosion hazard is slight. Fine filaments or threads of lime or salts may be found in the C horizons of some pedons. This soil is subject to brief periods of flash flooding in small areas late in spring and summer. The unit is used primarily for livestock grazing, irrigated cropland, and wildlife habitat. The unit has few limitations to hay and pasture and is suited to range seeding. It is in the "Foothill Swale" range site. The average annual air-dry vegetative production is about 2,000 pounds per acre.

Map Unit 38C - Havre loam, 0-4% slopes

- Route A = In corridor - not crossed
- Route A with deviation = In corridor - not crossed
- Route B = In corridor - not crossed

See "Map Unit 38 - Havre loam, 0-4% slopes."

Map Unit 39 - Turley fine sandy, sandy loam, 0-3% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 0.4 mi.

This deep soil was formed in calcareous alluvium and occurs on alluvial fans, narrow valley floors, and low terraces. The surface layer is a fine sandy loam about 4 in thick. The subsurface material is loam to 60 in. The pedon is strongly calcareous throughout and moderately to strongly alkaline. The erosion hazard is slight. The unit is used mainly for livestock grazing and irrigated cropland. It is in the "Alkaline Slopes" range site. The average annual air-dry vegetative production is about 650 pounds per acre. The unit is suitable for range seeding though it is limited by low summer precipitation, alkalinity, and salinity.

Map Unit 39C - Turley fine sandy loam, 3-8% slopes

- Route A = 0.3 mi.
- Route A with deviation = 2.1 mi.
- Route B = 0.8 mi.

The Turley is a deep soil that was formed in calcareous mixed alluvium derived from sandstone and shale. The surface layer is fine sandy loam about 4 in thick. The underlying material is a loam to 60 in. The typical pedon is strongly calcareous throughout and moderately to strongly alkaline. The erosion hazard is slight to moderate. The unit is used mainly for livestock grazing and wildife habitat. It is in the "Alkaline Slopes" range site. The average annual air-dry vegetative production is about 650 pounds per acre. The unit is suited to range seeding but is limited by low summer precipitation, alkalinity, and salinity.

Map Unit 41 - Glendive fine sandy loam (nearly level)

- Route A = 0.6 mi.
- Route A with deviation = 0.6 mi.
- Route B = 1.6 mi.

The Glendive fine sandy loam is a deep soil that was formed in stratified calcareous alluvium primarily from sedimentary rock formations. It occurs in narrow valley bottoms along drainageways. The surface layer is a fine sandy loam about 6 in thick. The subsurface material is a stratified fine sandy loam to 60 in. The typical pedon is calcareous, moderately alkaline in the upper part and calcareous, strongly alkaline in the lower part. The control section has 5 to 15 percent fine channery rock fragments throughout. The erosion hazard is slight. This unit is used primarily for livestock grazing and wildlife habitat with a few areas used for irrigated pasture. It is well suited to pasture. The main limitation to urban development is flooding hazard. The limitations to range seeding are low precipitation and droughtiness of soil. The unit is classified in the "Foothills Swale" range site. Average annual air-dry vegetative production is about 2,000 pounds per acre.

Map Unit 46C - Kobar silty clay loam, 38% slopes

- Route A = 1.4 mi.
- Route A with deviation = 1.4 mi.
- Route B = 0 mi.

This is a deep soil located on entrenched flood plains, fans, and narrow valley bottoms. It was formed in fine alluvium derived from shale and sandstone. The typical surface layer is silty clay loam about 3 in thick. The underlying material, to a depth of 60 in, ranges from heavy silty clay loam to silty clay. The pedon is weakly calcareous, moderately alkaline at the surface increasing to calcareous, strongly alkaline in the lower horizons. Masses and seams of calcium carbonate and gypsum exist in lower horizons. Scattered pebbles, channery rock fragments and shale chips are found throughout the profile. Permeability is slow, runoff is medium to rapid, and the erosion hazard is moderate. The unit is used mainly for irrigated and non-irrigated cropland and livestock grazing. It is classified in the "Deep Clay Loam" range site. The average annual air-dry vegetative production is

about 2,000 pounds per acre. The unit is well suited to range seeding but is constrained by slow permeability and low precipitation.

Map Unit 46D - Kobar silty clay loam, 8-15% slopes

- Route A = 0.7 mi.
- Route A with deviation = 0.7 mi.
- Route B = 0 mi.

The Kobar silty clay loam is a deep soil that was formed in calcareous alluvium and colluvium derived primarily from shale. This Kobar soil is positioned on fans and upper valley sides. The typical surface layer is a silty clay loam about 2 in thick. The underlying material ranges from silty clay loam to silty clay to a depth of 60 in. The pedon is weakly calcareous, moderately alkaline at the surface increasing to calcareous, strongly alkaline in the lower horizons. Masses and seams of calcium carbonate and gypsum exist in lower horizons. Scattered pebbles, channery rock fragments and shale chips are throughout the profile. Permeability is slow, runoff is rapid and the erosion hazard is moderate to high. The unit is used primarily for livestock grazing and some non-irrigated crops. It is classified in the "Deep Clay Loam" range site. The average annual air-dry vegetative production is about 1,500 pounds per acre. It is suited to range seeding but is limited by slow permeability, low precipitation during critical periods, slope, and erosion hazard.

Map Unit 47 - Abor clay loam, 5-30% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 6.43 mi.

This moderately deep soil is found on uplands and low mountain sideslopes and was formed in residuum derived primarily from clayey shale and sandstone. The typical surface layer is brown clay loam about 4 in thick. Subsoil materials range from silty clay loam to silty clay. Shale bedrock occurs from 20 to 40 in. The pedon is calcareous and moderately to strongly alkaline. A high percentage of shale chips is comon in the lower horizon. Visable fine threads and seams of calcium carbonate are present at lower depths. Permeability is slow - very slow and the available water capacity is low. Runoff is rapid and the erosion

hazard is high. The unit is used mainly for livestock grazing and wildlife habitat. The average annual air-dry vegetative production is approximately 900 pounds per acre. The unit is classified in the "Clayey Foothills" range site. It is suitable for range seeding but is limited primarily by steep slopes.

Map Unit 48 - Bulkley channery silty clay loam 5-30% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 0.76 mi.

This is a deep soil that was formed in residuum and colluvium derived primarily from interbedded shale and sandstone. It occurs on uplands and foothills. The surface layer is typically a channery silty clay loam about 5 in thick. The underlying material is clay loam to silty clay. Depth to shale is from 40 to 60 in. The pedon is predominantly calcareous and moderately alkaline. There are fine and medium seams and soft masses of lime in the lower horizon. The surface soil is 0 to 10 percent basalt cobbles and stones. Permeability is slow, runoff is rapid, and the erosion hazard is high. The unit is used primarily for livestock grazing and wildlife habitat and some woodland. It is classified in the "Pinyon-Juniper" woodland site. The average annual air-dry vegetative production is about 600 pounds per acre. The unit is suited to range seeding when slopes are less than 15 percent. The main limitations to seeding are competition from trees and erosion hazard.

Map Unit 50C - Patent loam, 3-8% slopes

- Route A = 2.7 mi.
- Route A with deviation = 2.7 mi.
- Route B = 0 mi.

This deep soil is located on fans, uplands, and toeslopes. It was formed in alluvium, colluvium, and as a thin mantle of eolian material. The surface layer is a loam about 10 in thick and the underlying soil ranges from very fine sandy loam to loam to a depth of 60 in. The pedon is calcareous and mildly to moderately alkaline throughout. Below the A horizon is disseminated calcium carbonate. Some pedons have as much as 15 percent rock fragments throughout. Erosion hazard is high. The

unit is used mainly for irrigated and nonirrigated cropland livestock grazing. It is in the "Rolling Loam" range site. The average annual air-dry vegetative production is about 800 pounds per acre. It is suited to range seeding. The main limitation is low precipitation in summer.

Map Unit 50D - Patent loam, 8-15% slopes

- Route A = In corridor - not crossed
- Route A with deviation = In corridor - not crossed
- Route B = In corridor - not crossed

The Patent loam is a deep soil that was formed in alluvium, colluvium, and as a thin mantle of eolian material. It is located on fans, uplands, and toeslopes. Typically, the surface layer is a loam 10 in thick. The underlying layer ranges from very fine sandy loam to loam to a depth of 60 in. The pedon is calcareous and mildly to moderately alkaline throughout. Below the A horizon is disseminated calcium carbonate. Some pedons have up to 15 percent rock fragments throughout. The erosion hazard is high. The unit is used primarily for livestock grazing, nonirrigated cropland, and wildlife habitat. It is in the "Rolling Loam" range site. The average annual air-dry vegetative production is about 750 pounds per acre. The unit is suitable to range seeding. The main limitations are slope and low summer precipitation.

Map Unit 63 - Rentsac channery loam, 5-50% slopes

- Route A = 0.2 mi.
- Route A with deviation = 0 mi.
- Route B = 0.1 mi.

The Rentsac soil is shallow and is located on ridges, foothills, and entrenched upland breaks. It was formed in residium derived primarily from calcareous sandstone. The surface layer of the profile is typically a channery loam about 5 in thick. The underlying material ranges from channery light loam to extremely flaggy light loam. Depth to hard sandstone ranges from 10 to 20 in. The pedon is slightly to strongly calcareous and moderately alkaline. The A horizon is 20 to 35 percent small rock fragments. Percentages and size of fragments increase with profile depth. Available water capacity is very low, runoff is rapid, and the erosion hazard is moderate to very high. The

unit is used primarily for livestock grazing and wildlife habitat. It is in the "Pinyon-Juniper Woodland" range site. The average annual air-dry vegetative production is approximately 500 pounds per acre.

Map Unit 65E - Moyerson stoney clay loam, 15-65% slopes

- Route A = 0.9 mi.
- Route A with deviation = 2.5 mi.
- Route B = 0.2 mi.

This shallow soil is found on upland ridges, side slopes, valleysides, and dissected plateaus. It was formed in residuum derived from calcareous shale. The surface layer is typically a stoney clay loam about 2 in thick and is covered with 5 to 20 percent stones, flags, and boulders. The subsurface material ranges from heavy clay loam to clay. Depth to shale ranges from 10 to 20 in. The pedon ranges from moderately to strongly alkaline and is calcareous throughout. Permeability is slow and available water capacity. Runoff is rapid and erosion hazard is very high. The unit is used primarily for limited livestock grazing and wildlife habitat. It is in the "Clayey Slopes" range site. The average annual air-dry vegetative production is about 650 pounds per acre.

Map Unit 70 - Piceance fine sandy loam, 5-15% slopes

- Route A = 0.4 mi.
- Route A with deviation = 0 mi.
- Route B = 0 mi.

The Piceance fine sandy loam is a moderately deep soil which is located on uplands and broad ridgetops. It was formed in eolian material and alluvium. The typical surface layer is a fine sandy loam about 4 in thick. The subsurface material, to depth of 20 to 40 in, ranges from loam to channery light loam. Hard sandstone bedrock is below this depth. The pedon ranges from non-calcareous to calcareous and mildly alkaline to moderately alkaline increasing with depth. Thin seams and soft masses of calcium carbonate are present in the lowest horizon. From 0 to 5 percent of the surface is covered with fine channery rock fragments. Rock fragments range from 5 to 35 percent throughout the profile; the percentage increasing with depth. Available water capacity is moderately low and the erosion hazard is moderate to

high. The unit is used primarily for livestock grazing and wildlife habitat. It is in the "Rolling Loam" range site. The average annual air-dry vegetative production is about 800 pounds per acre. It is suited to range seeding with the main limitation being low precipitation in summer.

Map Unit 72 - Chipeta silty clay loam, 3-25% slopes

- Route A = In corridor - not crossed
- Route A with deviation = In corridor - not crossed
- Route B = In corridor - not crossed

This Chipeta soil is shallow and was formed in residuum derived primarily from calcareous, gypsiferous shale. It is present on gently sloping to steep, low rolling hills and toeslopes of ridges. The surface layer is a silty clay loam about 3 in thick and the underlying material is a silty clay which has fine shale chips, seams of crystalline gypsum and few fine threads of calcium carbonate at depth. Depth to shale ranges from 10 to 20 in. The pedon is calcareous and moderately alkaline throughout. Content of salts varies in amount and distribution. Permeability is slow and the available water capacity is low. Runoff is rapid and erosion hazard is high.

The unit is used primarily for livestock grazing and wildlife habitat. It is in the "Clayey Saltdesert" range site. The average annual air-dry vegetative production is about 350 pounds per acre. The suitability of this unit to range seeding is poor due to shallow depth to shale, low precipitation, and slow permeability.

Map Unit 73 - Yamac loam, 2-15% slopes

- Route A = In corridor - not crossed
- Route A with deviation = In corridor - not crossed
- Route B = In corridor - not crossed

This deep soil is located on rolling uplands, terraces, and fans and was formed in eolian and alluvium materials. The typical surface layer is a loam about 4 in thick. The underlying material is a loam to 60 in. The pedon is calcareous and moderately to strongly alkaline. Alkalinity is highest with depth. Lime is present in lower horizons. Most pedons have 0 to 15 percent fine channery rock fragments throughout. Erosion hazard is slight to moderate. The unit is used primarily for

livestock grazing and wildlife habitat though a few areas are used for non-irrigated small grain. It is classsified in the "Rolling Loam" range site. The average annual air-dry vegetative production is about 800 pounds per acre. The unit is suited to range seeding with the major limitations being low summer precipitation and erosion hazard on steep slopes.

Map Unit 138 - Billings-Torrifluvents complex, gullied, 0-5% slopes

- Route A = 0.4 mi.
- Route A with deviation = 0.5 mi.
- Route B = 0.5 mi.

This unit is located on floodplains, low terraces, and narrow valley floors. The deep Billings soil was formed in alluvium derived from calcareous and gypsiferous shale. The typical surface layer is a silty loam about 2 in thick. The underlying material is silty clay loam to 60 in. The pedon is calcareous and ranges from mildly to strongly alkaline. It is non-saline or slightly saline and contains 1 to 5 percent gypsum crystals. Permeability is slow, runoff is rapid and the erosion hazard is high.

The Torrifluvent part is shallow to deep and has no set soil diagnostic characteristics. It is mainly located on remnants containing gullies and headcuts.

The unit is used primarily for very limited livestock grazing and wildlife habitat. It is classified in the "Alkaline Slopes" range site.

Map Unit 150 - Kinnear, fine sandy loam, 1-5% slopes

- Route A = 0.6 mi.
- Route A with deviation = 1.1 mi.
- Route B = 1.1 mi.

This is a deep soil located on fans and upland terraces and was formed in calcareous alluvium and eolian material. The surface layer is a fine sandy loam about 5 in thick. The underlying material to a depth of 60 in, ranges from loam to light loam. The pedon is calcareous and mildly or moderately alkaline. The C/Ca horizon has soft masses and concretions of calcium carbonate. The profile is 0 to 10 percent gravel-sized rock fragments. The erosion hazard is slight but the soil is susceptable to blowing if the surface is not protected. The soil is

used primarily for livestock grazing and wildlife habitat. It is in the "Saltdesert" range site. The average annual air-dry vegetative production is about 650 pounds per acre. The unit is suitable to range seeding and is a good source of topsoil.

Map Unit X5 - Northwater loam, 5-50% slopes

- Route A = 0.6 mi.
- Route A with deviation = 0.6 mi.
- Route B = 0.4

This is a deep soil located on mountainsides. It was formed in residuum and colluvium derived primarily from sedimentary rock. Typically, the surface layer is a loam about 4 in thick. The underlying material ranges from loam to very channery sandy loam. Fractured sandstone bedrock ranges from 40 to 60 in. The pedon is noncalcareous and neutral. Channery rock fragments range from 5 to 85 percent with amounts increasing with depth. Flagstones exist in lower horizons. Erosion hazard is moderate to very high. The unit is used primarily for livestock grazing and wildlife habitat. It is classified in the "Aspen" woodland site. The average annual air-dry vegetative production is about 2,000 pounds per acre.

Map Unit X6 - Irigul channery loam, 5-50% slopes

- Route A = 0 mi.
- Route A with deviation = 0.2 mi.
- Route B = 3.4 mi.

This shallow Irigul soil was formed in residuum derived primarily from sandstone and hard shale. It is located on upland ridges and mountainsides. The typical surface layer is a channery loam 5 in thick. The underlying material is an extremely channery loam. Hard flaggy sandstone or hard shale bedrock is at a depth of 10 to 20 in. The pedon is noncalcareous and mildly alkaline. The content of channery rock fragments equals or exceeds 30 percent throughout the profile. Available water capacity is very low, runoff is medium to rapid, and the erosion hazard is very high. This unit is used for limited livestock grazing and wildlife habitat. The average annual air-dry vegetative production is approximately 900 pounds per acre. It is in the "Loamy Slopes" range site. The main limitations for seeding are shallow soil depth and short growing season.

Map Unit X7 - Silas loam, 0-8% slopes

- Route A = 1.7 mi.
- Route A with deviation = 1.7 mi.
- Route B = 2.4 mi.

This deep soil is located on narrow mountain valley bottoms and was formed in mixed alluvium. The typical surface layer is a loam about 4 in thick. The subsurface material ranges from light loam to light sandy clay loam to a depth of 60 in. The profile is neutral and contains 5 to 15 percent fine channery rock fragments. Erosion hazard is slight to moderate. The unit is used primarily for livestock grazing, irrigated hazard pasture, and wildlife habitat. It is classified in the "Mountain Swale" range site. The average annual air-dry vegetative production is about 2,500 pounds per acre. The unit is suitable for range seeding. The main limitation is a short growing season.

Map Unit X26 - Razorba channery sandy loam, 30-75% slopes

- Route A = 0.9 mi.
- Route A with deviation = 0.9 mi.
- Route B = 0 mi.

This is a deep soil located on mountainsides which was formed in residuum and colluvium derived from sedimentary rock. The surface layer is typically a calcareous channery sandy loam about 9 in thick. The underlying material, to a depth of 60 in, is strongly calcareous channery sandy loam. The pedon is calcareous to strongly calcareous and moderately alkaline throughout. The average coarse fragment content is from 15 to 25 percent (mostly channery rock fragments). The water erosion hazard is very high and the available water capacity is low. The unit is used primarily for livestock grazing and wildlife habitat. It is classified in the "Spruce-Fir" woodland site. The average annual air-dry vegetative production is about 350 pounds per acre.

Map Unit X33 - Uffins loam, 0-5% slopes

- Route A = 0.1 mi.
- Route A with deviation = 1.1 mi.
- Route B = 0.1 mi.

This deep soil is present on fans, low terraces, and narrow valley bottoms. It was formed in calcareous, alkaline alluvium. The surface

layer is a loam about 2 in thick. The underlying material ranges from loam to light clay loam to 60 in. The pedon is strongly calcareous and strongly to moderately alkaline. Fine filaments or seams of calcium carbonate are common in root channels and in cracks of peds in a small portion of the lower profile. Permeability is moderately slow, runoff is slow, and the erosion hazard is moderate. The unit is used primarily for livestock grazing and wildlife habitat. It can be used for hazard pasture if irrigated. It is classified in the "Alkaline Slopes" range site. The average annual air-dry vegetative production is about 500 pounds per acre. The main limitations for seeding are salinity, alkalinity, and low precipitation. Salt-tolerant pasture grasses can be grown with irrigation.

Map Unit X38 - Billings silty clay loam, 0-5% slopes

- Route A = 0 mi.
- Route A with deviation = 0.1 mi.
- Route B = 0.6 mi.

This is a deep soil located on floodplains, narrow valley floors, and terraces. It was formed in calcareous alluvium derived primarily from shale. The surface layer is a silty clay loam as in the underlying material to a depth of 60 in. The pedon is calcareous and moderately alkaline to strongly alkaline in the lower half of the profile. It is non-saline to slightly saline. A few very fine filaments and seams of gypsum are in the upper part of the profile. Permeability is slow, runoff is rapid, and the erosion hazard is moderate to high. The unit is used primarily for livestock grazing and irrigated cropland. It is suited to range seeding with the main limitation being low precipitation. Alkalinity and slight salinity conditions should also be considered. The unit is classified in the "Alkaline Slopes" range site. The average annual air-dry vegetative production ranges approximately 650 pounds per acre.

Map Unit X39 - Nihill channery sandy loam, 5-50% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 0.7 mi.

This Nihill soil is deep and was formed in colluvium derived dominantly from calcareous sedimentary rock. It is present on narrow valley sides, toe slopes, terrace edges, and upland benches. The

typical surface layer is a channery sandy loam 5 in thick. The underlying material is very channery sandy loam to very channery loam to 60 in. The pedon is calcareous and moderately to strongly alkaline. Soft masses of lime or well disseminated lime bodies are in some lower horizons. The surface is covered with 5 to 10 percent flagstones and 35 percent channery rock fragments. The profile is 35 to 45 percent channery rock fragments and up to 10 to 15 percent flagstones. Permeability is moderately rapid and available water capacity is low. Drainage is somewhat excessive and the erosion hazard is moderate to very high. The unit is classified in the "Saltdesert Breaks" range site. The unit is used primarily for livestock grazing and wildlife habitat. The average annual air-dry vegetative production is about 350 pounds per acre. Reseeding is a suitable practice as slopes are less than 15 percent. The main limitations to seeding are slope, coarse fragments on the surface and low precipitation.

Map Unit X48 Blakabin-Rhone-Waybe complex, 5-50% slopes

- Route A = 0.3 mi.
- Route A with deviation = 0.3 mi.
- Route B = 0 mi.

This unit is on mountainsides and ridges. The Blakabin soil is deep and was formed in colluvium derived mainly from sandstone and shale. The typical surface layer is clay loam 3 in thick with the underlying material ranging from clay loam to clay to a depth of 60 in. The profile is weakly to strongly effervescent increasing with depth and moderately to strongly alkaline. Visible secondary calcium carbonate is present in lower horizons. From 0 to 15 percent sandstone and shale channery rock fragments are throughout the profile. Permeability is slow and the erosion hazard is high.

The Rhone soil is deep and was formed in colluvium derived dominantly from sandstone and shale. The surface layer is a loam about 24 in thick. The underlying material is a very channery loam to 50 inches. Fractured sandstone ranges from 40 to 60 in. The lower horizons may contain 35 to 65 percent rock fragments. The profile is neutral to mildly alkaline. Erosion hazard is slight to very high.

The Waybe soil is shallow and was formed in residuum derived primarily from interbedded shale and sandstone. The surface layer is a

clay loam about 4 in thick. The underlying material to 10 to 20 in is channery silty clay loam. Bedrock is weathered shale and sandstone. The pedon is weakly to violently effervescent and mildly to moderately alkaline increasing in strength with depth. There are 15 to 35 percent sandstone and/or shale channery fragments below the surface layer. Permeability is slow and available water capacity is moderate to low. Runoff is rapid and erosion hazard is moderate to very high.

The unit is used primarily for livestock grazing and wildlife habitat. The average annual air-dry vegetative production is about 2,000 pounds per acre. It is 75 percent "Brushy Loam" range site and 25 percent "Dry Exposure" range site. The main limitations for seeding are difficulty of brush removal and slope.

Map Unit X58-Starman-Vandamore complex, 5-40% slopes

- Route A = 0 mi.
- Route A with deviation = 0 mi.
- Route B = 13.0 mi.

This unit is located on windswept ridge crests. The shallow Starman part was formed in residuum from calcareous sandstone or marlstone. The upper layer is a channery loam about 2 in thick. The underlying layers are extremely channery loam to bedrock at about 10 to 20 in. The pedon is calcareous to strongly calcareous and moderately to strongly alkaline throughout. Coarse fragment content ranges from 30 to 75 percent throughout the profile. Flagstones occur at the lower depths. Available water capacity is low.

The Vandamore part is moderately deep and was formed in residuum from calcareous sandstone or marlstone. The surface layer is channery and extremely channery loam about 8 in thick. The underlying layer is a channery loam about 17 in thick overlying hard, fractured, fine-grained sandstone. The pedon is calcareous and moderately alkaline throughout. The coarse fragment content (primarily channery size) ranges from 25 to 80 percent increasing with depth. Lime occurs in thin seams and on rock fragments in the lower profile. The available water capacity is very low.

The unit is used for limited grazing and wildlife habitat. It is not suited to seeding due to soil depth, high winds, and wind erosion. It is classed in the "Dry Exposure" range site.

Map Unit X64-Blazon, moist-Rentsac complex, 8-65% slopes

- Route A = 0.5 mi.
- Route A with deviation = 0.5 mi.
- Route B = 0 mi.

This unit is located on the sides of foothills and ridges. The Blazon part is shallow and was formed in residuum derived primarily from shale. The surface layer is a channery loam about 4 in thick. The underlying material ranges from channery clay loam to very shaly, clay loam. Depth to weathered shale ranges from 10 to 20 in. The profile is calcareous and moderately alkaline. Coarse fragments make up to 15 to 25 percent of the A horizon and 35 to 50 percent of the underlying material. Permeability is moderately slow and available water capacity is low. Runoff is rapid and the erosion hazard is moderate to very high.

The shallow Rentsac soil was formed in residuum derived primarily from sandstone. The surface layer is a channery loam 5 in thick. The underlying material ranges from channery light loam to extremely flaggy light loam. Depth to hard sandstone ranges from 10 to 20 in. The pedon is slightly to strongly calcareous and moderately alkaline. The A horizon is 20 to 35 percent small rock fragments. Percentages and size of fragments increase with depth. Permeability is moderately rapid and available water capacity is low. Runoff is rapid and the erosion hazard is moderate to very high.

The unit is used primarily for livestock grazing and wildlife habitat. The average potential production of native understory vegetation (air-dry) is about 550 pounds per acre. This unit is classified in the "Pinyon-Juniper" woodland site.

Map Unit X66-Rentsac-Moyerson-Rock Outcrop complex, 5-65% slopes

- Route A = 7.1 mi.
- Route A with deviation = 6.4 mi.
- Route B = 5.1 mi.

This unit is located on foothills, ridges, and entrenched sides of uplands. The shallow Rentsac soil was formed in residuum derived predominantly from sandstone or hard shale. The surface layer is a channery loam 5 in thick. The underlying material, to a depth of 16 in,

ranges from very channery light loam to extremely flaggy light loam. Depth to bedrock ranges from 10 to 20 in. The pedon is slightly to strongly calcareous and moderately alkaline. The A horizon is 20 to 35 percent small rock fragments. Percentages and size of fragments increase with depth. Permeability is moderately rapid and the available water capacity is very low. The erosion hazard is moderate to very high.

The Moyerson part is shallow and was formed in residuum derived dominantly from shale and interbedded sandstone. The surface layer is a stoney clay loam about 2 in thick. The underlying material ranges from clay loam to clay. Depth to shale ranges from 10 to 20 in. The pedon is moderately to strongly alkaline and calcareous throughout. Permeability is slow and available water capacity is low. Runoff is medium to rapid and the erosion hazard is very high.

The Rock Outcrop portion consists of ridge caps, ridge points, and long vertical bluffs. Small amounts of soil material may be located in crevices and at the base of slopes.

The unit is used primarily for livestock grazing woodland, and wildlife habitat. The potential native understory vegetative production (air-dry) is about 600 pounds per acre. Range seeding is not advisable due to surface stones, slope, low precipitation, and shallow rooting depth. The Rentsac soil is in the "Pinyon-Juniper" woodland site and the Moyerson soil is in the "Clayey Slopes" range site.

Map Unit X89-Cliffdown-Cliffdown varient complex, 5-65% slopes

- Route A = 0.1 mi.
- Route A with deviation = 0.2 mi.
- Route B = 0.2 mi.

This map unit is located on sides of terraces. The Cliffdown soil is deep and was formed in calcareous coarse-textured gravelly and cobbly outwash and river deposits derived primarily from mixed sources. The typical surface layer is 5 in of gravelly loam. The underlying material to a depth of 60 in is mainly calcareous very gravelly sandy loam. The pedon is calcareous and moderately to strongly alkaline. Lime coatings are present on undersides of subsurface rock fragments. The profile contains salts in variable amounts and distribution. Coarse fragment

content ranges from 20 to 70 percent, increasing with depth. Permeability is moderately rapid and available water capacity is very low. Drainage is somewhat excessive, and the erosion hazard is slight to moderate.

The Cliffdown varient part is moderately deep and was formed in calcareous gravelly cobbly outwash derived primarily from mixed sources. The surface layer is a very cobbly loam about 5 in thick. The subsurface material to a depth of 24 in ranges from very gravelly loam to gravelly clay loam. Depth to weathered shale is from 20 to 40 in. The pedon can range from calcareous-moderately alkaline to calcareous-strongly alkaline. There is a moderate to high percentage of coarse fragments in the soil. Permeability is moderate to very slow and available water capacity is very low. Drainage is somewhat excessive and runoff is rapid. The erosion hazard is moderate to high.

The unit is used primarily for livestock grazing and wildlife habitat. The average annual production of air-dry vegetation is about 350 pounds per acre. The unit is in the "Saltdesert Breaks" range site.

Map Unit BL-Badlands, (10-65% Slopes)

- Route A = 0.1 mi.
- Route A with deviation = 0.5 mi.
- Toute B = 0.7 mi.

This map unit is located on rolling to very steep, nearly barren mountainsides, low hills, ridgetops, and canyonsides. It was formed in residuum derived primarily from highly calcareous and gypsiferous shale and bentonite deposits. Soils present are very shallow and have no significant characteristics. Permeability is very slow and available water capacity is very low. Runoff is very rapid and the erosion hazard is very high. Use of the unit is very limited.

Map Unit RT-Torriorthents-Rock Outcrop complex, 15-90% Slopes

- Route A = 2.3 mi.
- Route A with deviation = 2.4 mi.
- Route B = 2.9 mi.

This unit is present on steep, primarily south-facing slopes of mountains, hills, ridges, and canyonsides in extremely rough and eroded areas. The very shallow to moderately deep torriorthents soil was formed

in residuum and colluvium derived mainly from sandstone, shale, limestone, or siltstone. In a representative profile, the surface layer is a channery loam about 3 in thick. The underlying material ranges from fine sandy loam to very channery loam. Shale or sandstone bedrock is at 16 in. Available water capacity is very low, runoff is rapid, and the water erosion hazard is very high.

The rock outcrop part consists of barren escarpments, ridge caps and rock points of sandstone, shale, limestone, or siltstone.

The unit is used primarily for wildlife habitat and limited livestock grazing. The average annual air-dry vegetative production is about 100 pounds per acre. The unit is classified in the "Stony Foothills" range site.

Map Unit RG - Torrifluvents, gullied (0-5% slopes)

- Route A= 1.7 mi.
- Route A with deviation = 1.7 mi.
- Route B = 0.1 mi.

The Torrifluvents soils is moderately deep to deep and was formed in highly calcareous and gypsiferous, mixed, stratified sandy, loamy, and clayey alluvium derived predominantly from sandstone and shale. The unit is located on nearly level to sloping areas along drainageways of narrow valley bottoms, swales, and eroded fans. Permeability of the Torrifluvents soil is moderately rapid to slow and drainage is somewhat excessive. Runoff is rapid and the erosion hazard is very high. This nearly barren unit has very little value for livestock grazing or wildlife habitat.

Map Unit RO - Rock Outcrop (50-100% slopes)

- Route A = 0 mi.
- Route A with deviation = 0.3 mi.
- Route B = 0.4 mi.

This unit is located on very steep and extremely steep mountains, canyons, ridges, hills, and upland breaks. It is composed of barren exposures of sandstone, hard shale, siltstone, or limestone. The unit is 90 percent or more exposed bedrock. Some soil material is present in crevices and at the base of slopes are accumulations of boulders and stones. Use of the unit is limited, though some wildlife use these areas for shelter and cover.

Range Site 228 - Mountain Loam

This site is located mainly on alluvial - colluvial slopes, terraces, fans or valley positions. Slopes range from 5 to 10 percent, but can reach 30 to 40 percent. Grass accounts for most of the vegetative cover. The soils are fairly deep, have good water holding capacity, are moderately fine to moderately coarse-textured. Many soils are somewhat gravelly to stoney. A large percent of the soil moisture is available for plant growth. The site has a high value for livestock grazing and big game habitat. The average annual production of air-dry vegetation in median years is 1,500 pounds per acre. Soils of this site are:

Blevington sandy loam
Buffmeysi sandy loam
Carpening fine sandy loam
Costner fine sandy loam
Duffoon loam
Gelkre sandy loam
Keyor gravelly sandy loam
Leavitt loam
Lucky gravelly sandy loam
Marop stony loam
Mirack fine sandy loam
Marghouse stony loam
Owen Creek sandy loam
Parlin channery loam
Splitro loam

Range Site 238 - Brushy loam

This site is located on gently rolling to steep upland slopes. Slopes for this site range from 3 to 65 percent. The potential native vegetative community is shrub dominated. The soils are sandy loam to light clay loam acid surface soil to 20 in thick. The subsoil is clay loam to light clay from 1 to 4 ft thick. It is moderately permeable and the lime zone is deep. Stones and cobbles may occur throughout the profile. The soil is very favorable for plant growth. This site has medium to high values for livestock grazing and wildlife habitat. The average annual production of air-dry vegetation in median years is 1,000 pounds per acre. Soils in this site are Rico loan and Routt loam.

SOIL MAPPING UNIT DESCRIPTIONS FOR
LA SAL ALTERNATIVES

- 03C - Rivra - Rivra Variant - Bitton association, 0 to 15 percent slopes.

  These are deep, level to moderately sloping soils forming in gravelly alluvium in drainages and on fans in the Clear Creek valley. They are highly permeable and typically contain 35 to 80 percent rock fragments. Rivra and Rivra Variant soils occur adjacent to Clear Creek, and are formed in alluvium. Bitton soils occur on alluvial fans, and are formed from local alluvium from slopewash and colluvium. These soils receive about 14 in of precipitation annually. The growing season is about 90 days in length.

- 05C - Glendive - Havre - Nihill Variant association, 2 to 8 percent slopes.

  These are deep, well drained, nearly level to moderately sloping soils that occur along Piceance Creek and associate side drainages. Glendive soils are coarse-textured (sandy) and rapidly permeable. They formed in streamlain alluvium along the drainageway. Havre soils occur adjacent to Glendive soils. They are also formed from streamlain alluvium, but are loamy and moderately permeable. Nihill Variant soils occur in alluvial fan positions below sideslopes, and contain about 60 percent sandstone rock fragments. These soils receive about 14 in of precipitation annually and have a growing season of 90 to 100 days.

- 12F - Lolo - Grobutte association, 40 to 75 percent slopes.

  These are deep, well drained, steeply sloping soils formed on talus sideslopes along Clear Creek. They typically contain about 80 percent rock fragments and are rapidly permeable. Slope stability is a potential hazard with this unit because of its steepness and lack of cohesion inherent to the soils. This mapping unit receives 14 to 16 in of precipitation annually. The growing season is about 95 days.

- 15 - Starman - Rock Outcrop - Irigul complex, 20 to 80 percent slopes.

  This unit consists of shallow, excessively drained soils with rock outcrop on steep and very steep slopes. Both Starman and Irigul soils contain about 60 percent rock fragments and are less than 20 in deep over bedrock. This unit occurs about elevations of about 7,400 ft. These soils receive 18 to 20 in of precipitation annually, with a growing season of about 80 days.

- 40 - Parachute - Dateman Complex, 5 to 15 percent slopes.

  These are moderately deep, gently sloping to moderately steep soils that form on flat ridgetops above about 8,000 ft. Parachute and Dateman soils are 20 to 40 in deep over bedrock and contain about 50 percent rock fragments below a depth of about 10 in. Both soils have thick, organic-enriched, loamy surface layers. The mean annual precipitation is 18 to 20 in and the growing season is about 80 days.

- 43 - Parachute - Dateman - Irigul complex, 15 to 50 percent slopes.

  These are shallow and moderately deep soils that occur on steep sideslopes above an elevation of about 7,500 ft. Parachute and Dateman soils are 20 to 40 in deep over bedrock. Irigul soils are typically 10 to 15 in deep to bedrock. All three soils contain 50 to 75 percent rock fragments. The mean annual precipitation is 18 to 20 in and the growing season is about 80 days.

- 55 - Rhone - Northwater - Silas Variant association, 3 to 60 percent slopes.

  These are deep, loamy, organic-enriched soils that formed in swales and on north- and east-facing slopes at elevtations of about 7,600 ft. Rhone soils are 50 to 60 in deep over bedrock and are loamy throughout. They occur on steep slopes under both aspen and mountain brush vegetation. Northwater soils also occur on steep slopes under aspen. These soils are loamy to a depth of about 24 in. Below this depth, Northwater soils contain about 50 percent rock fragments; depth to bedrock is 50 to 60 in. Silas Variant soils occur in swales and are loamy throughout. In some areas, Silas Variant soils are influenced by a water table at depth of about 36 in. Silas Variant soils are over 60 in deep to bedrock. The mean annual precipitation is 18 to 20 in and the growing season is about 80 days.

- 60 - Veatch - Work complex, 5 to 15 percent slopes.

  These are moderately deep and deep soils that occur north of Piceance Creek. Veatch soils are 20 to 40 in deep over bedrock and are loamy throughout. Work soils are 40 to 60 in deep over bedrock and have clayey subsoils. The mean annual precipitation is about 14 in and the growing season is 90 to 100 days.

- 66 - Rentsac - Redcreek - Castner complex, 5 to 50 percent slopes.

  These are shallow, somewhat excessively drained soils that occur on ridges near Piceance Creek. All three soils are less than 20 in deep over bedrock, and contain about 50 percent

rock fragments. This unit occurs on both flat ridgetops and steep sideslopes at elevations below about 7,400 ft. They receive about 14 in of precipitation annually. The growing season is about 90 to 100 days.

- 70 - Camborthids - Haplargids complex, 5 to 15 percent slopes.

  These are moderately deep and deep soils that occur on flatter ridgetops near Piceance Creek. They are loamy to somewhat sandy in texture and range in depth from about 30 to 50 in over bedrock. These soils receive about 14 in of precipitation annually. The growing season is 90 to 100 days.

- RT - Rock Outcrop - Torriorthents complex, 25 to 75 percent slopes.

  This unit consists of steep rock outcrops and shallow rocky soils on ridge sideslopes below an elevation of about 7,400 ft.

APPENDIX B

CULTURAL RESOURCE SITES ALONG PIPELINE ROUTES A AND B TO RANGELY

TABLE 1

CULTURAL RESOURCE ALONG THE PIPELINE ROUTE A AND DEVIATION

Number	7.5' Quadrangle	Location	Type	Cultural Affiliation	Recorder	Recommendations	Land Status	Nature of Impact
5RB1607	Black Cabin Gulch	T3s, R100w Sec. 36, 25	Rock Art, Open Camp	Fremont	WCRM	Eligible to the NRHP	Private	Direct
5RB1608	Black Cabin Gulch	T3s, R100w Sec. 25	Open Camp	Unknown	WCRM	Likely to be Eligible to the NRHP	Private	Indirect
5RB265	Black Cabin Gulch	T3s, R100w Sec. 24	Rock Art				BLM	Indirect
5RB829	Black Cabin Gulch	T3s, R100w Sec. 15	Rock Art				BLM	Indirect
5RB245	Black Cabin Gulch	T3s, R100w Sec. 15	Rock Art	Fremont		Eligible to the NRHP	BLM	Indirect
5RB827	Black Cabin Gulch	T3s, R100w Sec. 16					BLM	Indirect
5RB250	Black Cabin Gulch	T3s, R100w Sec. 16	Rock Art	Fremont		Eligible to the NRHP	BLM	Indirect
5RB851	White Coyote Draw	T3s, R100w Sec. 16, 17	Rock Art				BLM	Direct
5RB901	White Coyote Draw	T3s, R100w Sec. 16, 17	Rock Shelter		G & K	Likely to be Eligible to the NRHP	BLM	Indirect
5RB228	White Coyote Draw	T3s, R100w Sec. 8					BLM	Indirect

TABLE 1 (contd)

Number	7.5' Quadrangle	Location	Type	Cultural Affiliation	Recorder	Recommendations	Land Status	Nature of Impact
5RB900	White Coyote Draw	T3s, R100 Sec. 8	Rock Shelter		G & K	Likely to be Eligible	BLM	Direct
5RB251	White Coyote Draw	T3s, R100w Sec. 8	Rock Art		G & K	Likely to be Eligible	BLM	Direct
5RB341	White Coyote Draw	T2s, R101w Sec. 36	Petroglyph		LOPA	Not Eligible	BLM	Indirect
5RB1598	White Coyote Draw	T2s, R101w Sec. 35	Open Prehistoric Camp		LOPA	Not Eligible	BLM	Indirect
5RB340	White Coyote Draw	T2s, R101w Sec. 26	Petroglyph		LOPA	Likely to be Eligible	Private	Direct
5RB337	White Coyote Draw	T2s, R101w Sec. 26	Petroglyph		LOPA	Eligible	BLM	Direct
5RB335	White Coyote Draw	T2s, R101w Sec. 22	Pictograph		LOPA	Likely to be Eligible	BLM	Direct
5RB336	White Coyote Draw	T2s, R101w Sec. 22	Pictograph		LOPA	Likely to be Eligible	BLM	Direct
5RB333	White Coyote Draw	T2s, R101w Sec. 22	Pictograph		LOPA	Likely to be Eligible	BLM	Indirect
5RB334	White Coyote Draw	T2s, R101w Sec. 22	Petroglyph		LOPA	Likely to be Eligible	BLM	Indirect
5RB473	White Coyote Draw	T2s, R101w Sec. 22	Open Lithic		LOPA	CPHD	BLM	Direct
5RB446	White Coyote Draw	T2s, R101w Sec. 22	Petroglyph		LOPA	CPHD	BLM	Direct

TABLE 1 (contd)

Number	7.5' Quadrangle	Location	Type	Cultural Affiliation	Recorder	Recommendations	Land Status	Nature of Impact
5RB663	White Coyote Draw	T2s, R101w Sec. 22	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB332	White Coyote Draw	T2s, R101w Sec. 22	Pictograph		LOPA	CPHD	BLM	Direct
5RB665	White Coyote Draw	T2s, R101w Sec. 22	Open Prehistoric Camp/ Petrograph		LOPA	CPHD	BLM	Direct
5RB664	White Coyote Draw	T2s, R101w Sec. 15	Sheltered Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB468	White Coyote Draw	T2s, R101w Sec. 15	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB669	Philadelphia Creek	T2s, R101w Sec. 16	Petroglyph		LOPA	CPHD	BLM	Direct
5RB88	Philadelphia Creek	T2s, R101w Sec. 9	Petroglyph		LOPA	CPHD	BLM	Direct
5RB87	Philadelphia Creek	T2s, R101w Sec. 9	Petroglyph		LOPA	CPHD	BLM	Direct
5RB82	Philadelphia Creek	T2s, R101w Sec. 9	Sheltered Prehistoric Camp		LOPA	CPHD	BLM	Indirect
5RB92	Philadelphia Creek	T2s, R101w Sec. 9	Petrophyph		LOPA	CPHD	BLM	Indirect

TABLE 1 (contd)

Number	7.5' Quadrangle	Location	Type	Cultural Affiliation	Recorder	Recommendations	Status	Nature of Impact
5RB684	Water Canyon	T1s, R101w Sec. 29	Open Prehistoric Camp		LOPA	CPHD	BLM	Indirect
5RB685	Water Canyon	T1s, R101w Sec. 19	Open Prehistoric Camp		LOPA	CPHD	BLM	Indirect
5RB707	Water Canyon	T1s, R101w Sec. 20	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB690	Water Canyon	T1s, R101w Sec. 29	Open Lithic		LOPA	CPHD	BLM	Indirect
5RB709a	Water Canyon	T1s, R101w Sec. 18	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB689	Water Canyon	T1s, R101w Sec. 18	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB693	Water Canyon	T1s, R101w Sec. 18	Open Lithic		LOPA	CPHD	BLM	Direct
5RB695	Water Canyon	T1s, R101w Sec. 18	Open Prehistoric Camp		LOPA	CPHD	BLM	Indirect
5RB735	Water Canyon	T1s, R101w Sec. 7	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB733	Water Canyon	T1s, R101w Sec. 18	Open Prehistoric Camp		LOPA	CPHD	BLM	Indirect
5RB738	Water Canyon	T1s, R101w Sec. 6	Sheltered Prehistoric Camp		LOPA	CPHD	BLM	Direct

TABLE 1 (contd)

Number	7.5' Quadrangle	Location	Type	Cultural Affiliation	Recorder	Recommendations	Land Status	Nature of Impact
5RB740	Water Canyon	T1s, R101w Sec. 6	Petroglyph		LOPA	CPHD	BLM	Direct
5RB720	Water Canyon	T1s, R101w Sec. 6	Petroglyph		LOPA	CPHD	BLM	Direct
5RB741	Water Canyon	T1s, R102w Sec. 1	Sheltered Architectural		LOPA	CPHD	BLM	Direct
5RB743	Rangely	T1n, R101w Sec. 31	Sheltered Architectural		LOPA	CPHD	BLM	Direct
5RB747	Rangely	T1n, R101w Sec. 31	Petroglyph		LOPA	CPHD	BLM	Direct
5RB742	Rangely	T1n, R101w Sec. 36	Petroglyph		LOPA	CPHD	BLM	Indirect
5RB745	Rangely	T1n, R101w Sec. 31	Open Prehistoric Camp		LOPA	CPHD	BLM	Direct
5RB748	Rangely	T1n, R1012 Sec. 30	Open Architectural		LOPA	CPHD	BLM	Direct

KEY

BLM - Bureau of Land Management
CPHD - Canyon Pintado Historic District
G & K - Gordon and Kranzush, Inc.
NRHP - National Register of Historic Places
WCRM - Western Cultural Resource Management, Inc.

TABLE 2

CULTURAL RESOURCES ALONG THE PIPELINE ROUTE B

Number	7.5' Quadrangle	Location	Type	Recorder	Recommendations	Land Status	Nature of Impact
5RB148	Rangely	T1n, R101w Sec. 7	Sheltered Prehistoric Camp	LOPA	Likely to be Eligible	BLM	Indirect
5RB149	Rangely	T1n, R101w Sec. 7	Sheltered Prehistoric Camp	LOPA	Not Eligible	BLM	Indirect
5RB150	Rangely	T1n, R101w Sec. 7	Sheltered Prehistoric Camp	LOPA	Not Eligible	BLM	Indirect

APPENDIX C

SURFICIAL GEOLOGY AND GEOTECHNICAL CONSIDERATIONS

SURFICIAL GEOLOGY

C.1 General

The stratigraphic sequence along the corridor route ranges in age from Upper Cretaceous to Recent. The oldest rocks are exposed near the White River crossing at Rangely. The youngest geologic formation in the corridor area is the alluvial, colluvial, and talus deposits of Quaternary age primarily found along streams, slopes, and at the base of Cathedral Bluffs. From Rangely to the Clear Creek Creek property, both Routes A and B cross progressively younger sedimentary units, except where crossing recent deposits. Most geologic contacts in the study area are conformable except were noted. The geologic units encountered within the corridor areas are described in the following paragraphs and illustrated on Maps 1 and 2.

C.2 Mancos Shale, Main Body

The Mancos Shale, of late Cretaceous age, is the oldest rock within the study area. It consists of brownish to dark gray marine shale, interbedded with siltstone, very fine grained sandstone, and thin beds of bentonite. The total thickness is about 4,500 ft. The upper portion of the Mancos is exposed in various locations along the perimeter of White River Valley near Rangely.

C.3 Tongue of Castlegate Sandstone

The Castlegate Sandstone, also of Upper Cretaceous age, overlies the main body of the Mancos Shale. It consists of light gray, fine to medium grained sandstone that is fairly resistent to erosion and outcrops south of Rangely in the form of ledges. The dip of the Castelgate Sandstone ranges from 10 to 22 degrees to the south within the corridor area, and its thickness is about 35 to 50 ft.

C.4 Buck Tongue of Mancos Shale

The Buck Tongue of the Mancos Shale is of Upper Cretaceous age and overlies the Castlegate Sandstone. It consists of gray to brownish gray marine shale. This shale is easily erodible and its thickness is about 250 to 300 ft.

C.5 Mesaverde Group

In the Rangely area, where detailed geologic information is available (Cullins 1971), the Mesaverde Group has been divided into different geologic units on the east and west side of Douglas Creek. The stratigraphy of the Mesaverde Group east of Douglas Creek is divided, in ascending order, into the Sego Sandstone, the Iles Formation, and the Williams Fork Formation. West of Douglas Creek, informal units are mapped (Cullins 1971) as part of the Mesaverde Group. These units in ascending order include the Sego Sandstone, the Minor Coal Unit, the Main Coal Unit, and the Upper Unit. The general lithologic description of the Mesaverde Group is presented in the following paragraphs.

C.5.1 Sego Sandstone

The Sego Sandstone overlies the Buck Tongue of the Mancos Shale and is of Upper Cretaceous Age. It consists of very light gray, fine grained massive sandstone at the top, brownish gray sandy shale in the middle, and yellowish gray to grayish orange fine grained sandstone at the base. The beds dip approximately 14 to 16 degrees to the south in the corridor area. Like the Castlegate Sandstone, the outcrops of the Sego Sandstone form erosion resistant ridges. It is approximately 200 to 210 feet in thickness.

C.5.2 West of Douglas Creek

C.5.2.1 Minor Coal Unit. The Minor Coal Unit overlies the Sego Sandstone and consists of interbedded light brown and yellowish gray fine to very fine grained sandstone, gray to light brown gray shale, brown carbonaceous shale, and thin coal beds up to 2.5 ft thick. Thickness ranges from 690 to 720 ft.

C.5.2.2. Main Coal Unit. This unit overlies the Minor Coal Unit and is composed of interbedded grayish orange, very fine grained lenticular sandstone; gray shale; brown carbonaceous shale; and coal.

The maximum measured coal thickness is 15 ft, and the thickness of the entire unit is about 540 to 680 ft thick.

C.5.2.3 Upper Unit. This unit overlies the Main Coal Unit and contains interbedded brown to yellowish gray, massive, lenticular sandstones and yellowish gray shale. Total thickness of this unit is about 1,100 ft, but only the lower portion of this unit is exposed in the corridor area.

C.5.3 East of Douglas Creek

C.5.3.1 Iles Formation. The main body of the Iles Formation, which is equivalent to the lower two-thirds of the Minor Coal Unit west of Douglas Creek, overlies the Sego Sandstone. It is composed of interbedded light brown and yellowish gray, fine to very fine grained sandstone; gray shale; brown carbonaceous shale; and thin coal beds. The thickness is about 500 ft.

The Trout Creek Member overlies the main body of the Iles Formation and consists of a light to brownish gray, fine grained, massive porous sandstone. Its thickness is about 60 ft.

C.5.3.2 Williams Fork Formation. The Williams Fork Formation, which is equivalent to the Upper Unit, Main Coal Unit, and upper 250 ft of the Minor Coal Unit west of Douglas Creek, overlies the Iles Formation. It consists of interbedded grayish orange to yellowish gray fine grained lenticular sandstone, gray shale, brown carbonaceous shale, and coal beds up to 8 ft in thickness. Numerous occurrences of burned and baked strata, through the in situ burning of coal beds, are located in the Williams Fork Formation. The thickness of this formation is about 1,890 ft.

C.6 Ohio Creek Formation

The Ohio Creek Formation, which unconformably overlies the Mesaverde Group, is of Paleocene Age. It consists of a light gray, very fine grained sandstone; gray and green mudstone and shale; and lenses of conglomerate. Generally, it weathers to ledges and steep slopes. The thickness ranges from 80 to 300 ft.

C.7 Wasatch Formation

The Wasatch Formation, of late Paleocene and early Eocene Age, unconformably overlies the Ohio Creek Formation. It consists of gray and brown, very fine to medium grained sandstone; gray, greenish gray, and red mudstone and shale; isolated thin lenses of conglomerate; carbonaceous shale; and coal. The Wasatch Formation is generally nonresistant to erosion and its outcrop forms a lowland between cliffs or ridges of the overlying Green River Formation and the underlying Mesaverde Group. The thickness of the Wasatch varies greatly, but in the vicinity of the corridor area, it is about 200 to 350 ft.

C.8 Green River Formation

The Green River Formation, of Eocene Age, conformably overlies the Wasatch Formation. In the corridor area, the Green River Formation has been subdivided, in ascending order, into three basic members; the Douglas Creek Member, Garden Gulch Member, and Parachute Creek Member. These three members are described in more detail in the following paragraphs.

C.8.1 Douglas Creek Member

The Douglas Creek Member conformably overlies the Wasatch Formation, and at many places, the contact is transitional. These rocks are resistant to erosion and commonly form a series of benches. It consists of brown to buff, crossbedded and ripple-marked sandstone; algal and ostrocodal limestone; oolitic sandstone and limestone; and minor amounts of gray shale. The thickness of this member is about 450 to 500 ft.

C.8.2 Garden Gulch Member

The Garden Gulch Member conformably overlies the Douglas Creek Member. It consists of dark gray flaky and papery shale; gray and yellow brown siltstone and very fine grained sandstone; marlstone; and thin beds of gray oil shale. It is generally nonresistant to erosion, forms steep cliffs, and is subject to landsliding. The thickness of this unit is about 650 ft.

C.8.3 Parachute Creek Member

The Parachute Creek Member conformably overlies the Garden Gulch Member and contains the riches and thickest oil shale beds in the Green River Formation. It consists of gray and tan platy to massive marlstone, dark gray to blue gray oil shale, and numerous thin gray and yellow brown tuff beds. It generally weathers to cliffs and steep slopes. The whitish cliffs along Cathedral Bluffs is the Parachute Creek Member. A particular kerogen-rich zone, the Mahogany Zone, occurs in the upper part of the Parachute Creek Member and forms a prominent resistent ledge in outcrop.

The thickness varies throughout the region, but in the vicinity of Cathedral Bluffs is about 1,000 ft.

C.9 Uinta Formation

The Uinta Formation, of late Eocene Age, conformably overlies the Green River Formation and is the surface rock over much of the corridor area near the Clear Creek site. In this area, the Uinta was formally known as the Evacuation Creek Member and the Green River Formation. However, on the basis of stratigraphic correlations, Cashion and Donnell (1975) revised the original nomenclature. The Uinta consists of brown and gray siltstone, very fine grained sandstone, and some barren light gray marlstone. Some beds of oil shale are present near the base in parts of the area. The Uinta outcrops at the top of the Cathedral Bluffs and forms buff to light brown rounded hills on the Roan Plateau. The lower part intertongues with the Parachute Creek Member, and has been mapped as such by Hail (1977) and Johnson (1977). On the geologic map, the contact is placed at the base of the lowermost tan siltstone or sandstone bed overlying the gray dolomitic oil shale and clay shale beds that compromise the upper part of the Parachute Creek Member. Only the lower 400 ft is exposed in the vicinity of the corridor area.

C.10 Alluvium and Colluvium

Alluvium and colluvium of Quarternary Age is present throughout the entire corridor area along streams and slopes. Alluvial fan and terrace deposits have also been identified in the Rangely area (Cullins 1971).

The fans are large, coalescent features formed along Douglas Creek when the river was at higher base level. Terrace deposits are identified south of the White River and along Douglas Creek. All of these deposits consist of silt, sand, and gravel. Alluvium in the flood plain of the White River is estimated to be about 90 feet thick.

C.11 Landslide and Talus Deposits

Landslide and talus deposits of Quaternary age occur along the corridor area primarily at the base of steep cliffs, notably the Cathedral Bluffs. It consists of a heterogeneous mixture of the shale, siltstone, and sandstone that form the Cathedral Bluffs. The thickness of this material varies throughout the corridor area.

APPENDIX D

BENTHIC MACROINVERTEBRATES COLLECTED FROM STREAMS POTENTIALLY AFFECTED BY PIPELINE ROUTES A AND B TO RANGELY

TABLE D-1

BENTHIC MACROINVERTEBRATES COLLECTED FROM STREAMS POTENTIALLY AFFECTED BY PIPELINE ROUTES A AND B

Taxa	Cathedral Creek		Douglas Creek	East Fork Douglas Creek		Soldier Creek		Upper Clear Creek (August)		Upper Clear Creek (October)	
	Number	% RA		Number	% RA	Number	% RA	Number	% RA	Number	% RA
Nematoda			No Macro-invertebrates					1	0.5		
Ostracoda								5	2.3		
Ephemeroptera											
Baetidae											
Baetis sp.				1	0.5	3	27.3	93	43.3	51	30.2
Ephemerellidae											
Ephemerella sp.	6	9.5		21	11.4	2	18.2				
Heptageniidae											
Heptagenia sp.	5	7.9						5	2.3		
Unknown Heptageniidae	2	3.2		8	4.3						
Leptophlebiidae											
Paraleptophlebia sp.										1	0.6
Tricorythidae											
Tricorythodes sp.	3	4.8		12	6.5						
Plecoptera											
Capniidae											
Near Utacapnia										8	4.7
Immature Capniidae	2	3.2		1	0.5	2	18.2				
Nemouridae											
Malenka sp.						2	18.2			2	1.2
Perlodidae											
Isoperla sp.				3	1.6					5	3.0
Immature Plecoptera								2	0.9		

TABLE D-1 (CONTINUED)

Taxa	Cathedral Creek		Douglas Creek	East Fork Douglas Creek		Soldier Creek		Upper Clear Creek (August)		Upper Clear Creek (October)	
	Number	% RA		Number	% RA	Number	% RA	Number	% RA	Number	% RA
Trichoptera											
Brachycentridae											
Brachycentrus sp.										2	1.2
Hydropsychidae											
Hydropsyche sp.	35	55.6		124	67.4	2	18.2			55	32.5
Hydroptilidae											
Hydroptila sp.				1	0.5					1	0.6
Lepidostomatidae											
Lepidostoma sp.										1	0.6
Limnephilidae											
Immature Limnephilidae								2	0.9		
Coleoptera											
Dytiscidae											
Oreodytes sp.								4	1.9		
Elmidae											
Microcylloepus sp.				3	1.6						
Optioservus sp.	2	3.2						7	3.3	15	8.9
Haliplidae											
Brychias sp								4	1.9		
Diptera											
Chironomidae											
Unidentified Chironomids	8	12.7		10	5.4			13	6.0	15	8.9
Muscidae											
Unknown Muscidae								1	0.5	2	1.2
Psychodidae											
Pericoma sp.								2	0.9	1	0.6
Simuliidae											
Prosimulium sp.								3	1.4		
Simulium sp.								18	8.4		

TABLE D-1 (CONTINUED)

Taxa	Cathedral Creek		Douglas Creek	East Fork Douglas Creek		Soldier Creek		Upper Clear Creek (August)		Upper Clear Creek (October)	
	Number	% RA		Number	% RA	Number	% RA	Number	% RA	Number	% RA
Diptera (continued)											
Stratiomyidae											
Euparyphus sp.								41	19.1	2	1.2
Tipulidae											
Limnophila sp.								13	6.0	8	4.7
Unknown Diptera Pupae								1	0.5		
Total Number of Organisms	63			184		11		215		169	
Number of Taxa	8			10		5		17		15	

R102 W

R101 W

R100 W

R99 W

T2N

TIN

TIS

T2S

Route A

Route A Deviation

Route B

Old Coal Mines

EPOCH STRATIGRAPHIC COLUMN OF CORRIDOR AREA PERIOD

Qls Qol Qc

R 102 W

R 101 W

R 100 W

R 99 W

T 2 S

T 3 S

T 4 S

Route A

Route B

STRATIGRAPHIC COLUMN OF CORRIDOR AREA

EPOCH		PERIOD
Pleistocene and Holocene	Qls Landslide and Talus Deposits; Qal Alluvium; Qc Colluvium; Qaf Alluvial Fan Deposits; Qt Terrace Deposits	Quaternary
	UNCONFORMITY	
Eocene	Tu UINTA FORMATION	Tertiary
	GREEN RIVER FORMATION	
	Tgp Parachute Creek Member	
	Tgg Garden Gulch Member	
	UNCONFORMITY	
	Tgd Douglas Creek Member	
	UNCONFORMITY	
Paleocene	Tw WASATCH FORMATION	
	Tac OHIO CREEK FORMATION	
	UNCONFORMITY	
Upper Cretaceous	Kmv MESAVERDE GROUP	Cretaceous
	West of Douglas Creek: Kmvu Upper Unit; Kmvc Main Coal Unit; Kmvm Minor Coal Unit	East of Douglas Creek: Kwf WILLIAMS FORK FORMATION; ILES FORMATION; Kit Trout Creek Sandstone Member; Ki Main Body
	Kmvs Sego Sandstone	
	Kmb Buck Tongue of Mancos Shale	
	Kmc Tongue of Castlegate Sandstone	
	Km Main Body of Mancos Shale	

GEOLOGIC MAP LEGEND

- Burned and Baked Strata
- 12 — Strike and Dip of Beds
- U 20 / D ? ---- Fault, dashed where approximate, inferred, or covered by younger deposits; queried where existence uncertain. Displacement in feet, shown on some faults. U, upthrown side; D, downthrown side.
- ——— Geologic contacts from USGS quad maps and inferred from air photos, aerial and ground reconnaissance

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO RANGELY

PROPOSED ROUTE ALTERNATIVES
GEOLOGIC MAP

DATE 1/21/82 — MAP 1

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY INC

Rangely

COLORADO

N

0 1/4 1/2 1 2
MILES

R 97 W

R 96 W

T 4 S

T 4 S

Qal

Tu

La Sal
Magnolia Camp

Route 1

Route 1A

Tgp

Route 1

Route 2

Route 2C

Route 2A

Route 2B

Chevron Clear Creek Pump Station

La Sal Parachute Pump Station

Parachute

T 5 S

R 97 W

KIMBALL MOUNTAIN

HORSE MOUNTAIN

ROAN CLIFFS

PARACHUTE CREEK MEMBER

NAVAL OIL SHALE RESERVE

COLORADO

Pipeline Study Area

Grand Junction

		Epoch	Period
Qal	Alluvium and Terrace Deposits	Pleistocene and Holocene	Quaternary
Qt	Talus and Landslide Deposits		
	Unconformity		
Tu	Uinta Formation	Eocene	Tertiary
	Green River Formation		
Tgp	Parachute Creek Member		
Tgd	Garden Gulch and Douglas Creek Member		

U ——— D Fault, dashed where approximate or inferred, dotted where covered by younger sediments; U, upthrown side; D, downthrown side

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

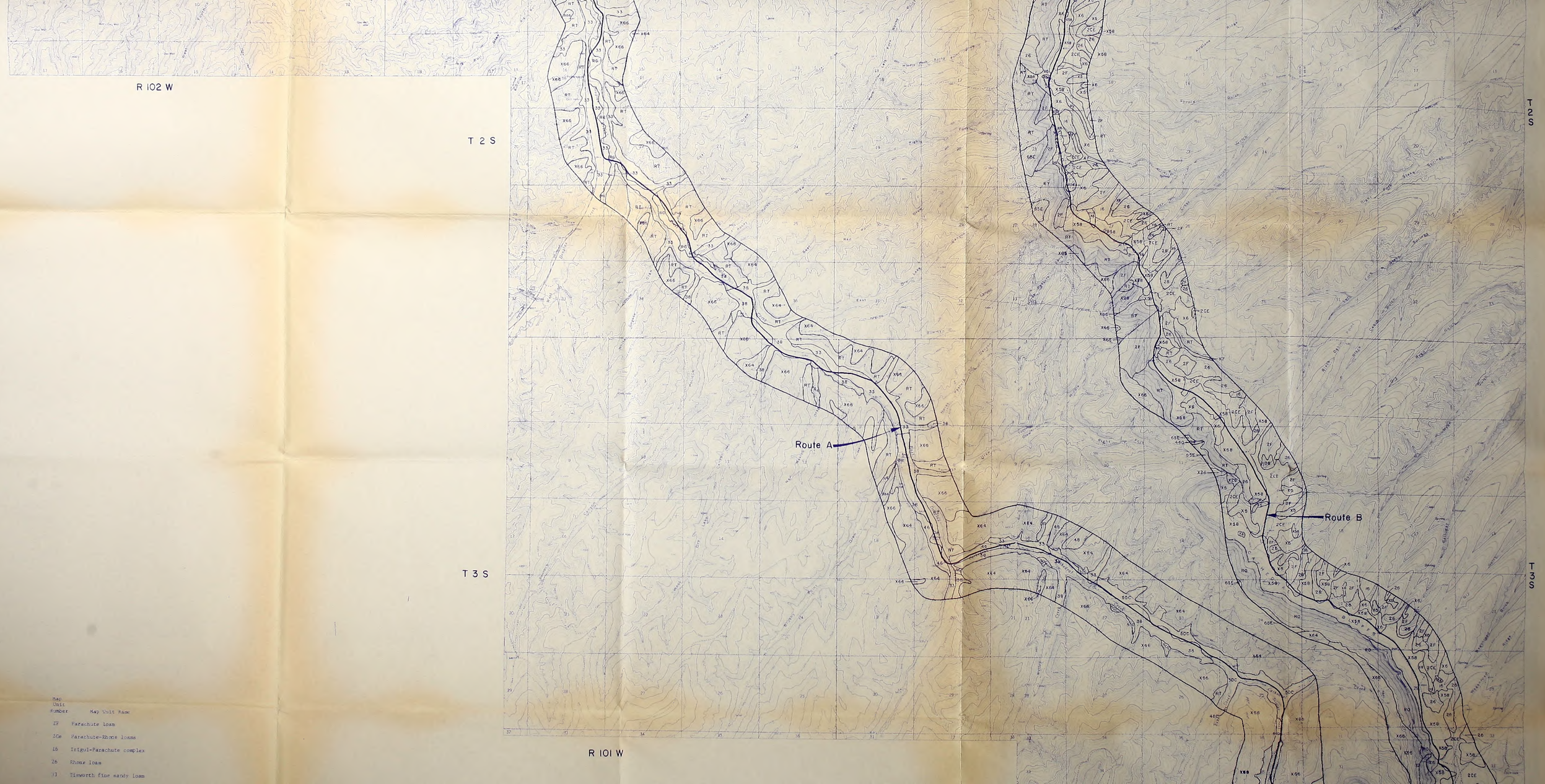
PROPOSED ROUTE ALTERNATIVES
GEOLOGIC MAP

DRAWN BY: ALN | SCALE 1:50000 | MAP 2
FIGURE NO. | DATE 1/81/82

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY INC.


R 102 W
R 101 W
R 100 W
T 2 N
T 1 N
Route A
Route A Deviation
Route B
R 100 W
R 99 W


R 102 W
R 100 W
R 99 W
T 1 S
T 1 S
T 2
Route A
Route B



Map Unit Number	Map Unit Name
2F	Parachute loam
2Ce	Parachute-Rhone loams
16	Irigul-Parachute complex
26	Rhone loam
33	Tisworth fine sandy loam

Map Unit Number	Map Unit Name
2F	Parachute loam
2Ge	Parachute-Rhone loams
16	Irigul-Parachute complex
26	Rhone loam
33	Tisworth fine sandy loam
38	Havre loam
38C	Havre loam
39	Turley fine sandy loam
39D	Turley fine sandy loam
41	Glendive fine sandy loam
46C	Kobar silty clay loam
46D	Kobar silty clay loam
47	Abor clay loam
48	Bulkley channery silty clay loam
50C	Patent loam
50D	Patent loam
63	Rentsac channery loam
65E	Moyerson stoney clay loam
X38	Billings silty clay loam
X39	Nihill channery sandy loam
X48	Blakabin-Rhone-Waybe complex
X58	Starman-Wandamore complex
X64	Blazon, moist-Rentsac complex
70	Piceance firm sandy loam
72	Chipeta silty clay loam
73	Yamac loam
138	Billings-Torrifluvents complex
150	Kinnear fine sandy loam
X5	Northwater loam
X6	Irigul channery loam
X7	Silas loam
X26	Kazorba channery sandy loam
X33	Uffens loam
X66	Rentsac-Moyerson-Rock Outcrop complex
X89	Cliffdown-Cliffdown variant complex
RL	Badlands
RT	Torriorthents-Rock Outcrop complex
R6	Torrifluvents, gullied
RO	Rock Outcrop
4	Golarow sandy loam

R 101 W

T 4 S

R 100 W

R 99 W

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO RANGELY

PROPOSED ROUTE ALTERNATIVES
SOILS MAP

DATE 1/31/82

MAP 3

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC

Rangely

COLORADO

N

0 1/4 1/2 1 MILES 2

R 97 W

R 96 W

La Sal
Magnolia Camp

Route 1

Route 1A

Route 1

Route 2

Route 1

T
4
S

T
4
S

Route 1

Route 2

Route 2C

Route 2

Chevron Clear Creek Pump Station

Route 2B

Route 2A

Route 2B

La Sal Parachute Pump Station

T 5 S

T 5 S

Parachute

Pipeline Study Area

Grand Junction

COLORADO

R 97 W

GUIDE TO MAPPING UNITS

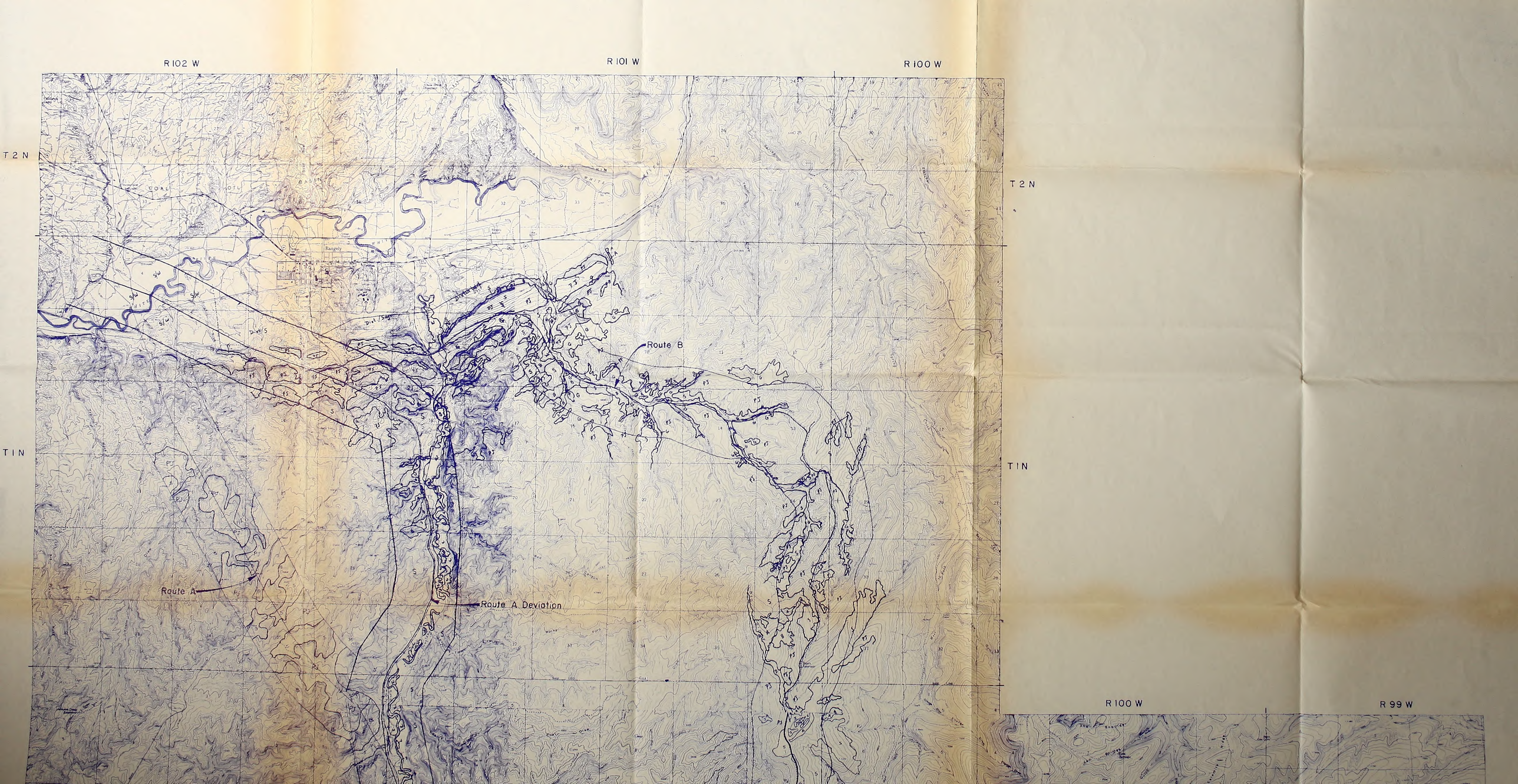
Symbol	Soils
03C	Rivra-Rivra Variant-Bitton association, 0 to 15 percent slopes.
05C	Glendive-Havre-Nihill Variant association, 2 to 8 percent slopes.
12F	Lolo-Grabutte association, 40 to 75 percent slopes.
15	Starman-Rock Outcrop-Irigul complex, 20 to 80 percent slopes.
40	Parachute-Dolemon complex, 5 to 15 percent slopes.
43	Parachute-Doleman-Irigul complex, 15 to 50 percent slopes.
55	Rhone-Northwater-Silas Variant association, 3 to 60 percent slopes.
60	Veatch-Work complex, 5 to 15 percent slopes.
66	Rentsac-Redcreek-Castner complex, 5 to 50 percent slopes.
70	Camborthids-Haplargids complex, 5 to 15 percent slopes.
RT	Rock Outcrop-Torriorthents complex, 25 to 75 percent slopes.

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

PROPOSED ROUTE ALTERNATIVES
SOILS MAP

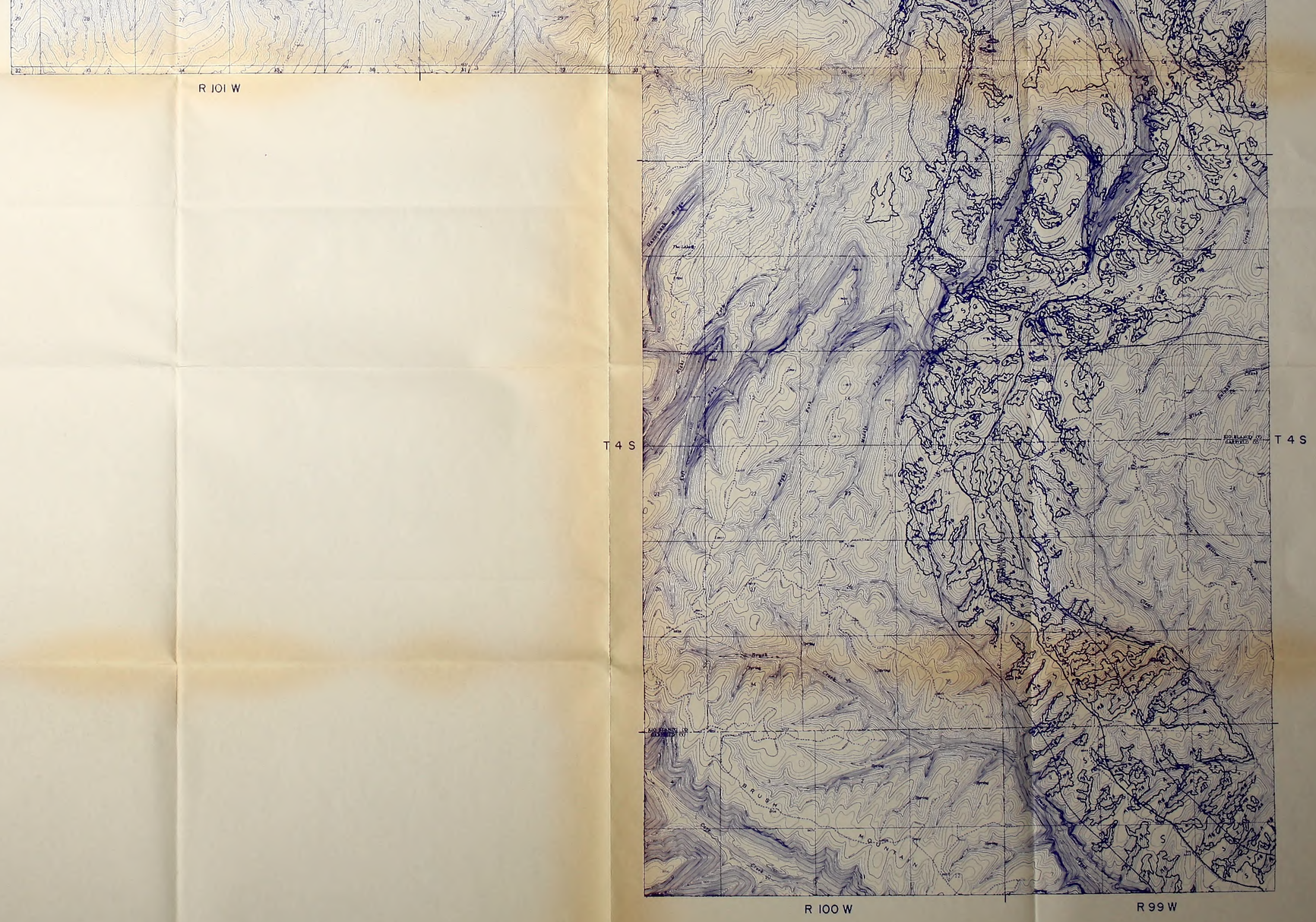
DRAWN BY: RLN | SCALE: 1:50000 | DATE: 1/8/82 | MAP 4

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.


R102 W
R101 W
R100 W
T2N
TIN
Route B
Route A
Route A Deviation
R100 W
R99 W


R 100 W
R 99 W
T 1 S
T 1 S
Route A
Route B
R 102 W
T 2 S
T 2 S


R 102 W
T 2 S
T 2 S
Route B
Route A
T 3 S
T 3 S
R 101 W



COVER TYPES

G	Grassland
S	Sagebrush
PJ	Pinyon-Juniper
As	Aspen
MB	Mixed Brush
W	Greasewood
A	Agriculture
C	Conifer
D	Riparian
B	Bare

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO RANGELY

PROPOSED ROUTE ALTERNATIVES
VEGETATION MAP

Date 1/25/82

MAP 5

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.

Rangely

COLORADO

N

MILES

R 97 W

R 96 W

T 4 S

T 4 S

La Sal
Magnolia Camp

Route 1

Route 1A

Route 1

Route 2

Route 1

Route 2C

Route 2

Route 1

Route 2

Route 2C

Route 2

Chevron Clear Creek Pump Station

Route 2B

Route 2A

Route 2B

La Sal Parachute Pump Station

T 5 S

T 5 S

Parachute

R 97 W

LEGEND

A Aspen

B Barren

C Conifer

G Grassland

S Saltbush

P/J Pinyon-Juniper

MB Mixed Shrub

S(T) Plateau Sagebrush

R(T) Plateau Riparian

S Valley Sagebrush

R Valley Riparian

Ag Agriculture

1MB Valley, Moist-Slope Mixed Shrub

2MB Valley, Dry-Slope Mixed Shrub

Pipeline Study Area

Grand Junction

COLORADO

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

PROPOSED ROUTE ALTERNATIVES
VEGETATION MAP

DRAWN BY: KLN

FIGURE NO.

SCALE 1:50000

DATE 1/22/82

MAP 6

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.

R 97 W

R 96 W

La Sal
Magnolia Camp

Route 1

Route 1A

Route 1

Route 2

Route 1

T 4 S

T 4 S

Route 1

Route 2

Route 2C

Route 2

Chevron Clear Creek Pump Station

Route 2A

Route 2B

Route 2B

La Sal Parachute Pump Station

T 5 S

T 5 S

Parachute

R 97 W

- Population of Barneby's columbine (Aquilegia barnebyi) and sullivantia (Sullivantia purpusii)
- Potential habitat for Barneby's columbine and sullivantia
- Population of fescue (Festuca dasyclada)
- Population of dragon milkvetch (Astragalus lutosus)
- Potential habitat for fescue and dragon milkvetch

Pipeline Study Area

Grand Junction

COLORADO

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

PROPOSED ROUTE ALTERNATIVES
Actual Populations and Potential Habitats for Candidate Threatened and Sensitive Plant Species

DRAWN BY: RLN | SCALE 1:50000 | DATE 1/13/82 | MAP 7

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY INC.

12 Miles Upstream
Colorado River Squawfish
(Ptychocheilus lucius)

R 102 W
R 101 W
R 100 W
R 99 W

T 2 N
T 1 N
T 1 S
T 2 S

Route A
Route A Deviation
Route B

R 102 W

R 101 W

R 100 W

R 99 W

T 2 S

T 3 S

T 4 S

Route A

Route B

Route A

ENVIRONMENTAL CONSTRAINTS OR AVOIDANCE AREAS

Visual Resources

- II Class II (Restrictive)
- III Class III
- IV Class IV

Cultural Resources

- Historic District
- Known Sites

Wildlife Resources

- Mule Deer Critical Winter Range
- CDOW Managed Lands
- Sage Grouse Strutting Grounds

Threatened and/or Endangered Species

- Bald Eagle Wintering Along White River
- 7 Rare or Unusual Plants
  - 7 Astragalus lutosus (dragon milk vetch)
  - 13 Aquilegia barnebyi (Barneby's columbine)
  - 14 Sullivantia purpusii (sullivantia)

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO RANGELY

PROPOSED ROUTE ALTERNATIVES
ENVIRONMENTAL CONSTRAINTS

DATE 1/21/82 | MAP 8

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY INC

Rangely

COLORADO

N

0 1/4 1/2 1 2
MILES

R 97 W

R 96 W

DEER

DEER

DEER

DEER

DEER

La Sal
Magnolia Camp

Route 1

Route 1A

Route 1

Route 2

Route 2C

Route 2

T
4
S

T
4
S

Route 1

Route 2

Route 2C

Route 2

Route 2A

Chevron Clear Creek Pump Station

Golden Eagle Perch Sites

La Sal Parachute Pump Station

Route 2B

Route 2B

ELK

ELK

Active Golden Eagle Nest

DEER

DEER

DEER

Parachute

T 5 S

T 5 S

R 97 W

LEGEND

Elk Critical Winter Range (CDOW)

Deer Critical Winter Range (CDOW)

Sage Grouse Strutting Ground

Wild Horse Watering Holes

Pipeline Study Area

Grand Junction

COLORADO

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

PROPOSED ROUTE ALTERNATIVES
WILDLIFE

DRAWN BY: RLN | SCALE 1:50000 | DATE 1/8/82 | MAP 9

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.

R 97 W

R 96 W

La Sal
Magnolia Camp

III

IV

II

III

Route 1

Route 1A

IV

Route 1

T
4
S

Route 1

Route 2

T
4
S

Route 1

Route 2

Route 2C

Route 2

Route 2A

Route 2B

Route 2B

Chevron Clear Creek Pump Station

La Sal Parachute Pump Station

II

IV

II

T 5 S

T 5 S

Parachute

R 97 W

LEGEND

II VRM CLASS II

III VRM CLASS III

IV VRM CLASS IV

Pipeline Study Area

Grand Junction

COLORADO

CHEVRON CLEAR CREEK PROJECT
SYNCRUDE PIPELINE ALTERNATIVES
CLEAR CREEK TO LA SAL

PROPOSED ROUTE ALTERNATIVES
VISUAL RESOURCE MANAGEMENT CLASSES

DRAWN BY: RLN | SCALE 1:50,000 | DATE 1/18/80 | MAP II

ERT ENVIRONMENTAL RESEARCH & TECHNOLOGY INC.

Form 1279–3
(June 1984)

BORROWER'S CARD

TD 195 .P4 E58 1982

Environmental baseline
report for Chevron's

DATE LOANED	BORROWER

USDI – BLM