3.1 GEOLOGY AND MINERALS

3.1.1 AREA OF ANALYSIS AND METHODOLOGY

The focus of study for geologic constraints and hazards is the transmission line corridor and surrounding area within approximately 0.5 mile. The area of analysis for minerals encompasses the area within approximately 4 miles of the transmission line route alternatives for mines and within 10 miles for general mining districts. The method of analysis was predominantly integration of published geologic information and interpretation of large-scale (1:24,000) U.S. Geological Survey (USGS) topographic maps. The Nevada Bureau of Mines and Geology (NBMG) maintains various mining-related databases, including active mines and oil, gas and geothermal wells that were accessed in preparing this EIS. Results of the database inquiry are presented separately in a technical memorandum: "Active Mines, Oil/Gas Wells and Geothermal Wells Within 10 Miles of the Falcon to Gonder Transmission Project" (EDAW 2001). Leasable oil, gas and geothermal resources in the study area were not inventoried in detail as the transmission line would not be expected to substantially interfere with extraction operations. These resources can usually be tapped at several locations, and angle drilling to tap the resources can be done to avoid transmission line towers. Analysis of potential conflicts with these types of leasable resources is more appropriate in the COM Plan, in which the exact locations of the towers will be identified and impacts can be avoided or mitigated as appropriate.

REGULATORY FRAMEWORK

Grading

On federal lands, construction and grading are regulated by the BLM under the use permits issued for development projects. As part of the right-of-way grant, the BLM requires that a COM Plan be developed, approved by the BLM, and implemented by the applicant. The COM Plan must be developed following the guidelines in the most recent edition of the BLM Rights-of-Way Construction Operation and Maintenance Plan. This plan provides guidance on clearing, blasting, erosion control, protection of resources, revegetation, and restoration and other elements. Construction on slopes is given particular attention because of potential soil erosion, health and safety hazards, and water quality concerns. (See also Section 3.2, Soils.)

In areas under local government jurisdiction, grading and construction are regulated through local use permits and grading permits in compliance with local ordinances. New construction generally must meet the requirements of the most recent version of the Uniform Building Code, including sections dealing with natural hazards from unstable and corrosive soils and earthquakes.

Mining

The Federal Mining and Mineral Policy Act of 1970 established a policy of the federal government to foster and encourage the development of mining of locatable minerals (hard rock), as well as other materials (aggregate, quarried dimension stone, and other resources). However, under provisions of the Federal Land Policy and Management Act of 1976 (FLPMA) as well as NEPA, exploration, development, and operation of mines and associated roads must also be considered in relation to their potential conflicts with other resource values and potential to affect the environment. Alternatives for oil and gas leasing are defined through consistency with land use designations in BLM Manual 1624. As a result, the BLM has adopted Resource Management Plans for each of the three districts through which the proposed transmission line would trend and has designated areas open to leasable resource (including oil, natural gas, and geothermal resources) development. In general, BLM has five designations for oil/natural gas and geothermal leases:

1. Open to leasing, subject to standard leasing stipulations limited;
2. Open to leasing with major restrictions, no surface occupancy (to protect other resources such as sage grouse strutting grounds and special recreation management areas);
3. Open to leasing with minor restrictions (e.g., subject to seasonal restrictions as related to seasonal wildlife activity periods, such as mule deer winter and spring ranges, chukar habitat, golden eagle habitat, etc.);
4. Closed to leasing based on discretionary considerations (e.g., recreations sites, natural features, National Register District); and
5. Closed to leasing based on nondiscretionary considerations (e.g., wilderness areas to be protected) (BLM 1992).

For the BLM's Ely District, areas for mineral exploration and development are designated and subject to management under a Geologic Area Management Plan that details the management practices and allowable uses needed to protect the area (BLM 1987).

Mining is also regulated by the State of Nevada and local government. With regard to environmental compliance requirements, the Nevada Division of Environmental Protection requires compliance with the National Pollutant Discharge Elimination System (NPDES) under the federal Clean Water Act for all surface and groundwater discharges from mining and other operations. Mining regulation under the local General Plans are discussed in the Land Use section of this EIS (Section 3.13). Construction grading is regulated under local grading ordinances.

Fossils

Disturbance of rocks and sediments with notable paleontological resources are also protected under federal and state laws. See discussion in Section 3.17, Paleontology.

3.1.2 AFFECTED ENVIRONMENT

REGIONAL GEOLOGIC SETTING

The Falcon to Gonder project is located in the Great Basin subsection of the Basin and Range Physiographic Province. The Great Basin subsection is further subdivided; the project area is located in the Central Area. The region as a whole, including the Central Area, has a complex geologic history, with the area at times a region of marine sediment deposition and volcanism, and at times uplifted with erosion, terrestrial sediment deposition, and volcanic rock formation (BLM 1992). In the early Paleozoic Era (570 million – 225 million years before present [b.p.]), the region was a marginal coastal zone with deposition of sediments in a geosynclinal (downwarp) area. The resultant rocks are marine shales and limestones with some carbonates. Subsequently, in the middle Paleozoic Era, the region experienced a period of compressional orogeny (uplift, compression, and mountain building). A subduction zone was established to the west, and a volcanic island arc formed with a foreland basin. Sediments consisting of shale, limestone, clastic sand, and silt formations were also deposited. Renewed orogeny occurred in the late Paleozoic Era and included volcanism, followed by a period of subsidence in which marine environments reestablished themselves. In the Jurassic Period (195 – 136 million years b.p.), episodes of sediment deposition occurred, and the region experienced the onset of the Rocky Mountain uplift (a.k.a. Cordilleran Orogeny). During the Cretaceous Period (136 – 65 million years b.p.), compression resulted in folding and faulting as well as volcanism. From the middle Cenozoic Era (65 million years b.p.) to the present, extensional forces developed with the Basin and Range. As a result, high angle faulting created semi-parallel range building interspersed with long valleys on a general north-south axis. Valley fill occurred within the area from the erosion of the mountain blocks. Volcanic activity was renewed.

The region at present is characterized by a structural geologic system of upraised fault blocks forming semi-parallel mountain ranges separated by down-dropped inter-range areas, typically graben structures (down-dropped blocks) that have been filled to great depths by alluvium. The structures are aligned on predominantly north-south axes. The ranges are predominantly linear in form and separated by valleys, many of which are closed basins. Some ranges, such as the Diamond Mountains, are oriented almost due north-south. Others, like the Cortez and Sulphur Spring Range, are oriented more northeast-southwest. The orientation of the ranges is reflected in the parallel arrangement of the intervening valleys, such as Crescent Valley and Pine Valley. The key mountain ranges in the study area from north to south include the Shoshone Range, Cortez Mountains, Pinyon Range, Roberts Mountains, Sulphur Spring Range, Whistler Mountain, Mahogany Hills, Diamond Mountains, Buck Mountain, Butte Mountains, and Egan Range. The relief between the mountain ranges and the adjacent valleys is substantial, typically on the order of 1,000 to 3,000 m (USGS topographic maps). The base of each range commonly is lined by pediment slopes and alluvial aprons that are inclined at low angles, and stretch broadly to the flat-floored valleys. Key valleys in the study from north to south include Boulder Valley, Crescent Valley, Grass Valley, Denay Valley, Huntington Valley, Garden Valley, Diamond Valley, Pine Valley, Newark Valley, Smith Valley, and Steptoe Valley.

The fault block structures of the region are the product of extensive faulting that is characteristic of the region between the Rocky Mountains on the east and the Sierra Nevada on the west. Faulting occurred as early as the Cretaceous Period in some areas, and the current interpretation is that there were two primary periods of faulting and orogeny. The older event occurred sometime during the late Mesozoic Era (Cretaceous Period) and the early Cenozoic Era, and the younger episode may have started in the middle Cenozoic era (Oligocene Epoch) and reached a climax in the late Miocene Epoch or early Pliocene Epoch (Hose and Lake 1976; Stewart and McKee 1977). The latter Cenozoic Era episode is referred to as the Basin and Range Orogeny. While some mountain ranges may be remnants of the earlier orogeny, most of the characteristic topography of the region has been a product of the younger orogeny (Hose and Blake 1976). The Basin and Range orogeny continues to the present, as evidenced by historic fault-based earthquakes (Stewart and McKee 1977).

The down-faulted blocks are buried under the debris washed into the valleys by erosion of the uplifted blocks. The block faulting has continued into historic time, and in many valleys the alluvial gravel fans and other fill are faulted along with bedrock. Structural deformation continues to the present as evidenced by: (1) numerous earthquake epicenters in the region; (2) numerous Holocene epoch (10,000 years b.p. to present) fault scarps and warped or faulted ancient lake shorelines; and (3) measured displacement of benchmarks and measurements by tiltmeters (Hunt 1967). These deformations are more active to the west and east of the Central Area but are present within the study area. One of the most distinguishing characteristics of the region's faulting is that the normal faulting is antithetic (i.e., the faults dip opposite to the direction in which the rock strata dip) (Thornbury 1965). As a result, the same stratigraphic units along a profile across the ranges may repeat themselves several times. The faulting, which largely came as a late event in the region's geologic history, was imposed upon rocks that already had been subjected to considerable earlier deformation (folding, faulting), erosion, and episodes of stratigraphic generation. High-angle normal faults are most characteristic of the region; however, low angle thrust faults also are present. While fault scarps form the front of many fault blocks in the region, fault-line scarps also are characteristic. Additionally, range-marginal scarps may exist without being expressed topographically by scarps (Thornbury, 1965). In sum, each mountain range must be interpreted based on its own geologic, structural and geomorphic history.

Faulting and tilting of the block mountains have created internal drainage; in some areas, there is no drainage outlet for the rivers. The fault block system was sufficiently formed in the Pleistocene that in some of the basin areas, large lakes formed that persisted for thousands of years, coincident with the formation of Lake Bonneville to the east and Lake Lahontan to the west (Flint 1970). Although none of the lakes in the region reached the size of those two lakes, many in the study area were of large size and depth. With climatic change to a warmer cycle, the lakes evaporated, leaving evidence of their presence by stratified lake sediments with fossil assemblages (e.g., fresh water mollusks) and remnant geomorphological features of the ancient shorelines (e.g., wave cut cusps and benches). The more humid conditions of the Pleistocene Epoch resulted in significant erosion of the mountains and the deposition of eroded debris in the adjacent valleys. The valleys were filled to great depth with sediment, and large alluvial fans formed at the foot of each mountain range.

The onset of arid conditions at the close of the Pleistocene changed the nature of geomorphologic processes shaping the land. While faulting and volcanic episodes continued, erosion of the mountain ranges was accomplished through continued sediment transport from the higher elevations, with extensive deposition at the base of the mountains. The result seen today is the formation of steep slopes in the mountains with extensive bedrock exposures and thin soils, while extensive gently sloping alluvial fans formed and coalesced to form almost continuous alluvial aprons at the base of each range (see discussion of stream processes in Chapter 3.3, Hydrology and Water Resources). In some areas, the alluvial fans have been formed over the lower portions of the pediment slopes at the foot of the mountains. The alluvial and pediment slopes have merged to form a continuous slope that drops gently down to the valley bottom. In other areas, where uplift was particularly strong and continuous, no pediment slope was formed and the alluvial fans form deep deposits, which also are expressed in the topography as long, gentle slopes dropping to the valley floor. A variety of characteristic landforms are present, including mountain valley fans, piedmont fans, alluvial plains, ballenas, and fan skirts (Peterson 1981). The resulting characteristic topography as expressed in the current landscape is comprised of a broad, flat basin plain, typically formed by fine-grained sediment and having closed drainage. The flat basin plain gives way to a broad, gently inclined, alluvial apron comprised of stratified coarse sediments leading up to the mountain front. In general, the alluvial veneer thins as the mountain front is approached, except in the areas of mountain canyon mouths. At the mountain front there is an abrupt steepening of slope where harder geologic materials (rock with a thin soil veneer) form the surface. The mountains are characterized by steep slopes and deeply eroded surfaces.

Concurrent with the Basin and Range Orogeny block faulting, there were extensive eruptions of lavas and volcanic tuffs in the southwest part of the Central Area (Hunt 1967; Stewart and McKee 1977; Hose and Blake 1976). Tertiary volcanic rocks (e.g., basalts, lavas, tuffs, rhyolites, and other rocks) crop out at places throughout the study area.

GEOLOGIC MATERIALS IN THE PROJECT AREA

Geologic materials in the study area (within approximately 4 miles of the route alternatives) vary greatly in composition, texture, age, and structure. The rocks and sediments are described in summary fashion below from youngest (Cenozoic Era) to oldest (Paleozoic Era). Tables are presented in the impact analysis that identify the geologic materials encountered along each segment route. The geologic unit identifier on geologic maps are specified in parentheses in the following discussion. Refer to the cited reports for detailed information about the geologic materials.

Cenozoic Era (6.5 million years ago to present)

Quaternary Period (approximately 2 million years ago to the present) rocks and deposits comprise the most widespread geologic materials in the project area. Most of the proposed transmission line would be located in valley areas comprised of various Quaternary sediments, chiefly alluvium. Most of these sediments are unconsolidated at the surface. A few areas along segments cross volcanic rocks dating to the Quaternary.

Quaternary sedimentary rocks and materials (Qs)

This grouping is a general classification of sediments and rocks deposited in the Quaternary (Hose and Blake 1976). These materials are predominantly stream-laid deposits ranging from clays and silts to coarse boulders and cobbles. The sediments were laid by depositional processes and are generally stratified. Quaternary alluvium is a general category that encompasses the types of deposits distinguished by type and age in some geologic reports in the area, as described below. This category also includes calcareous and siliceous sinter deposits from hot springs.

Quaternary alluvium (Qal)

Sediments in this grouping are stream-laid deposits ranging from clays and silts to coarse boulders and cobbles. The deposits were derived by weathering and erosion of the mountains, transported by streams, and laid by depositional processes in the valleys. Quaternary alluvium is a general category that encompasses the types of deposits that are distinguished by type and age in some geologic reports in the area, as described below.

Quaternary alluvial fan deposits (Qf)

These sediments are comprised of stream-laid deposits ranging from clays and silts to coarse boulders and cobbles, but mostly comprised of gravel and sand. They are distinguished from other alluvium based on their depositional environment at the bases of mountain ranges in fan formations. The materials are generally poorly sorted. (Roberts et al. 1967) They are not further distinguished by age group in this designation.

Quaternary playa deposits/ pluvial lake deposits (Qp)

These sediments consist of clay and fine silts that were deposited in dry lakes (playas). They are stratified, unconsolidated deposits and contain local lenses of sand and gravel (Roberts et al. 1967). Pluvial lake deposits are similar in character to playa deposits but date to earlier episodes of wetter climate during the Pleistocene Epoch.

Quaternary valley alluvium (Qa)

Sediments in this grouping are stream-laid deposits ranging from clays and silts to coarse boulders and cobbles. The alluvium was laid by depositional processes and is stratified. Quaternary valley alluvium is generally associated with younger age deposits (i.e., Holocene [about 10,000 years b.p. to present] and Pleistocene [about 2 million – 10,000 years b.p.] epochs).

Quaternary older fan deposits (Qoa)

These sediments are comprised of stream-laid deposits, as described above. They are distinguished by greater age in this designation than the Holocene (Recent) fans, typically dating to the Pleistocene Epoch. Some geologists, however, believe that some of the older sediments may date to the Tertiary Period (pre-Pleistocene Epoch) (Stewart and McKee 1977). The sediments are commonly dissected.

Quaternary sedimentary deposits undivided (QTsu)

This grouping encompasses a general category of sedimentary deposits that date to the late Tertiary to early Quaternary Periods (Roberts et al. 1967). The deposits are similar to the Quaternary sedimentary rocks and materials described previously.

Quaternary volcanic rocks undivided (QTvu)

This grouping encompasses a general category of volcanic rocks that date to the late Tertiary to early Quaternary Periods. The deposits are varied volcanic rocks and include andesite and basalt flows (Roberts et al. 1967).

Tertiary volcanic rock undivided (Tvu)

A variety of Tertiary volcanic rocks are present in the study area. These include basalt and basaltic andesite flows, diabase (doloritic) dikes, tuffs, conglomeritic tuffs, volcanic breccia, rhyolite flows, quartz latite, and other volcanic extrusive rocks (Roberts et al. 1967).

Tertiary gravels (Tg)

These deposits consist of poorly sorted gravels comprised of pebbles and boulders (Roberts et al. 1967) in the Cortez and Simpson Park Mountains in Eureka County. They are overlain by basaltic andesite lava flows.

Tertiary sedimentary and volcanic rocks (Tys)

These deposits consist of younger (20 – 21 million years old) inter-bedded sedimentary rocks of well-bedded light-gray, fissile, calcareous siltstone, fine-grained calcareous sandstone, and conglomerate. The sediments are in part tuffaceous and associated with ash flows. The siltstone contains a high proportion of vitric ash and air-fall tuff, much of it cemented with calcite. The unit contains some fossils locally (Hose and Blake 1976).

Tertiary younger ash flow tuffs (Tyt)

These are welded tuff ash-flow deposits. The volcanic deposits generally lack megascopic crystals (Hose and Blake 1976).

Miocene basaltic andesite (Tba)

These are volcanic deposits that range from reddish-gray, platy, flow-banded to massive, slightly vesicular, dark-gray rock. The rocks are about 15 million years old (Stewart and McKee 1977).

Tertiary older volcanic rocks (Tov)

These volcanic deposits consist of rhyodacite, quartz latite, andesite, thin inter-beds of air-fall tuff, and related sedimentary rock and welded tuff. These Oligocene volcanic deposits are dated at 25 million to 32 million years old (Hose and Blake 1976).

Caetano tuff (Tc)

The Caetano tuff is an Oligocene, very thick (500 – 8,000 feet) composite ash-flow sheet with inter-beds of sedimentary rock. The principal rock in the formation is gray to purplish crystal-rich welded tuff (Stewart and McKee 1977).

Mesozoic Era (195 million – 65 million years b.p.)

The Cretaceous Period (approximately 136 million to 65 million years b.p.) and the Jurassic Period (approximately 195 million to 136 million years b.p.) are represented by several rock formations that crop out in the immediate transmission corridor study area.

Newark Canyon Formation (Kn)

This is a Cretaceous sedimentary deposit formed in freshwater. Silt, shale, sandstone, and grit predominate, but conglomerate and light- to medium-gray freshwater limestone are also present. Locally, the formation contains conglomerate limestone beds. The rock is carbonaceous and dark in color, but locally is reddish and brown. It is fossiliferous (Roberts et al. 1967).

Intrusive rock (ir)

This group of igneous intrusive rocks ranges in age from the Jurassic to the Tertiary, but most are considered early Cretaceous to early Tertiary. They consist primarily of quartz monzonite and granodiorite, with lesser quartz diorite and alaskite (Roberts et al. 1967).

Volcanic rocks (KJv)

These thick (3,500 – 10,000 feet) extrusive rock formations date to the Jurassic or Cretaceous. They consist of a volcanic medium-grained, light-brown, and thin-bedded wacke member; a middle ash-flow tuff member comprised predominantly of white silicic ash-flow tuff and subordinate green ash-flow tuff with current-bedded sandstone; and an upper member comprised of maroon and black rhyolite and rhyodacite flows, and subordinate green and white flow-breccias. The upper member contains iron deposits. Welded tuffs and andesitic lava-flows are present in some areas. The formation may contain Permian porphyritic quartz latite rocks exposed in the Dry Hills (Roberts et al. 1967).

Paleozoic Era (570 million – 225 million years b.p.)

Paleozoic Era rocks crop out in mountain ranges crossed by the project. The ancient rocks date to the Permian Period (280 million – 225 million years b.p.), Pennsylvanian Period (320 million – 280 million years b.p.), Mississippian Period (345 million – 320 million years b.p.), the Devonian Period (395 million – 345 million years b.p.), Silurian Period (440 million – 395 million years b.p.), and Ordovician Period (500 million – 440 million years b.p.). Ordovician rocks are the oldest rocks encountered along the routes of proposed transmission segments. The rock formations are described below.

Arcturus (Pa) and Rib Hill (Pr) Formations (or Par)

The Permian Arcturus Formation consists of limestone with lenticular beds of sandstone. The lower part consists mainly of massive light-olive gray to cream-colored resistant limestone, much of which is sandy or silty. The upper part is very fine-grained, yellowish-gray calcareous sandstone and siltstone. It contains gypsum and is fossiliferous (Hose and Blake 1976). The Rib Hill Formation is a Permian sandstone and lays below the Arcturus Formation. It mostly consists of very fine-grained to medium-grained yellowish calcareous sandstone. The rock erodes to form gentle, even slopes. It contains thin inter-beds of medium-light-gray dolomite and sandy to silty limestone that erodes to form narrow ledges. It is fossiliferous. The Rib Hill sandstone lays over the Riepe Spring limestone (Hose and Blake 1976).

Garden Valley Formation (Pg)

This Permian formation (also called Unit G in the Diamond Range) consists of four members: a limestone made up of sandy limestone and calcareous sandstone and local chert pebble conglomerate layers and cherty limestone beds form the basal unit. The basal unit is overlain by a siliceous cobble and boulder conglomerate, sandy carbonaceous shale, and carbonaceous sandstone. The third member is a reddish-brown siliceous conglomerate with quartzite and chert cobbles cemented by silica. That member is highly resistant and forms prominent ridges. The upper member consists of purple and red shales and conglomerates (Roberts et al. 1967).

Riepe Spring limestone and Pilot shale (PP)

The Pennsylvanian Riepe Spring limestone of Steele is a medium gray limestone similar to the Ely limestone; until 1960, it was included as part of that system. The rock weathers to a medium-gray to olive-gray color. The rock has a coarsely crystalline to granular texture. Eroded outcrops of the Riepe Spring system form characteristic alternating ledges or cliffs with intermediate gentle slopes. The slope-forming component is comprised of platy medium-gray to yellowish-gray silty limestone. The limestone contains abundant nodules, concretions, lenses, and bands of chert, and locally contains conglomerate. It is comprised of marine fauna and flora and is fossiliferous. It overlies and is gradational to the Diamond Peak Formation (Hose and Blake 1976). The Mississippian Pilot shale is described below.

Pennsylvanian/Mississippian Diamond Peak and Chainman Formations (PMdc)

See below.

Diamond Peak Formation (Md)

Rocks in this Mississippian formation vary somewhat, depending on locality. In some areas, it is predominantly olive-gray siltstone and silty claystone with some sandstone and minor conglomerate. In other areas, the sandstone and conglomerate components are substantial. The sandstone is cross-bedded and platy and ranges from very fine- to very coarse-grained. The conglomerate contains pebbles and cobbles consisting mainly of quartzite and chert. It weathers grayish-yellow, moderate yellowish-orange, and brick-red. It contains diverse marine fossils, most of which are Mississippian; however, the upper parts of the formation may have Pennsylvanian Age fossils (Roberts et al. 1967). The Diamond Peak Formation lies over the Chainman shale (see below) (Hose and Blake 1976).

Mississippian sedimentary rocks undivided (Mu)

These formations are comprised of varied sedimentary strata including the Chainman and Diamond Peak Formations, Joana limestone, an unnamed conglomerate, and the Tonka Formation of Dott, which consists of chert-pebble conglomerates with quartzite and shale inter-beds (Roberts et al. 1967).

Chainman shale, Joana limestone, and Pilot shale (MD)

These comprise a Devonian-Mississippian system. The Chainman shale is the uppermost unit in the sequence. The shale is uniform in lithology and consists of very dark-gray to black shale and olive-gray platy siltstone or silty shale. It is comprised of soft, incompetent rocks, and is infrequently exposed (Hose and Blake 1976).

The Joana limestone (present in the Eureka district of the Diamond Mountains) is a dense porcelaneous limestone that is coarsely crystalline and contains nodular, cherty limestone. It is a massive medium-gray to medium-light-gray limestone that forms generally resistant, somewhat rounded ledges or cliffs (Hose and Blake 1976). It is locally fossiliferous (crinoids). In places it contains shale like the underlying Pilot shale. It is early Mississippian (Roberts et al. 1967). The Pilot shale (present in the Eureka district of the Diamond Mountains) is a platy, calcareous shale, dun-colored to black on fresh surfaces and weathers to pinkish or light yellowish-brown or gray. The lower part contains much thin-bedded shaly limestone, and the upper part is chiefly shale. It overlies the Devonian Devil's Gate Formation (see below). It is locally fossiliferous (Roberts et al. 1967).

Devonian limestone (Dl)

This formation is comprised of a thick-bedded to massive, dark-gray limestone with subordinate yellow-gray-weathering, slabby, silty limestone. In some places, the massive limestone is cliff-forming. In some areas, it is thin-bedded with some shale. It is fossiliferous (Stewart and McKee 1977).

Slaven chert (Ds)

This Devonian formation consists predominantly of very thin- to thin-bedded black chert in sequences many hundreds of feet thick. Locally thin beds of limy brown-weathering sandstone, feldspathic siltstone, and limestone are present in the formation. It is fossiliferous.(Stewart and McKee 1977).

Devonian sedimentary rocks undivided (Dwu or Deu)

These contemporaneous formations are distinguished by a western assemblage of siliceous rocks (Dwu) and an eastern assemblage of carbonate rocks (Deu) that includes the Wenban limestone (a thick sequence of both thick-bedded argillaceous limestone and bioclastic limestone) and Pilot shale in the Cortez area (Roberts et al. 1967).

Guilmette Formation (Dg)

The Devonian Guilmette Formation is an even-bedded, dark-gray to grayish black, sublithographic limestone that weathers to olive-gray to medium-light-gray. It is locally cut by small veins of white calcite. It is similar in character and age to the Devil's Gate Formation and correlates in age with the Nevada Formation (see below). It is fossiliferous (Hose and Blake 1976).

Devil's Gate limestone (Dd)

These rocks are calcareous gray to blue-gray limestones that are mostly thickly bedded. The limestones are middle to late Devonian and typically overlay the Nevada Formation and are gradational to it (Roberts et al. 1967).

Nevada Formation (Dn)

The Nevada Formation designates an early to middle Devonian sequence that ranges from dolomite to limestone, and shaly limestone (Roberts et al. 1967).

Devonian, Silurian, and Ordovician Valmy, Vanini, Nohm, and Valder Formations (DOs)

This grouping of formations includes mudstone, shale, chert, siltstone, gray quartzite, greenstone, and minor limestone (Coats 1987). Valmy and Vanini formations are described below. The Valder Formation consists of middle to lower Ordovician shale and volcanic rocks. The Noh Formation is of Silurian age and consists of dark-gray chert and light-gray shale in a basal unit; a middle unit of light-brown-weathering siliceous shale and siltstone; and an upper unit of tan-and light-brown weathering, thin-bedded siltstone, sandstone, and minor shale (Coats 1987).

Devonian Sevy, Simonson, and Nevada Formations (Dn, Dd)

These formations are sometimes combined. The Sevy dolomite is a very fine-textured dolomite with a medium-gray color that weathers to light-gray to yellowish-gray. In places, it contains layers of very fine-textured darker dolomite and becomes somewhat coarser toward its lower part. It contains few fossils. The Simonson dolomite varies according to sub-units. The oldest unit consists of sugary-textured pale-yellowish-brown dolomite that weathers to pale-brown to light-olive-gray. This member is friable and where eroded forms rounded ledges. The next higher member contains beds of light-colored dolomite, alternating with beds of coarser medium-dark-gray dolomite that weathers to olive-gray. The darker beds are strikingly laminated. The next higher member consists of finely crystalline, dark to medium-gray dolomite that weathers olive-gray to pale-yellowish-brown. It is more resistant than the members above and below it and forms brown cliffs. It has abundant fossils. The highest member of the Simonson is also a dense, light-colored dolomite that contains lenses of fine-grained medium-gray limestone. The Simonson lies over the Sevy dolomite, but is gradational in character to it (Hose and Blake 1976). The Nevada Formation is described above.

Vanini Formation (Ov)

This Ordovician formation consists of quartzite, gray sandy limestone, sandy siltstone, chert, clay shale, organic shale, and some andesitic volcanic rock types. Shale and siltstone are especially common in the area. Toward the west, the formation merges indistinguishably with rocks referred to as the Valmy Formation (Stewart and McKee 1977).

Valmy Formation (Ova)

The Ordovician Valmy Formation consists mostly of chert, quartzite (or sandstone), and siltstone, argillite, or shale. The quartzite commonly occurs in massive units. Color varies from light-gray, dark-gray, green, or red. Greenstone occurs as pillow lavas to ash in some areas (Stewart and McKee 1977).

Ordovician Lower Part Pogonip Group and Eureka Quartzite (Ol)

The Eureka quartzite is a distinctive, dense, milky white to cream-colored, sugary to vitreous quartzite that forms bold outcrops and prominent cliffs and escarpments. It is comprised of well-sorted fine to medium quartz grains (Roberts et al. 1967). The Pogonip Group lies below the Eureka quartzite. The Pogonip Group consists mainly of platy- to thin-bedded, fine- to coarse-textured, medium-gray to medium-light-gray detrital limestone. It is inter-bedded in many places with flat-pebble conglomerate locally containing quartz. Much of the limestone is silty with dark-yellowish-orange nodules. Shale occurs in the upper part of the Pogonip Group. The Pogonip generally forms a slope interrupted by ledges of resistant rock. The Pogonip dates to the lower Ordovician (Hose and Blake 1976).

SEISMICITY

The entire study area is located in an area in which seismic and volcanic forces are active, as evidenced by historic earthquakes and hot springs (see Figure 3.1-1). The fault block structures of the region are complex. Each mountain range is formed by uplift along a fault system, forming tilt blocks or up-thrown blocks (the latter are referred to as horst structures), and many valleys have been formed by down-dropping along bordering faults (referred to as graben structures). The alluvium that fills these valleys obscures the great extent of uplift and down-dropping along fault systems in the region. Many of the larger fault systems have been mapped in the region. Records of earthquake epicenters are available; however, data on slip rates and activity levels for most faults have not been developed. The major fault systems in the study area crossed by the study corridor segments include the following: Boulder Valley, east side of the Shoshone Range, west side of Cortez Range, east side of Whirlwind Valley, east side of Garden Valley, northwest side of Roberts Mountains, east and west sides of the Diamond Mountains, west side of Pinyon Range, east side of Newark Valley, east side of Butte Mountains, and southeast side of the Egan Range. Structures within an active fault zone have a risk of damage from rupture of the fault and the resultant ground displacement, as well as high intensity ground shaking.

The Uniform Building Code generally interprets the composite seismic risk of the study region as Zone 2 in the eastern part and Zone 3 in the western part. Zone 2 would be expected to have moderate damage to structures during major earthquakes, and the damages equate approximately to Intensity VII of the Modified Mercalli Scale. Intensity VII is generally equated with an average peak velocity of 8 – 12 centimeters per second and average peak ground gravitational acceleration of 0.10g to 0.15g (g is gravitation acceleration). That intensity is interpreted as an earthquake of sufficient size that expected damage would be negligible in structures of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built or badly designed structures (Bolt 1988). Zone 3 is expected to experience major structural damage, and Modified Mercalli Intensity is rated as VIII or higher. Intensity VIII is generally equated with an average peak acceleration of 20 to 30 centimeters per second and an average peak ground acceleration of 0.25g to 0.30g. This intensity is interpreted as resulting in slight damage in specially designed structures, considerable in ordinary substantial buildings, with partial collapse and great in poorly built structures. Additionally, this level of intensity would be expected to result in fall of columns, monuments, and walls (Bolt 1988).

The secondary hazards of earthquakes include liquefaction, rapid ground settlement, and induced landslides and rockfalls. Liquefaction is the rapid transformation of loose saturated sand to a fluid-like state because of ground shaking during an earthquake. The rapid loss of pore pressure in the sand causes it to lose its strength (inter-granular friction), with the result that the soils loses its bearing capacity and may spread laterally. The hazard would be restricted to alluvial materials that are saturated. Given the aridity of the region, liquefaction is likely to be a hazard only in valley bottoms where groundwater saturates sandy soil. Alluvial materials also may densify because of ground shaking with the result that rapid settlement of the soil occurs. In the areas within or near mountain ranges, ground shaking also may dislodge landslides and rocks.

Figure 3.1-1: Fault Systems
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FIGURE 3.1-1: FAULT SYSTEMS

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SLOPE

Slope is an important indicator of constraints related to engineering requirements, erosion hazard, and potential slope instability. For purposes of mapping, slopes are classified into four groups: flat (under 1% slope); gently sloping (1 to 5%); moderately sloping (5 to 15%), and steeply sloping (greater than 15%). While the region is occupied by numerous mountain ranges with steep slopes, most of the land area is occupied by the broad, long valley areas characterized by gentle slope. The broad valley floors, including playa (dry lake) surfaces, are predominantly flat slopes. The alluvial fan and pediment slopes are predominantly flat in the lower-lying areas where they merge into the valley bottoms, and increase in slope toward the mountain front. Most of the alluvial fan slopes are gently sloping features. Local erosion channels in the fans may have moderately and steeply sloping channels. Typically, the mountain front of a range is characterized by a relatively abrupt change in slope. Mountain slopes of the mountains are moderate to steep. Narrow valley floors in the mountains have gentle to steep gradients, with a wide range in slope being characteristic.

MINERAL, OIL, GAS, AND GEOTHERMAL RESOURCES

The study area encompasses a major mineral resource area, and mining operations are scattered throughout the project area. Metals produced commercially in the region include antimony, copper, gold (lode and placer), iron, lead, manganese, mercury, molybdenum, platinum, rhenium, silver, tungsten (lode and placer), and zinc. Gold, silver, and copper are mined heavily and are the most economically valuable mined resource. Commercially mined non-metals include barite, coal, fire clay, fluorspar, garnet, lime, magnesite, phosphate, sand and gravel, siliceous flux, stone (dimension and crushed), and turquoise. The Cortez gold mine is the largest mining operation in the study area. It is an open pit gold mine, and its operating company has expansion plans for the mine that could conflict with the proposed transmission line centerline on Segment B (BLM 1999).

The Ruby Hill gold mine project (BLM 1997) and the expansion of the Bald Mountain mining project (BLM 1995) also are near potential transmission line segments, but not close enough to directly conflict. Commodities with the potential for development include beryllium, bismuth, nickel, selenium, and tellurium and non-metals (deweylite, gypsum, hallosyte, perlite, petroleum, and potash) (Smith 1976). These resources are largely relegated to the mountainous areas. The broad alluvial plains have relatively few minerals of economic value. Aggregate (sand and gravel) is mined in areas with alluvial fans and aprons. Aggregate is a common resource in the region and has widespread distribution. Numerous aggregate quarries and borrow pits are scattered throughout the study area.

Segments of the proposed project route alternatives cross seven designated mining districts: Beowawe, Cortez, Pine Valley, Mount Hope, Eureka, Bald Mountain, and Illipah. Additionally, the segments pass within 10 linear miles of the following mining districts: Argenta, Alpha, Antelope (Eureka), Bateman Canyon, Buckhorn, Bullion, Carlin, Chase, Diamond Marsh, Duck Creek, Huntington Creek-White Pine, Lone Mountain (Eureka), Mineral Hill, Modarelli-Frenchie Creek, Newark, Pancake, Pinto, Railroad, Robinson, Robinson Mountain, Safford, San Francisco, and Union (Eureka-Elko). Both shaft and open pit mines are present.

Within the mining districts are many active mining claims. An active claim is a pre-existing, legal right to explore for mineral resources. Renewal of the claim requires some site development activity, and the renewal must be filed annually with the BLM and the counties in which they are located. There are approximately 122 active mining claims in the study area, of which approximately 70 active claims are within or near the study corridor (Hirschman 2000). Active claims provide the legal right to explore for minerals, but do not necessarily indicate the existence of active commercial mining operations.

The area also has oil and natural gas resources. Exploration began in the 1920s and development was initiated in the 1950s in the Egan Resource area of the BLM Ely District (BLM 1992). Major oil companies have explored the area for potential resource development. A notable concentration of oil development is located in Pine Valley in Eureka County; however, oil development is scattered throughout the region.

Geothermal resources are present locally, but the nature of geothermal energy in the region has not led to its widespread development for energy or other notable uses. Geothermal resources have been developed in the Beowawe area (The Geysers) for energy generation and at scattered sites in Crescent Valley at the southerly end of the Dry Hills, along the eastern side of the Sulphur Springs Range and near Buck Mountain. Local hot springs have obtained value primarily for their interest to tourism and their unique habitat values.

Table 3.1-1 provides a summary of the elevation, topography, geology and hazards in the study area.

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
Segment A						
0 – 8.5	1418 –1450	Flat floodplain, Humboldt River floodplain	Quaternary alluvium (Qal)	Crossing of a major fault zone at about MP 6.6	Parallels existing TL	
8.5 – 16.7	1450 – 1500	Gently sloping alluvial apron	Quaternary alluvium (Qoa); Tertiary volcanic rock (Tvu)		Parallels existing TL	Gravel pits w/in 3 miles; Beowawe Mining District w/in 1 mi. and Argenta Mining District w/in 6 mi.; scattered geothermal wells in Boulder Valley
Segment B						
0 – 5.0	1450 – 1575	Gently sloping alluvial apron	Quaternary alluvial fan deposits (Qf)		Hot springs near alignment; ca. ½ mile from The Geysers; geothermal plant; Beowawe Mining District; ATR Ginn No. 1-13 oil well on TL alignment	At edge of Beowawe Mining District: Argenta Mining District w/in ½ mi.
5 – 9.5	1560 – 1740	Low hills (Malpais Hills)	Miocene basaltic andesite (Tba)	Crossing of major fault zone near MP 9		Abandoned Bante Mine w/in 5 miles and open pit mines in Slaven Canyon w/in 3 miles Argenta Mining District w/in 1 mi.; Bateman Canyon Mining District w/in 3 mi.
9.5 – 32.0	1450 – 1600	Gently sloping to flat valley floor (Crescent Valley)	Quaternary alluvial fan deposits (Qf) and Quaternary Valley alluvium (Qa)		Mud Spring Mine adjacent to TL and staging area; Large open pit Cortez Gold Mine, mine dump and tailings ponds w/in ½ mile of TL	Numerous large open pit mines in Rosebud Gulch, Spring Gulch, Mill/Triplet Gulch and Hot Springs Point w/in 4 – 5 miles of TL; Bullion Mining District w/in 3 mi.; geothermal wells in Crescent Valley at southern end of Dry Hills at western edge of Cortez Mountains
32.0 – 37.7	1550 – 1850	Steep hills and canyons (Cortez Mountains/Toiyabe Range); gently sloping fan slopes of upper Grass Valley	Devonian limestone (Dl), Devonian chert (Ds); Quaternary fan deposits (Qf)	Crossing of fault zone and scarp at foot of Cortez Range near MP 32-33; slope instability; erosion		Open pit mine north of Cortez Canyon, in Mill Canyon, Mount Tenabo and Copper Canyon; many prospects within 1 – 5 miles of TL; passes through Cortez Mining District; Buckhorn Mining District w/in 6 mi.;

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
37.7 – 41.0	1740 – 1930	Gently sloping fan slopes	Quaternary fan deposits (Qf) or Quaternary older fan deposits (Qoa)		w/in ½ mile of springs	w/in 1 – 4 miles of several gravel pits and prospects in the southern end of the Cortez Mountains; w/in Cortez Mining District
41.0 – 44.0	1850 – 2000	Dissected hills	Ordovician Vinini Formation (Ov); Tertiary gravels	Crossing of major fault zone near MP 41	Prospects w/in ½ mile	w/in 1.5 mile of gravel pit; w/in Cortez Mining District; w/in 6 mi. of Buckhorn Mining District
44.0 – 61.8	1700 – 1850	Alluvial fans and flat valley bottom	Quaternary Older fan deposits (Qoa); Quaternary sedimentary deposits undivided (Qtsu); Quaternary alluvium (Qal)	Crossing of major fault zone near MP 54	w/in ½ mi of two oil wells	w/in 1 – 4 miles of gravel pits, an open pit mine, numerous prospects; w/in 5 mi. of Alpha Mining District and 7 mi. of Antelope (Eureka) Mining District
Segment C						
0 – 2.0	1450 – 1500	Gently sloping alluvial apron and flat valley bottom (Whirlwind Valley)	Quaternary alluvium (Qoa) and older alluvium (Qoa)		Hot springs near alignment; ca. ½ mile from The Geysers; geothermal plant; Beowawe Mining District	w/in Beowawe Mining District; gravel pit w/in 1 mi.; w/in 4 mi. of Argenta Mining District
2.0 – 3.5	1500 – 1650	Steeply dissected hills (Malpais Hills and moderately sloping alluvial apron/pediment	Ordovician Valmy Frm. (Ova) and Tertiary volcanic rocks undivided (Tvu)	Crossing of a major fault zone near MP 2		w/in Beowawe Mining District; gravel pit w/in 1 mi.; scattered prospects w/in 1 mi.
3.5 – 12.0	1400 – 1600	Gently sloping alluvial slopes and flat valley bottom (Crescent Valley)	Quaternary older alluvium (Qoa), Quaternary playa deposits (Qp), and Quaternary alluvium (Qal)	Crossing of a major fault zone at MP 11.5		Gravel pit and scattered prospects w/in 1 mi.; geothermal wells at Beowawe and to south in Crescent Valley at southern edge of Dry Hills
12.0 – 16.5	1550 – 1900	Steep to moderately sloping hills (Dry Hills)	Jurassic/Cretaceous volcanic rocks and Permian porphyritic rocks KJv)	Erosion		Mine w/in 1 ½ mi. and scattered prospects w/in 1 - 2 mi.
16.5 – 20.7	1600 - 1850	Gently sloping alluvial fans and flat valley bottom (Crescent Valley east arm [Thomas Creek])	Quaternary older alluvium (Qoa)			Scattered prospects w/in 2 – 4 mi.; w/in 4 mi. of Safford Mining District and 7 mi. of Modarelli-Frenchie Creek Mining District
20.7 – 24.0	1650 - 2025	Moderately to steeply sloping dissected hills (Cortez Mountains)	Jurassic/Cretaceous volcanic rocks (KJv); Cretaceous Newark Canyon Frm. (Kn), and minor Tertiary volcanic rocks undivided (Tvu)	Crossing of a major fault zone at MP 21.5; erosion		w/in 4 mi. of Railroad Mining District, 9 mi. of Carlin Mining District
24.0 – 35.7	1625 - 1650	Low to moderate slopes with short segments of steep slope formed on dissected alluvial fan/pediment forming west side of Pine Valley	Tertiary sedimentary deposits, undivided (QTsu) interspersed w/ Quaternary alluvium (Qal)	Erosion	w/in ½ mi. of oil well	w/in 1½ mi. of Pine Valley Mining District near junction w/ Alignment E, w/in 5 mi. of Robinson Mountain Mining District and 6 mi. of Larrabee Mining District; Pine Valley Oil Field; geothermal wells in Pine Creek Valley

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
Segment D						
0 – 13.0	1625 – 1725	Gently sloping alluvial fan and valley bottom (Pine Valley)	Tertiary sedimentary deposits, undivided (QTsu) and Quaternary alluvium (Qal)		w/in ½ mi. of three oil wells of the Pine Valley Oil Field	w/in 1 mi. of Pine Valley Mining District; w/in 5 mi. of Mineral Hill Mining District, 6 MI OF Modarelli-Frenchie Creek, 8 mi. of Buckhorn, and 8 mi. of Union (Eureka-Elko) Mining District; w/in ½ mi. of 2 gravel pits; many oil wells of Pine Valley Oil Field
13.0 – 19.5	1675 – 1775	Gently sloping alluvial fan and valley bottom (Garden Valley)	Quaternary older alluvium (Qoa)	Crossing of major fault zone near MP 16-17		w/in ½ mi. of 2 gravel pits; w/in 5 mi. of Alpha Mining District and 6 mi. of Antelope (Eureka) Mining District
Segment E						
0 – 1.5	1575 – 1600	Flat valley bottom of Pine Creek and gently sloping alluvial fan slopes	Quaternary alluvium (Qal) and Tertiary sedimentary deposits, undivided (QTsu)	Expansive soils	Crosses through Pine Valley Mining District; w/in ¼ mi. of mines and numerous prospects	Prospects w/in 4 mi.; w/in 6 mi. of Modarelli-Frenchie Creek Mining District; many wells of Pine Valley Oil Field
1.5 – 6.0	1600 – 1800	Flat to gently sloping valley floor and alluvial fan slopes Sulphur Spring Range	Quaternary alluvium (Qal) and Tertiary sedimentary deposits, undivided (QTsu), and Quaternary older alluvium (Qoa)		Crosses through Pine Valley Mining District; w/in ¼ mi. of mines and numerous prospects; w/in ½ mi. of oil well in Pine Valley Oil Field	w/in 1 – 4 mi. of scattered prospects; many wells of Pine Valley Oil Field
6.0 – 12.5	1800 – 1950	Steep to moderately sloping mountain slopes (Sulphur Springs and Pinyon Range, Black Mountain)	Devonian sedimentary rocks, undivided (Dwu); Devonian Sevy, Simonson, Nevada Frms (Dn, Dd); Pennsylvanian/Mississippian Diamond Peak and Chainman Frm. (PMdc); Devonian, Silurian and Ordovician Valmy, Vanini and Valder Frms.) DOs, and Quaternary alluvium (Qa)	Crossing of a major fault zones near MP 6; erosion, slope stability		w/in 2 mi. of Larrabee Mining District; 3 mi. Union-(Eureka-Elko) Mining District; 5 mi. Robinson Mountain Mining District, 6 mi. of Mineral Hill Mining District; w/in 1 mi. of scattered prospects; geothermal wells in Pine Valley
12.5 – 22.0	1775 – 1950	Mostly gently sloping alluvial fan slopes (Garcia Flat[Diamond Valley]); local moderate slope	Quaternary alluvium (Qa, Qal); Quaternary pluvial lake deposits (Qp); Quaternary older alluvium (Qoa)		w/in ½ mi. of oil well at Garcia Flat	w/in 2 mi. of scattered prospects; w/in 6 mi. of Diamond Marsh Mining District; scattered oil wells in Huntington Valley
22.0 – 24.0	1825 – 1875	Gentle to moderate hill slopes on flank of Diamond Mountains	Mississippian Diamond Peak Frm. (Md)	Fault crossing		
24.0 – 36.5	1775 – 1850	Gently sloping coalesced alluvial fan slopes and flat valley bottom (Huntington Valley)	Quaternary sedimentary materials (Qs)	Crossing of a major fault zone (assumed) near MP 28.5		w/in 4 – 5 mi. of the Huntington Creek (Eureka White Pine) Mining District and Chase Mining District; scattered oil wells in Huntington Valley

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
36.5 – 41.0	1850 – 1925	Gently sloping dissected alluvial fans and low to moderately sloping hills	Quaternary sedimentary materials (Qs); minor Tertiary sedimentary and volcanic rocks (Tys)		Gravel pit w/in ½ mi.	w/in ¼ mi. of prospects; w/in 3 mi. of Bald Mountain Mine proposed process area expansion in the Bald Mountain Mining District; w/in 4 – 5 mi. of the Huntington Creek (Eureka White Pine) Mining District and Chase Mining District; geothermal wells in Diamond Valley
41.0 – 52.5	1775 – 1950	Flat valley bottom (Newark Valley) and gently sloping alluvial fan slopes at foot of Ruby Mountains	Quaternary sedimentary materials (Qs)		Gravel pit w/in ½ mi.; geothermal well w/in ½ mi.	Prospects w/in 1 mi.; gravel pit w/in 2 mi.; w/in 8 mi. of Diamond Mining District; scattered oil wells and geothermal well in Newark Valley
52.5 – 65.0	1950 - 2175	Gently to steeply sloping mountain slopes and hills (Ruby Mountains)	Devonian – Mississippian Chainman Shale, Joana Limestone and Pilot Shale (MD); Tertiary older volcanic rocks (Tov); and Quaternary sedimentary rocks and materials (Qs)	Crossing of minor fault; erosion	Crossing of Bald Mountain Mining District; numerous prospects w/in ¼ mi.; oil well w/in ½ mi.	w/in 3 mi. of Alligator Ridge Gold Mine; w/in 2 – 3 mi. of numerous prospects; scattered oil wells in Long Valley
65.0 – 70.5	1875 – 1950	Gently sloping alluvial fan apron of Dry Mountain	Quaternary sedimentary rocks and materials (Qs); Permian Arcturus and Rib Hill Frm (Par); and Pennsylvanian Riepe Spring Limestone of Steele (PP)	Crossing of a major fault zone	Gravel pit w/in ¼ mi.	
70.5 – 74.8	1800 – 2000	Dissected sloping alluvial fans and gently sloping hills of White Pine Range	Quaternary sedimentary rocks and materials (Qs); Tertiary older volcanic rocks (Tov)	Erosion	w/in ½ mi. of gravel pit and drill hole; oil wells w/in ½ mi.	w/in 1mi of Illipah Mining District; scattered oil wells in Newark Valley
Segment F						
0 – 14.0	1725 – 2075	Alluvial fans and flat valley bottom	Quaternary older alluvium (Qoa), and minor areas of Quaternary alluvium (Qal) and Tertiary volcanic rocks undivided (Tvu)	Crossing of major fault zone near MP 1.5		w/in ½ mi. of gravel pit; w/in 4mi of Prince of Wales Mine; w/in 1 mi. of Alpha Mining District, 6 mi. of Diamond Marsh Mining District
14.0 – 16.8	2075 – 2150	Compound alluvial fans/pediment	Ordovician Vinini Formation (Ov) and minor Jurassic to Tertiary intrusive rocks (ir)	Crossing of two unnamed faults near Mt. Hope	Prospects w/in ½ mi.; crosses Mt. Hope Mining District	w/in 2 mi. of Mt. Hope Mine; w/in 4 mi. of Antelope (Eureka) Mining District
Segment G						
0 – 2.0	2000 – 2150	Compound alluvial fans/ pediment	Ordovician Vinini Formation (Ov) and Quaternary older alluvium (Qoa)	Crossing of short unnamed fault	Crosses Mt. Hope Mining District; prospects w/in ½ mi.	w/in 2 mi. of Mt. Hope Mine; w/in 4 mi. of Antelope (Eureka) Mining District, and 8 mi. of Alpha Mining District

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
2.0 – 17.5	1850 – 2000	Alluvial fans and flat valley bottom	Quaternary older alluvium (Qoa)		Gravel pit and a few prospects w/in ½ mi.	w/in 4 mi. of Mt. Hope Mine; w/in 5 mi. of Lone Mountain (Eureka) Mining District
17.5 – 19.9	1850 – 2000	Alluvial fans/pediment	Ordovician Vinini Formation (Ov) and Quaternary older alluvium (Qoa), Devonian Devil's Gate Limestone (Dd) and Mississippian Undivided sedimentary rocks (Chainman and Diamond Peak FRS.)	Crossing of fault	Gravel pit w/in ½ mi.	w/in 1 – 4 mi. of prospects;; w/in 2 mi. of Yahoo Canyon mine and w/in 3 mi. of Eureka Mining District and 6 mi. of Fish Creek Mining District
Segment H						
0 – 2.0	2000 – 2200	Moderate to gently sloping alluvial fans/pediments	Ordovician Vinini Formation (Ov) and minor Jurassic to Tertiary intrusive rocks (ir) and Quaternary older alluvium (Qoa), and Devonian Nevada Frm (Dn)		w/in ½ mi. of Mt. Hope Mine and numerous prospects; crosses Mount Hope Mining District	w/in 5 mi. of Antelope (Eureka) Mining District, 7 mi. of Alpha Mining District
2.0 – 4.5	1950 – 2000	Gently sloping alluvial fans	Quaternary older alluvium (Qoa),			w/in 1 – 2 mi. of Mt. Hope Mine and numerous prospects
4.5 – 7.0	1850 – 2050	Moderate sloping hills and alluvial fans/pediments	Ordovician Vinini Formation (Ov) and minor Devonian sedimentary rocks undivided (Deu), Permian Garden Valley Frm (Pg)	Erosion		w/in 1 – 2 mi. of 2 gravel pits, mine shaft and scattered prospects
7.0 – 20.5	1850 – 1900	Gently sloping alluvial fans and flat valley bottom	Quaternary alluvium (Qal) and older alluvium (Qoa)	Expansive soils in valley bottoms	w/in ½ mi. of gravel pit	w/in 1 – 2 mi. of 2 gravel pits, mine shaft and scattered prospects; w/in 8 mi. of Diamond Mining District; 3 mi. of Eureka Mining District, and 7 mi. of Fish Creek Mining District; scattered oil wells in Diamond Valley
Segment I						
0 – 6.5	1800 – 2000	Gently sloping alluvial fans and flat valley bottom	Quaternary older alluvium (Qoa)		w/in 500 feet of Ruby Hill gold mine stockpile and rock waste dump; w/in ¼ mile of gravel pits and scattered prospects	w/in 1 – 2 miles of Eureka Mining District, and w/in 6 mi. of Fish Creek Mining District; numerous mines and prospects
6.5 – 13.0	1820 – 2250	Steep dissected hill slopes of Diamond Mountains	Quaternary volcanic rocks undivided (QTvu), Mississippian sedimentary rocks, undivided (Mu) including the Diamond Peak Frm (Md) and minor Cretaceous Newark Canyon Frm (Kn).	erosion, slope instability	Crosses Eureka Mining District; w/in ¼ mi. of gravel pit	w/in 4 mi. of prospects; w/in 3 mi. of Pinto Mining District

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
13.0 – 28.5	1800 – 1900	Flat valley bottom to gently sloping alluvial valley (Newark Valley)	Quaternary sedimentary materials (Qs)			w/in 1 mi. of gravel pit; w/in 2 mi. of Newark Mining District; scattered oil wells in Newark Valley
28.5 – 30.3	1900 –2050	Gently sloping alluvial fan/pediment and moderately sloping hills	Mississippian Diamond Peak Frm (White Pine Range)			w/in 1 mi. of Pancake Mining District and 1 mi. of Illipah Mining District
Segment J						
0 – 9.0	2025 – 2250	Moderate to steeply sloping dissected hills and interspersed gently sloping valleys of the White Pine Range and Butte Mountain	Permian Arcturus Frm. and Rib Hill Sandstone (Par); Pennsylvanian Riepe Spring Limestone (Ely Limestone) (PP); Diamond Peak Frm (Md) and Chainman Shale, Joanna Limestone and Pilot Shale (MD); Tertiary older volcanic rocks (Tov); Tertiary younger sedimentary and volcanic rocks (Tov); and minor Tertiary younger ash-flow tuffs (Tyt); Quaternary sedimentary materials (Qs)	Erosion, slope stability; fault crossing	Crossing of Illipah Mining District	w/in 1 mile of scattered prospects; scattered oil wells in Antelope Mountain and Butte Mountains
9.0 – 18.5	1950 – 2100	Gently sloping valleys, fans and flat valley bottom (Jakes Valley)	Quaternary sedimentary materials (Qs)	Major fault zone crossing near MP 13.5	w/in ½ mi. of 2 gravel pits	w/in 1 mi. of scattered prospects; oil well in Butte Mountains
18.5 – 30.0	2100 – 2400	Moderate to steeply sloping dissected hills and gently sloping alluvial valleys of Egan Range	Tertiary older volcanics (Tov); Permian Arcturus Frm; Rib Hill Sandstone (Pr); Pennsylvania Riepe Spring Limestone (Ely Limestone) (PP); and Quaternary sedimentary materials (Qs)	Erosion, slope stability; 1 minor fault crossing		w/in 1 mi. of gravel pit and scattered prospects and oil wells
30.0 – 40.1	1875 – 1950	Gently sloping alluvial fan and valley bottom; crossing of steep hill in southern Smith Valley and just south of Hercules Gap	Tertiary sedimentary materials (Qs) and minor Devonian Guilmette Frm (Dg) and Ordovician Lower Part Pogonip Group and Eureka Quartzite (Ol)	1 major fault crossing at MP 36; 1 minor fault crossing; erosion on the two steep hills	w/in ¼ mi. of gravel pit	w/in 1 mi. of min shaft so. of State Prison and w/in 1 mi. of scattered prospects; w/in 1 mi. of San Francisco Mining District, 2 mi. of Duck Creek Mining District and 3 mi. of Robinson Mining District; scattered oil wells and geothermal wells

TABLE 3.1-1: ELEVATION, TOPOGRAPHY, GEOLOGY, AND HAZARDS (CONT.)

Milepost	Elevation (meters)	Topography	Geology	Hazards	Features within ½ mile	Features within 10 miles
K Re-route						
0 – 4.5	1650 – 2060	Steep hills and canyons (Toiyabe Range): gently sloping fan slopes of Upper Grass Valley	Oligocene Caetano Tuff (Itc) and Devonian Slaven chert (Ds): Quaternary fan deposits (Qf))	Crossing of fault and thrust fault: slope instability; erosion; crossing of Cortez Mining District	Spring Mine and many prospects w/in ½ mile	Mines and many prospects w/in 1 – 5 miles of TL; w/in 7 mi. of Buckhorn Mining District and 8 mi. of Bullion Mining District
L Re-route						
0 – 7.0	1450 – 1600	Gently sloping alluvial apron	Quaternary alluvial fan deposits (Qf)			w/in 1 mi. of Argenta Mining District, 3 mi. of Bateman Canyon Mining District; 4 mi. of Beowawe Mining District and 8 mi. of Bullion Mining District

3.1.3 ENVIRONMENTAL CONSEQUENCES

This section presents the project-related actions for construction and long-term operation that may have significant impacts on the geological environment, extraction of mineral, oil, gas and geothermal resources, as well as significant geologic hazards that may affect the safety and operational reliability of the transmission line facilities. This section also includes mitigation to avoid or eliminate the impacts or reduce the effects to a less-than-significant level. The specific locations for the transmission towers, materials yards and spur roads have not yet been determined. Therefore, this assessment addresses potential impacts, some of which are likely to be avoided by discretionary site selection decisions by the project engineers and construction contractor. Site-specific impacts and mitigation measures will be addressed fully in the COM Plan. However, for purposes of a conservative analysis in this EIS, no assumptions are made about specific siting to avoid hazards or impacts.

As many of the route alternatives share segments (e.g., Segments A and J are common to all of the routes), the analysis first addresses impacts that are common to all of the route alternatives. It then examines impacts that are specific to each of the route alternatives. This serves to reduce redundancy in discussion of the impacts and to present a clearer comparison of the alternatives. A discussion of the No Action alternative is also included.

SIGNIFICANCE CRITERIA

Project construction and operation activities would have a significant impact on topography due to grading, erosion, and other effects if they would occur on steep slopes.

A significant impact would result if the proposed facilities were to fail or create hazards to adjacent property due to:

- Effects of fault rupture or other earthquake effects from an earthquake; and/or
- Natural or induced soil movements and slope instability; and/or
- Adverse soil conditions (e.g., soft compressible, expansive, or corrosive soils).

A significant impact would result if:

- The proposed facilities were to cross an existing or proposed mining operation with an approved mining plan and/or preclude mining operations or leasing of oil, gas, and geothermal resources in the affected area.

Steep Slope

Slope is not a specific environmental attribute that would be affected by project construction and operations. However, slope is an indicator of the relative degree of hazard and potential impact because it has a strong influence over grading requirements, relative stability of earth materials, soil erosion potential, and other factors. Therefore, slope brings together a range of conditions and hazards that indicate the potential for impact. Other geologic factors have substantial influence as well, but slope is generally a good measure of hazard and impact. The hazard increases with slope; thus, construction activities and placement of transmission towers or other facilities on slopes with 15% or greater gradient are considered to constitute high potential for significant impact before mitigation. Construction activity and placement of transmission towers or other facilities on slopes with 4% or less gradient are considered to constitute a low potential for significant impact.

Fault Zone Crossing

Placement of transmission towers or other facilities within active (Holocene or historic) fault hazard zones is considered to constitute a high potential for significant impact before mitigation. Similarly, construction in areas of potential liquefaction hazards would constitute a potentially significant hazard and impact.

Slope Stability

Placement of transmission towers or other facilities within unstable slopes and soils subject to rapid displacement (e.g., from landslides and earthflows) requiring substantial engineering to ensure stability of the structures is considered to constitute a high potential for significant impact before mitigation.

Mining

Active mining claims in the study area are concentrated along Segments B, E and I. The major gold companies with active claims in the study area are Placer Dome, Newmont Gold, Homestake Mining, Cortez Gold, and Oro Nevada Exploration. As listed in the database developed by the Nevada Bureau of Mines and Geology (see separate technical memorandum "Active Mines, Oil/Gas Wells and Geothermal Wells Within 10 Miles of the Falcon to Gonder Transmission Project" (EDAW 2001), the number of active mines within 10 miles of proposed transmission corridor segments include the following: Three active mines in the vicinity of Segment B (Cortez Gold Mines, Mule Canyon Gold Mine, and Argenta Barite Mine). Mule Canyon and Argenta are also within 10 miles of Segments A and the L re-route, and Cortez is within 10 miles of the Segment K re-route. Three active mines are found within 10 miles of Segment E (Yankee Gold Mine, Alligator Ridge Gold Mine and Bald Mountain Gold Mine). One mine (Ruby Hill Gold Mine) lies close to Segment I, and also within 10 miles of Segments G and H. There are also a few individuals and some small gold exploration companies that have active claims in or near the ROW (see also Section 3.13, Land Use and Access). Through early communications with the existing mining companies, SPPC made efforts to site the route alternatives to avoid active mining claims and potential mineral development areas.

All the route alternatives would cross mining districts. However, few areas within these districts are currently being mined, and this land use category only indicates areas with commercial mining potential. Within these mining districts are approximately 122 active mining claims in the study area. Of these, 70 claims are within or adjacent to the ROW, while 52 claims are outside of the ROW vicinity. The proposed transmission line would pass within about 450 feet of a stockpile at the Ruby Hill gold mining project near Eureka. Interference with the Ruby Hill gold mine is not expected, as there are no known plans for expansion of the mine to the north and the mine is anticipated to begin reclamation in about one year.

The transmission line would not be expected to preclude or substantially interfere with extraction of leasable gas, oil and geothermal resources, as these resources can usually be tapped at several locations or drilling can be done at an angle to avoid transmission line towers. Drilling pads can be located to allow sufficient separation from a transmission line so as not to interfere with the operations of either facility. The proposed transmission line would be routed to avoid effects on the Beowawe Geothermal Plant (Segment B) and the transmission line would not have any significant impact on operation of the geothermal resources field. In general, transmission lines can span and clear almost any geothermal facility, and that is common in many developed geothermal fields.

Similarly, while Segment D of the proposed transmission line would pass near the Pine Valley Oil Field, it would not interfere with existing operations. On all route segments, only one oil well is in the immediate alignment (Segment B would pass directly at ATR Ginn No. 1-13). Oil/gas wells within 1,000 feet horizontally of a proposed corridor segment include two for Segment B, one for Segment C, one for Segment D, and four for Segment E (see technical memorandum: "Active Mines, Oil/Gas Wells and Geothermal Wells Within 10 Miles of the Falcon to Gonder Transmission Project" (EDAW 2001). In general, a 1,000-foot separation from any existing well may be considered ample distance to ensure no interference with operation of that well.

ENVIRONMENTAL IMPACTS – COMPARISON OF ROUTE ALTERNATIVES

Impacts Common to All Route Alternatives

The following presents the impacts and associated mitigation measures that are common to all route alternatives. The transmission line would traverse a wide variety landforms and geological materials, which pose site-specific constraints and potential for impact. While the constraints and impacts would be specific to given sections of a segment, there is a commonality of constraint types and potential impacts, which are described below.

In addition, the transmission would pass through a number of mining districts; and the potential for impact on existing and planned mining operations would be unique to each mining area. However, the nature of the impact would be similar for each mining area; therefore, the impacts are discussed in the following section.

☐ *Impact Geo-1: Construction on Steep or Unstable Slopes*

The project would require local grading that would alter the topography, particularly on steep slopes. Grading potentially could create unstable cut-and-fill slopes, especially on steep slopes and areas with weak rock materials. Most grading would be required for construction of suitable footings for the transmission towers. Some grading would be needed for the centerline travel route, temporary spur roads, widening of existing access roads, construction pads for structure sites located on steep slopes -- in order to provide safe and level surfaces for excavation equipment, cranes, bucket trucks, and tower assembly. Hazards from unstable slopes and seismic hazards could affect roads; however, in general, the impacts are likely to be less than significant. Debris clearing and road repair would be required as a normal response to such an event.

Most transmission tower construction would involve minor excavations and fill, and the potential impact on the environment would be less than significant. However, some sites would encounter steep and difficult terrain or would be subject to geotechnical hazards that would need to be corrected before the towers are constructed. Such conditions potentially would include the following:

- Steep slopes (generally 15% or greater) may require fill or cuts to accommodate the footings for the towers or provide sufficient space for the necessary road surface width, grade, and turning radius.
- Soft, compressible soils may require deeper footings for the towers, or imported fill material, or concrete to provide suitable restraint to meet code requirements. Similarly, weak soils may have to be re-graded or reinforced with imported fill material to provide a suitable base for access by construction and maintenance equipment.
- Unstable slopes may need to be stabilized to ensure that the towers and roads would be protected from hazards that may result in tipping or failure of a road. This may include unstable slope hazards at the immediate construction site as well as adjacent areas that could affect the site. Such hazards may include landslides, rockfall and debris avalanches, mudflows, erosion on steep slopes, and areas subject to liquefaction in earthquakes.

The preceding geotechnical hazard conditions would be site specific. As individual tower placement and road construction plans are not yet available, the hazards and impacts are treated here generically. The hazards would be evaluated by SPPC or its contractors for each tower location site and road construction area. The options would be avoidance of the site by selection of a site with stable conditions or correction of the unstable slope conditions, which usually entails grading and other methods. Correction of the unstable soil conditions would have potential impacts, notably topographic alteration produced by cut-and-fill slopes. If not properly engineered and constructed, the cut-and-fill slopes themselves could create unstable conditions in the long-term, which could compromise the operational reliability of the line. Construction spoil material could be improperly dumped at the site, creating unstable soil conditions.

The impact is significant and mitigation would be required as presented in the following mitigation measures.

☐ *Mitigation Measure Geo-1a*

SPPC would retain a qualified engineering geologist to evaluate if geotechnical hazards and unstable slopes are present on the centerline route and areas of new road construction or widening on slopes with over 15% gradient. The engineering geologist would evaluate the nature of the steep slope and/or unstable soil hazard at tower sites with these constraints and the immediate vicinity to allow options for avoiding the hazard. The evaluation should be based on an inspection of all sites where towers or roads would be constructed with slopes of 15% or greater or identified slope instability hazards. Soil testing would be conducted, if needed, to ascertain the depth and lateral extent of unstable materials, and consideration of hazards both upslope and downslope of the site. The engineering geologist would prepare a report that includes recommendations for moving the towers or roads, or identifies construction methods to stabilize the site or off-site areas that would threaten the hazard sites if the structures cannot be moved. SPPC would incorporate the recommendations of the engineering geologist into its COM Plan, including construction drawings and details for grading, drainage, specialized slope treatment (e.g., installation of retaining walls, wire retention structures, gabions, berms to deflect debris avalanches, etc.). SPPC's construction contractor would implement the plans, and SPPC quality assurance inspectors and the environmental monitors would inspect and certify that the slopes have been constructed and stabilized in accordance with details in the COM Plan.

❑ ***Mitigation Measure Geo-1b***

Under no circumstances would cut-or-fill slopes be allowed to pose a temporary or long-term hazard to the project facilities or to off-site property. All cut slopes would be cut at an angle of repose and/or benched or otherwise protected to ensure its long-term stability. SPPC would commit to appropriate re-contouring, erosion control, and reseeding of all cut-and-fill slopes. SPPC would also ensure the long-term stability of all slopes. Monitoring and stability requirements would be detailed in the Reclamation section of the COM Plan.

❑ ***Mitigation Measure Geo-1c***

To reduce the environmental impacts of slope alteration, all practicable measures should be taken to avoid sites for towers and roads that have severe geotechnical hazards requiring substantial grading and other engineering of cut-and-fill slopes.

❑ ***Impact Geo-2: Construction in Seismic Hazard Areas***

The project would be subject to earthquakes that could damage facilities and affect reliable use of the line. The entire region is located within Zone 2 or 3 of the Uniform Building Code (UBC), which represents an area of seismic hazard. Primary earthquake hazards include damage from ground displacement along a fault zone, severe ground shaking, and induced secondary hazards such as liquefaction, rapid differential settlement, lurching, landslides, and rockfalls. Most of the earthquake-related hazards can be accommodated by engineering design or avoidance of high hazard areas. In general, the most severe hazard is posed by ground displacement along a fault zone. Vertical or lateral ground displacement induced by movement along a fault zone could result in transmission tower tipping. Such events have been rare in the United States because location of transmission towers in active fault zones is generally avoided by prudent siting. Often, known and mapped fault rupture zones can be avoided or spanned. Usually, there is sufficient leeway in conductor wires to accommodate some ground displacement without damage to the wires. In major earthquakes, wrapping of conductors potentially could occur as a result of the ground motions, resulting in operational failure.

Severe ground shaking also can damage towers, although that is a fairly rare occurrence in the United States. The Landers Earthquake in 1992 in California resulted in sufficient ground shaking to damage towers on soft soils in which amplified ground movements occurred during the earthquake. Most of the transmission corridor would be located on deep alluvial soils that may be generally expected to experience amplified ground shaking during earthquakes. The greatest hazards to the facilities from ground shaking would occur where they are located on alluvial soils and artificial fill, especially un-engineered fill (e.g., old road fills and mining spoils dumps). Ground shaking on bedrock substrate potentially may result in some damage to transmission towers if the shaking is violent. In general, however, the nature of ground shaking on bedrock has had minor effect on transmission towers even for large earthquakes in the United States. As a general rule, the vibration and motion established by earthquakes is no greater than the maximum induced by severe windstorms. The evaluation of both earthquake-induced vibration and wind-induced vibration should be carried out in conjunction with one another.

Liquefaction is the rapid loss of physical soil structure caused by ground shaking of saturation of fine sandy soil and the resultant change in water pore pressure; in effect, the soil becomes fluid like quicksand. Liquefaction results in a loss of the ability of the soil to support structures. Tower footings could lose their support and sink or become laterally displaced. The towers could be damaged or tip. Liquefaction hazard only occurs in soft soils, like alluvium, but not all alluvial soils are subject to liquefaction. Alluvium must have at least one stratum of material that is comprised of fine sandy material and is saturated by groundwater. If these conditions are not met in a substantial, relatively thick stratum in the alluvium, then the potential for liquefaction is very low. As a whole, it is expected that the hazard would be most prevalent in the flat valley bottom areas or areas near the base of an alluvial fan. However, alluvial fills in valley bottoms even in valleys in the mountains would be subject to liquefaction hazard if the soils are sandy and saturated. There are other related effects in alluvial soils, such as lurching (the lateral movement of the ground surface toward an unsupported face, such as a river bank), lateral spreading (the lateral displacement of the ground surface usually related to liquefaction of saturated soils), collapse of stream banks created by ground shaking, and differential rapid settlement resulting from sudden changes in the physical structure of the supporting soils.

Additional secondary effects of earthquakes include induced landslides and rockfalls. The ground shaking accompanying an earthquake may be sufficient to dislodge unstable soil and rock material. The hazard to the facilities would depend on the location of the facilities in relation to the landslide or rock avalanche slope. Transmission towers and roads could be sited on unstable soils that move laterally or horizontally and result in damage to the facilities. Similarly, adjacent landslides may move onto the site of the towers or roads, burying them in debris. Earthquakes have often reactivated ancient landslides that have remained conditionally stable for centuries. The ground motions of the earthquake reactivate movements on the slide plane. In mountainous areas with steep slopes, rockfall avalanches may be created by earthquake ground shaking that could damage towers and cover roads.

☐ *Mitigation Measure Geo-2a*

To reduce the hazards of damage from ground rupture, all practicable measures should be taken to avoid sites for transmission towers that are located within known fault zones. Fault zones with a record of historic or Holocene (within the last 10,000 years) fault displacement should be considered capable fault zones. A geotechnical engineering investigation will be conducted for the project. A licensed geotechnical engineer will conduct the investigation in a manner consistent with Nevada geologic and engineering standards. The geotechnical engineer will prepare a report that summarizes the results of a field investigation, including site inspection and soil testing, potential geologic hazards (including fault rupture and severe secondary effects of earthquakes), and design criteria and construction methods to effectively construct the project with an acceptable level of risk. The report will address all geologic and geotechnical factors related to the design and construction of the project. The geotechnical engineering investigation will delineate areas of active and potentially active faults. To the extent possible, it will identify fault traces and locate them in the field so faults can be avoided during tower siting. A more detailed geologic investigation may be necessary in some active and potentially active fault areas if the trace is not sufficiently defined by surface geologic features.

Transmission lines will necessarily cross active fault zones. The large span length and tower design will tolerate deflections greater than the maximum horizontal or vertical displacements that would be anticipated from worst-case fault rupture. While it may not be possible to entirely eliminate the potential for tower failure in a fault rupture zone, it is possible to design and construct the facilities to criteria that establish an acceptable level of risk.

☐ *Mitigation Measure Geo-2b*

To reduce the hazards of damage from ground shaking and secondary earthquake hazards (liquefaction, lurching, lateral spreading, rapid differential settlement, induced land sliding, and rock-fall avalanche), all practicable measures should be taken to design and construct the transmission towers and substation facilities and equipment to withstand the projected ground shaking associated with the maximum probable earthquake (MPE) in the area. SPPC's project geotechnical engineering investigation will provide regional seismic criteria for the design of project facilities including transmission components, new roads, and substation additions. To minimize potential damage from ground shaking and secondary earthquake effects, SPPC would design the transmission line structures using project-specific criteria in accordance with the latest revision of the National Electric Safety Code (ANSI C.2). Substation facilities would meet the appropriate design criteria contained in the most current edition of the Uniform Building Code for the seismic zone in which they are located.

Impact Geo-3: Construction in Problematic Soils

The proposed facilities would be located in areas that may have problematic, expansive clay soil and/or corrosive and hydro-thermal soil. Expansive clay soils swell when wet and shrink when dry. The result of this soil behavior can be damaging to roadbeds. Some soils along the routes may be corrosive to metal and cement and over time weaken their ability to support structures. Alkaline/saline and hydro-thermal conditions in soils may enhance corrosive effects of cement, wood and metal. These effects would be most problematic for transmission tower foundations and over time they could be weakened. While this is a potentially significant impact, the effects of problematic soils generally can be readily remedied using common construction methods to engineer soils and moderate the corrosive effect. (See also Section 3.2, Soils.)

Mitigation Measure Geo-3

The project geotechnical engineering investigation will identify foundation problems, including presence of expansive clay soil, corrosive soil, and hydro-thermal soils, and provide recommendations for appropriate foundation design and construction solutions. Towers and foundations will be protected from corrosion and other soil problems in accordance with the geotechnical investigation and industry standards. SPPC would incorporate the recommendations of the engineering geologist into its site planning, prepare construction drawings for grading, drainage, and specialized design treatment and specify construction requirements in the COM Plan. SPPC's construction contractor would implement the plans.

Impact Geo-4: Potential Interference with Mining

SPPC would avoid locating the proposed transmission line such that it would conflict with existing active mining operations or proposed expansion plans (e.g., Cortez Mine on Segment B) or provide compensation where appropriate and reasonable for existing holders of active mining claims within the right-of-way. Thus the project would not have a significant impact on existing mining operations or active claim holders. Once constructed, however, the transmission line could potentially conflict with future plans for mineral development in the right-of-way.

Mitigation Measure Geo-4

If there are existing mining rights associated with private lands or existing active mining claims on public lands, SPPC would attempt to evaluate and compensate for the loss of potential mining profits based on available information (e.g., existing records, site evaluations, etc.) in order to utilize the land to construct the proposed transmission line. As an alternative to compensation for loss to potential mining profits, SPPC and the landowner or existing active claim holder may negotiate a settlement covering relocation of the transmission line or specific towers so as to present no substantial limitation to the future development of any mining rights or claims (personal communication with John Berdrow, SPPC, March 22, 2001). Compensation for the loss of potential mining profits and the conditions for relocation would be site specific and handled on a case-by-case basis. Thus, the proposed transmission line would not have a significant impact on mineral development.

As all of the route alternatives include Segments A and J, their geologic characteristics and potential impacts are discussed below.

Segment A

The Falcon substation is located in Boulder Valley. As shown in Table 3.1-1, from Milepost (MP) 0 to 8.5, the transmission line crosses the flat alluvial floodplain of Boulder Valley, rising to foot of the Shoshone Range. The substrate is comprised of deep alluvium on almost flat topography. From MP 8.5 – 16.7, the alignment skirts the western edge of Whirlwind Valley along the gently sloping coalesced alluvial apron at the foot of the Shoshone Range. The route runs parallel to an existing transmission line. Substrate varies between Quaternary older alluvium and bedrock of Tertiary volcanic materials (basaltic andesites) (Roberts et. al. 1967). A major fault zone is crossed at about MP 6.6 near Dunphy. No mines are located in the immediate segment vicinity though the Mule Canyon and Argenta Mines are within 10 miles. The route passes near the Beowawe Mining District, and the Argenta Mining District is in the general vicinity (i.e., within 10 linear miles of the route). The NBMG database lists one oil/gas well and 54 geothermal wells within 10 miles of Segment A. However, since none of the wells are located in or near the immediate Segment alignment, no impact is anticipated.

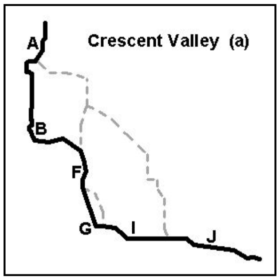
Segment J

As shown in Table 3.1-1, Segment J largely crosses gently and moderately sloping areas of older and younger age alluvial fans and flat valley floor areas comprised of alluvial deposits in Jakes Valley, Smith Valley, and Steptoe Valley (Hose and Blake 1976). Moderate and steep slopes are encountered in the Antelope Mountain area, Butte Mountains, and Egan Range, where volcanic rocks and sedimentary rocks of the Tertiary and Paleozoic crop out (Hose and Blake 1976). Two major fault zones are crossed by the segment: at MP 13.5 on the eastern side of the Butte Mountains, and at MP 36 on the eastern side of the Egan Range. The segment passes through the Illipah Mining District. The San Francisco, Robinson, and Duck Creek Mining Districts are in the general vicinity of the segment. The NBMG database lists no active mines, 20 oil/gas wells and 20 geothermal wells within 10 miles of Segment J. Since none of the mines or wells is located within one mile of the segment, no impact is anticipated.

Alternative-Specific Impacts

In addition to the impacts common to all route alternatives, the following presents impacts associated with specific route alternatives. Because the route alternatives differ by one or more segments, these alternative-specific impacts are best discussed in terms of their differentiating segments.

Crescent Valley (a) Route Alternative



The Crescent Valley (a) route alternative is comprised of Segments A, B, F, G, I, and J. In addition to the impacts common to all route alternatives discussed above (i.e., Impact Geo-1 through –4), specific impacts for the Crescent Valley (a) route alternative are described below.

Segment B

❑ ***Impact Geo-5: Potential Conflicts with Cortez Gold Mine and Oil/Gas Well ATR Ginn No. 1-13***

Segment B passes close to the existing Cortez gold mine open pit, heap leach pads, and process area, including mine tailings. While the proposed route bypasses this existing mine area, it would substantially conflict with the Cortez Gold Mine's newly proposed Pediment Mine Project, also on Segment B, which would be a significant impact. A plan of operations for the Pediment Mine Project was submitted to the BLM's Battle Mountain Field Office in January 2001 (Collord 2001). In addition, while the transmission line would not directly affect the proposed South Pipeline mining operations area (BLM 1999), it would pass through that project's area boundary. The NBMG database lists three active mines, 12 oil/gas wells and 88 geothermal wells within 10 miles of Segment B. The transmission project could affect at least one active oil/gas well (ATR Ginn No. 1-13) located directly on the route in Segment B, as identified in the NBMG database. While interference with operation of the well is unlikely; for safety reasons, it probably would be desirable not to co-locate the transmission facility and the well. However, any impact could be avoided entirely by using the Segment L re-route, which circumvents this well. The segment passes through the Beowawe geothermal field, but does not impact the geothermal power plant facilities and would not be expected to impact operations of the geothermal field.

☐ ***Mitigation Measure Geo-5***

SPPC will negotiate with the owners of the Cortez gold mine regarding planned future operations. If no conflict appears to occur with future mining operations, mitigation would not be required. However, if a potential conflict with operations or planned expansion of mining into the transmission corridor would occur, SPPC would either relocate its transmission line or negotiate with the gold mine owners to provide compensation.

Table 3.1-1 presents information about the topography and geology of Segment B. Segment B largely crosses gently sloping to flat areas of older and younger age alluvial fans, and valley floor areas comprised of alluvial deposits in Crescent Valley, the upper end of Grass Valley, upper Horse Creek Valley and Denay Valley (Stewart and McKee 1977; Roberts et al. 1967). Mountain areas with steeper slopes and varied geologic rocks are encountered in crossings of the Malpais Hills and Cortez Mountains that include volcanic basaltic andesite, limestone, and Vinini Formation rocks Valley (Stewart and McKee 1977; Roberts et al. 1967). The route passes near a hydro-thermal area in Whirlwind Valley near MP 3. A major fault zone is crossed at four locations: near MP 9 in the Malpais Hills; at MP 32-33 at the western edge of the Cortez Mountains, at MP 41 on the southern side of the Cortez Mountains, and at MP 54 in Denay Valley.

The route passes near the large open pit Cortez gold mine at MP31-33. The northern end of the route impinges on the edge of the Beowawe Mining District, and the Argenta, Bateman Canyon, and Bullion Mining Districts are in the general vicinity. The middle section of the segment passes through the Cortez Mining District in two locations. Numerous mines are concentrated in the Cortez Mountain section. The Buckhorn and Alpha Mining Districts are within the general vicinity.

K re-route (on Segment B)

Table 3.1-1 presents information about the geological environment of the K re-route, which was identified as a possible way to avoid sensitive resources on a portion of Segment B. The K re-route largely crosses moderately and steeply sloping areas of in the Cortez Mountains, where Quaternary volcanic rocks and fan deposits and Paleozoic sedimentary rocks crop out (Stewart and McKee 1977). No major fault zone is crossed by the segment. An important thrust fault is located in the vicinity and may underlie the segment. The K re-route passes through the Cortez Mining District, and is within 10 miles of the active Cortez mine. The Buckhorn and Bullion Mining Districts are in the general vicinity of the re-route. The NBMG database lists four geothermal wells and no oil/gas wells within 10 miles, but beyond 5 miles, of Segment K re-route; therefore, no impact is anticipated.

L re-route (on Segment B)

Table 3.1-1 also presents information about the geological environment of the L re-route. This re-route was identified as a possible way to avoid sensitive resources on a portion of Segment B. The L re-route largely crosses gently sloping on fan slopes of the Shoshone Range (Stewart and McKee 1977). No major fault zone is crossed by the re-route. The L re-route passes through the edge of the Argenta Mining District, and is within 10 miles of the active Mule Canyon and Argenta mines. The Beowawe, Bateman Canyon, and Bullion Mining Districts are located in the general vicinity of the re-route. The NBMG database lists 54 geothermal wells and four oil/gas wells within 10 miles of Segment L re-route. However, no impacts are anticipated, since none of these wells are in close proximity.

Segment F

As shown in Table 3.1-1, Segment F largely crosses gently sloping to flat areas of older and younger age alluvial fans, and valley floor areas comprised of alluvial deposits in Garden Valley (Roberts et al. 1967). Moderate slopes are encountered in the Hope Mountain area, where volcanic rocks and sedimentary rocks of the Vinini Formation crop out (Roberts et al 1967). A major fault zone is crossed near MP 1.5 on the northwestern side of the Roberts Mountains. The route passes through the Mount Hope Mountain Mining District. The Alpha, Antelope (Eureka) and Diamond Marsh Mining Districts are in the general vicinity of the segment. The NBMG database lists no active mines, 12 geothermal wells and 5 oil/gas wells within 10 miles, but none within one mile, of Segment F; therefore, no impact is anticipated.

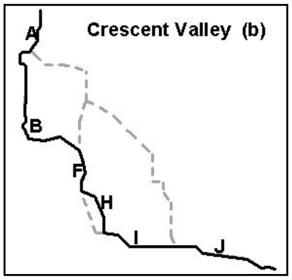
Segment G

As shown in Table 3.1-1, Segment G largely crosses gently sloping areas of older and younger age alluvial fans, and flat valley floor areas comprised of alluvial deposits in Kobeh Valley (Roberts et al. 1967). Moderate slopes are encountered in the Hope Mountain area, where volcanic rocks and sedimentary rocks of the Vinini Formation crop out (Roberts et al 1967). No major fault zone is crossed by the segment. The northern end of the route passes through the Mount Hope Mountain Mining District. The Antelope (Eureka), Alpha, Lone Mountain (Eureka), Eureka, and Fish Creek Mining Districts are in the general vicinity of the segment. The active Ruby Hill Mine, though within 10 miles, lies closest to Segment I. The NBMG database lists three geothermal wells and no oil/gas wells within 10 miles, but all beyond 5 miles, of Segment G; therefore, no impact is anticipated.

Segment I

Segment I largely crosses gently and moderately sloping areas of older and younger age alluvial fans and flat valley floor areas comprised of alluvial deposits in Diamond Valley, and Newark Valley (Roberts et al. 1967; Hose and Blake 1976). Moderate and steep slopes are encountered in the Diamond Mountains, where volcanic rocks and sedimentary rocks of the Diamond Peak and Newark Canyon Formations crop out (Roberts et al 1967). Two major fault zone is crossed by the segment: at MP 13 on the east side of the Diamond Mountains, and near MP 27 in Newark Valley. The segment passes through the Eureka Mining District, where many mines are located in the vicinity. The Fish Creek, Pinto, Newark Pancake, and Illipah Mining Districts are in the general vicinity of the segment. The NBMG database lists one active mine (Ruby Hill Gold Mine), 11 oil/gas wells, but no geothermal wells within 10 miles of Segment I. Segment I passes within 450 feet of an existing stockpile and east waste rock dump at the Ruby Hill gold mine. The transmission line also would cross the main access road; however, an existing overhead power line already crosses the road. The proposed route bypasses the existing operation area and would not substantially interfere or conflict with the mining operation (BLM 1997). None of the oil and gas wells are located within a mile of the segment; therefore, no impact is anticipated.

Crescent Valley (b) Route Alternative

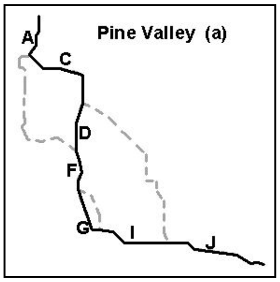


The Crescent Valley (b) route alternative is comprised of Segments A, B, F, H, I, and J. It follows a similar alignment to the Crescent Valley (a) route, except that it uses Segment H instead of Segment G.

Segment H

As shown in Table 3.1-1, Segment H largely crosses gently and moderately sloping areas of older and younger age alluvial fans and flat valley floor areas comprised of alluvial deposits in Kobeh Valley (Roberts et al. 1967). Moderate slopes are encountered in the Hope Mountain area, where volcanic rocks and sedimentary rocks of the Vinini Formation crop out (Roberts et al 1967). No major fault zone is crossed by the segment. The northern end of the route passes through the Mount Hope Mountain Mining District. The Antelope (Eureka), Alpha, Lone Mountain (Eureka), Diamond, Eureka, and Fish Creek Mining Districts are in the general vicinity of the segment. The active Ruby Hill Mine, though within 10 miles, lies closest to Segment I. The NBMG database lists three geothermal wells and four oil/gas wells within 10 miles, but all beyond 5 miles, of Segment H; therefore, no impact is anticipated.

Pine Valley (a) Route Alternative



The Pine Valley (a) route alternative is comprised of Segments A, C, D, F, G, I, and J. It follows a similar alignment to the Crescent Valley (a) route, except that it uses Segments C and D instead of Segment B.

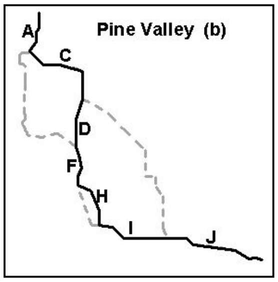
Segment C

Segment C largely crosses gently sloping to flat areas of older and younger age alluvial fans and valley floor areas comprised of alluvial deposits in Whirlwind Valley, Crescent Valley, and Pine Valley. Steep and moderate slopes are encountered in the Dry Hills and Cortez Mountains, where volcanic rocks and sedimentary rocks of the Valmy Formation and Newark Canyon Formation are encountered (Roberts et al. 1967). The route passes near a hydro-thermal area in Whirlwind Valley near MP 1-2. A major fault zone is crossed at three locations: near MP 2 in the Malpais Hills; at MP 11.5 at the western edge of the Dry Hills, and at MP 21.5 on the western of the Cortez Mountains. The route passes through the Beowawe Mining District at its northern end. The Argenta, Safford, Pine Valley, Carlin, Robinson Mountain, Larrabee, and Modarelli-Frenchie Creek Mining Districts are within the general vicinity. While the active Mule Canyon and Argenta Mines are both more than six miles away. The NBMG database lists 93 geothermal wells and 54 oil/gas wells within 10 miles of Segment C. Only one oil well (West Hay Ranch No. 12-1) is located about 1,000 feet from the segment. Because the separation from the transmission line segment is substantial, no impact is anticipated. The other wells are more distant and no impact would be anticipated.

Segment D

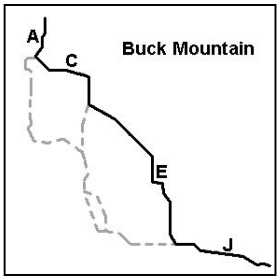
Segment D almost entirely crosses gently sloping to flat areas of older and younger age alluvial fans and valley floor areas comprised of alluvial deposits and Tertiary sediments in Pine Valley (Roberts et al., 1967; Hose and Blake 1976). A major fault zone is crossed at MP 16.5. No mining districts are crossed and there are no mines in the immediate segment vicinity. Mining districts in the general vicinity include the Pine Valley Mineral Hill, Union (Eureka-Elko), Alpha, Antelope (Eureka), Buckhorn, and Modarelli-Frenchie Creek Mining Districts. The NBMG database lists no active mines, 25 geothermal wells and 50 oil/gas wells within 10 miles of Segment D. The Segment passes through the Pine Valley Oil Field. Only one well (Big Pole Creek No. 1-11) is located about 1,000 feet from the segment. Because the separation from the transmission line segment is substantial, no impact is anticipated. The other wells are more distant and no impact would be anticipated.

Pine Valley (b) Route Alternative



The Pine Valley (b) route alternative is comprised of Segments A, C, D, F, H, I, and J. It follows a nearly identical alignment with the Pine Valley (a) route, except that Pine Valley (b) uses Segment H rather than Segment G, traversing the eastern side of Whistler Mountain rather than the west.

Buck Mountain Route Alternative



The Buck Mountain route alternative is comprised of Segments A, C, E, and J. Segment E is unique to the Buck Mountain route and is discussed below.

Segment E

As shown in Table 3.1-1, Segment E largely crosses gently sloping to flat areas of older and younger age alluvial fans, and valley floor areas comprised of alluvial deposits in Pine Valley, Diamond Valley, Huntington Valley, and Newark Valley (Hose and Blake 1976; Coats 1987). Steep and moderate slopes are encountered in the Sulphur Spring Range, Buck Mountains, and Dry Mountain, where a variety of volcanic rocks and sedimentary rocks of the Paleozoic Era crop out (Hose and Blake 1976). A major fault zone is crossed at three locations: near MP 6 on the western side of the Sulphur Springs Range, at MP 28.5 (assumed) in Newark Valley, and at MP 70 in Newark Valley.

The route passes through the Pine Valley and Bald Mountain Mining Districts (including near the proposed Bald Mountain Gold Mine expansion area) (BLM 1995). The Modarelli-Frenchie Creek, Larrabee, Robinson Mountain, Union (Eureka-Elko), Diamond Marsh, Huntington Creek (Eureka White Pine), Chase Diamond, and Illipah Mining Districts are in the general vicinity of the segment. The NBMG database lists three active mines, 25 geothermal wells and 69 oil/gas wells within 10 miles of Segment E. The nearest mine is more than 1.5 miles from the segment; therefore, no impact is anticipated. Four wells are located within about 1,000 feet of the segment; two are water wells (Federal N6509 No. 1 and No. 2). Two of the wells are oil/gas/water wells: Foreland-North Blackburn Federal No. (oil), and Stage Line Unit No. 1-A (oil/gas/water). Because the separation from the transmission line Segment is substantial, no impact is anticipated. The other wells are more distant and no impact would be anticipated.

Summary Comparison of Route Alternatives

TABLE 3.1-2: SUMMARY OF IMPACTS BY ROUTE ALTERNATIVE

Impact	Crescent Valley (a)	Crescent Valley (b)	Pine Valley (a)	Pine Valley (b)	BUCK MOUNTAIN
Impact Geo-1: Construction on Steep or Unstable Slopes	X	X	X	X	X
Impact Geo-2: Construction in Seismic Hazard Areas	X	X	X	X	X
Impact Geo-3: Construction in Problematic Soils	X	X	X	X	X
Impact Geo-4: Potential Interference with Mining	X	X	X	X	X
Impact Geo-5: Potential Conflicts with Cortez Gold Mine (Segment B)	X	X			

RESIDUAL IMPACTS

After implementing mitigation measures, minor residual impacts would remain. Hazards related to unstable slopes and earthquakes would remain and could damage the proposed facilities. Mitigation proposed by SPPC and in this EIS is directed to achieving an acceptable level of risk, meaning that additional regulatory action would not be required to ensure public safety and to achieve the objectives of the project. Implementation of the project would result in minor permanent topographic alteration related to construction activities; however, the impact would be less-than-significant because the proposed changes themselves are relatively small.

NO ACTION ALTERNATIVE

Under the No Action Alternative, potential project impacts related to geologic conditions, locatable and leasable minerals, and geothermal resources would not occur. However, similar impacts could occur in other areas as SPPC and the Nevada PUC would begin emergency planning efforts to pursue other transmission and/or generation projects to meet the projected energy load capacity shortfall.