2. Affected Environment

This section addresses the environmental setting and impacts related to the construction and operation of the proposed Project and alternatives involving the issues of geologic and seismic hazards, and paleontology. The primary reason to define geologic and seismic hazards is to protect structures from physical damage and to minimize injury/death of people due to structure damage or collapse. Sections 2.3 through 2.8 provide a summary of existing geological, soil, and paleontological conditions and associated geologic and seismic hazards present along the proposed alignment and alternatives of the SCE TRTP. Applicable regulations, plans, and standards are listed in Section 3. The approach that was used to analyze impacts to Geology, Soils, and Paleontology is presented in Section 4. Potential impacts and mitigation measures for the proposed Project and alternatives are presented in Sections 5 through 11.

2.1 Baseline Data Collection Methodology

Baseline geologic, seismic, soils, and paleontological information were collected from published and unpublished literature, GIS data, and online sources for the proposed Project and the surrounding area. The literature and data review was supplemented by a brief field reconnaissance of Segments 6, 7, and 8 of the proposed alignment. The literature review and field reconnaissance focused on the identification of specific geologic hazards and paleontologic resources along and adjacent to the Project ROW.

2.2 Regional Setting

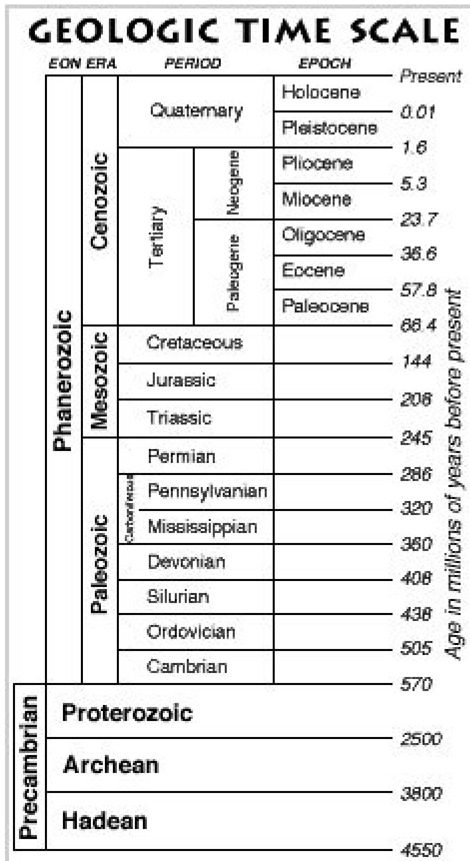
The Tehachapi Renewable Transmission Project is located within the Mojave Desert and Transverse Ranges geomorphic provinces of southern California, which is characterized by a complex series of mountain ranges and valleys with dominant east-west trends. The TRTP traverses six distinct geographic areas, the Antelope Valley, the Leona Valley (the San Andreas Rift Zone), the Liebre-Sierra Pelona Mountains, the San Gabriel Mountains, San Gabriel Valley, the Montebello and Puente and Chino Hills, and the Chino Valley. The Antelope Valley consists of approximately 1200 square miles of elevated desert terrain, located along the western edge of the Mojave Desert. The Leona Valley is a small, northwest-southeast trending longitudinal valley formed by movement on multiple overlapping strands of the San Andreas Fault in the San Andreas Rift Zone, and in the Project area is bounded on the northeast by the Portal Hills and on the southwest by foothills of the Sierra Pelona. The Liebre-Sierra Pelona Mountains are a small northwest-southeast trending mountain range within the central Transverse Ranges. The San Gabriel Mountains are comprised of Precambrian to Cretaceous igneous and metamorphic rock. The San Gabriel and Chino Valleys are deep structural basins predominantly filled with semi- to unconsolidated Quaternary alluvial deposits. The Montebello Hills consist predominantly of Pliocene marine and nonmarine sedimentary rock, whereas the Puente and Chino Hills are composed of older (Miocene and Pliocene) marine sedimentary rock units.

This section presents a discussion of the regional geology, seismicity, soils, mineral resources, and paleontology in the Project area. Section 2.3 presents more specific discussions of each of these issues along the proposed route, broken up into three areas based on the general geologic character the various Project segments cross.

2.2.1 Geologic Setting

The Tehachapi Renewable Transmission Project segments cross five areas of distinctive geologic character and province, the Antelope Valley, the San Andreas Rift Zone, the Liebre-Sierra Pelona Mountains, the San Gabriel Mountains, and the Los Angeles Basin. The proposed TRTP route is underlain in various areas by sedimentary, volcanic, igneous, and metamorphic units ranging in age from Quaternary (approximately the last 1.6 million years) to Pre-Cenozoic (greater than 65 million years). Figure 2-1 (Geologic Time Scale) shows the geologic time scale indicating the breakdown of geologic time units and corresponding ages.

Figure 2-1 Geologic Time Scale



The proposed route crosses lacustrine deposits, alluvial plains and valleys, alluvial fans and pediments, mountain passes, and hills. In addition to data provided in the PEA, geologic maps from the California Geological Survey (CGS) Geologic Map Sheet Series (Bakersfield Sheet, 1965; Los Angeles Sheet, 1969; Long Beach Sheet, 1962; the Santa Ana Sheet, 1966; and the San Bernardino Sheet, 1986), scale 1:250,000, and 7-5 Minute Geologic Quadrangle maps (Dibblee 1989, 1996, 1997, 1998, 1999, 2001a, 2001b, 2001c, 2002a, 2002b, and 2002c), were reviewed to determine location of faults and location and type of geologic units crossed by the Project route. Approximate locations (milepost locations) of geologic units, descriptions, and general characteristics along the Project ROWs are presented in Sections 2.3.1 through 2.3.4 by segment.

Antelope Valley. The Antelope Valley is primarily an alluviated desert plain containing bedrock hills and low mountains. Western Antelope Valley is characterized by relatively flat-lying topography and valley fill deposits. In the Project area and vicinity, the western Antelope Valley is covered primarily by alluvial deposits of Quaternary age: Holocene Alluvium and Pleistocene Older Alluvium. The Holocene alluvial deposits consist of slightly dissected alluvial fan deposits of gravel, sand and clay. The Older Alluvium is located primarily near the margins of the Antelope Valley at the flanks of Portal Ridge and consists of weakly consolidated, uplifted and moderately to severely dissected alluvial fan and terrace deposits composed primarily of sand and gravel (Dibblee, 2001c). The ridges are comprised of crystalline rocks of igneous and metamorphic composition. The west-trending Hitchbrook Fault, which diverges from the San Andreas Fault northwest of the Project area, separates Portal Ridge, with Pelona Schist on the southeast from granitic rocks on the northwest. Beyond the ridge, the Project alignment crosses into the San Andreas Rift Zone in Leona Valley (Norris and Web, 1990).

San Andreas Rift Zone. In the Project area, the San Andreas Fault lies within a linear, trough-like valley called the San Andreas Rift Zone. The Rift Zone in the Project area consists of several anastomosing fault segments (i.e. interlacing faults), which along with erosion by Amargosa Creek, has widened the zone into a valley, the Leona Valley. Holocene Alluvium, Pleistocene Older Alluvium, and the non-marine Pliocene Anaverde Formation underlie the Leona Valley. Exposed among interlacing fault strands within the San Andreas Fault Zone are several members of the Anaverde Formation: the sandstone, clay shale, and breccia members (CGS, 2003e; Dibblee, 2001c). The sandstone member is a medium-to thick-bedded, locally massive, fine to coarse-grained, locally pebbly, with local thin silty interbeds. The clay shale member is thin-bedded, sandy, silty, locally very gypsiferous clay shale with interbedded siltstone and sandstone layers. The breccia member is distinctive, reddish to dark gray, massive, pervasively sheared sedimentary breccia with angular clasts of hornblende diorite. Bedding within the Anaverde Formation strikes mostly parallel to the bounding faults, and has steep to vertical dips (CGS, 2003e).

Liebre-Sierra Pelona Mountains. The Liebre-Sierra Pelona Mountains are composed of late Mesozoic or older granitic and metamorphic rocks north of the Clearwater Fault, Paleocene (early Tertiary) San Francisquito Formation between the Clearwater and San Francisquito Faults, and Mesozoic Pelona Schist south of the San Francisquito Fault (Norris and Web, 1990). The granitic and metamorphic rocks consist of a complex mixture of biotite-rich, closely-fractured quartz diorite and gneiss with local inclusions of diorite and amphibolite. San Francisquito Formation is a layered marine clastic, lithified sedimentary rock formation comprised of thick-bedded arkosic sandstone, cobble and pebble conglomerate, and clay shale and siltstone. The Pelona Schist is primarily composed of distinctive bluish-gray schist that was metamorphosed from clastic and pryoclastic sedimentary rocks.

San Gabriel Mountains. The San Gabriel Mountains, part of the Transverse Ranges, are a 35 km-wide by 110 km-long, WNW-trending uplift bounded by the right-lateral San Andreas Fault on the north and the reverse San Fernando-Sierra Madre-Cucamonga faults on the south. The range is mainly composed of a complex of igneous and metamorphic rocks of Precambrian to early Cenozoic age. These igneous rocks include a diverse assemblage of Precambrian anorthosite-gabbro and Mesozoic granitic rocks (granodiorite, quartz monzonite, quartz diorite, gabbro) which complexly intrude various metamorphic rocks (gneiss, schist, and mylonite) of Precambrian to Mesozoic age. Sedimentary rocks (sandstone, shale, siltstone, and conglomerate) of Cenozoic age locally overlie the crystalline rocks mostly in the westernmost part of the range and occur extensively in the Santa Susana Mountains and unnamed hills to the north (McCalpin & Hart, 2002).

In the San Gabriel Mountains slopes are very steep, ridge tops are narrow, local relief ranges from several hundred to several thousand feet, rocks are dominantly intrusive or gneissic rocks, and local shearing and hydrothermal alteration zones are abundant and control local physiography. The San Gabriel Mountains rise abruptly from the San Fernando and San Gabriel Valleys (with approximate elevations of

900 to 1800 feet at the base of the range front) to an elevation of up to 10,065 feet at Mount San Antonio in the far eastern part of the range. In the range itself major canyons are incised approximately 900 to 1800 feet into a rugged topography where slopes are near the angle of repose, and ridge crests reach relatively uniform heights of 4500 to 6300 feet. Higher elevations are found only in the southeastern part of the range around Mt. San Antonio.

Los Angeles Basin. The Project crosses through the northeastern block of the Los Angeles basin, which is a northwest to southeast triangular wedge about 35 miles and is about 18 miles wide at its widest point. The northeastern block of the Los Angeles basin includes the Repetto, Puente, and San Jose Hills, the San Gabriel Valley, and the Chino basin. The Los Angeles basin developed in the Neogene (Miocene and Pliocene) as a result of regional crustal extension associated with the clockwise rotation of the Transverse Ranges during a crustal upheaval caused by a shift in the surrounding mountains. The underlying crustal weakening resulted in the formation of a large synclinal basin in which sediment from the sea and rivers accumulated, building up in thick layers. Since the early Pliocene, the basin has been deformed by numerous strike-slip, reverse, and blind-thrust faults that accommodate the oblique convergence between the Pacific and North American plates. This tectonic history has resulted in a complex physiographic and geologic structure in the Los Angeles basin (Komatitsch et. al, 2004).

The Los Angeles Basin is divided into four crustal blocks by significant northwest-trending faults. These are informally designated the southwestern, northwestern, central and northeastern blocks. Main faults involved in this division are: the Newport-Inglewood Fault Zone separating the central from the southwestern block, the Whittier Fault Zone separating the central from the northwestern block, and the east–west trending Santa Monica Fault Zone separating the northwestern from all other blocks. The TRTP alignment in the Los Angeles Basin crosses geographic features of the northeastern block, including the San Gabriel Valley, Puente Hills, Chino Hills, and Chino Basin.

2.2.2 Geologic Hazards

Slope Stability

Important factors that affect the slope stability of an area include the steepness of the slope, the relative strength of the underlying rock material, and the thickness and cohesion of the overlying colluvium. The steeper the slope and/or the less strong the rock, the more likely the area is susceptible to landslides. The steeper the slope and the thicker the colluvium, the more likely the area is susceptible to debris flows. Another indication of unstable slopes is the presence of old or recent landslides or debris flows.

Most of the proposed route does not cross any areas mapped as identified existing landslides; however, where the alignments cross mountainous and hilly areas they are partially underlain by landslide prone metamorphic (Pelona Schist and weathered gneiss), sheared igneous and metamorphic (along the San Gabriel fault), and sedimentary (Puente Formation) rocks that are susceptible to slope failures in areas with moderate to steep slopes and unfavorable bedding dip directions. Mapped landslides are present along and near the Project alignments where they cross these units. Unmapped landslides and areas of localized slope instability may also be encountered in the hills and mountains traversed by the proposed Project route. Areas underlain by granitic rocks are generally only susceptible to surficial soil creep, or to rockfall in over-steepened areas.

Soils

The soils along the proposed route reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of human modification. The route crosses undeveloped desert and forest land, agricultural and rural residential land, light industrial and commercial areas, and suburban residential areas. The TRTP segment routes cross areas included in multiple National Resource Conservation Service (NRCS) soil surveys including the Kern County, Southeastern Part – CA670 (2/2006); Antelope Valley Area – CA675 (3/2004); and the Angeles National Forest Area – CA776 (12/2004). The STATSGO databases for California (1994 and 2006) were reviewed for areas not covered by more detailed surveys. A summary of the major soil units traversed by the proposed TRTP segment routes is presented in Table 2-1, including the Project segments these units are mapped along, a general description, and select physical characteristics of hazard of erosion, shrink/swell potential, and corrosion potential. These units are mapped along the various segments as individual soil series and as associations, families and complexes of multiple soil series. General locations of the soil series, associations, families, and complexes along the TRTP segment routes are discussed below in Section 2.3 under the appropriate segment.

Potential soil erosion hazards vary depending on the use, conditions, and textures of the soils. For the purposes of this Project, erosion hazard potential was extracted from the Hazard of Erosion and Suitability for Roads tables from the National Resource Conservation Service (NRCS) GIS SSURGO soil databases and the GIS STATSGO databases for California (in areas not covered by more detailed surveys). Two types of potential erosion hazards are presented in this document: (1) hazard of erosion on roads and trails and (2) hazard of erosion off-road and off-trail. These two types of hazards represent the potential for soil erosion along the Project from ground disturbance due to Project construction.

Erosion hazard ratings for "Roads and Trails" apply to the potential for erosion on unsurfaced roads and trails and are ranked as follows:

- Slight – little or no erosion is likely;
- Moderate – some erosion is likely and simple erosion-control measures are needed;
- Severe – significant erosion is expected and major erosion control measures may be needed.

"Off-Road and Off-Trail" erosion hazard ratings apply to the potential for sheet or rill erosion in areas where 50 to 75 percent of the areas has been exposed by ground disturbance (i.e., grading) and are ranked as follows:

- Slight – erosion is unlikely under ordinary climate conditions;
- Moderate – some erosion is likely and erosion-control measures may be needed;
- Severe – erosion is very likely and erosion-control measures are advised; and
- Very severe – significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion control measures would generally be costly and impractical.

The properties of soil which influence erosion by rainfall and runoff are ones that affect the infiltration capacity of a soil, and those which affect the resistance of a soil to detachment and being carried away by falling or flowing water. Additionally, soils on steeper slopes would be more susceptible to erosion due to the effects of increased surface flow (runoff) on slopes where there is little time for water to infiltrate before runoff occurs.

Soils containing high percentages of fine sands and silt and that are low in density, are generally the most erodible. These soil types generally coincide with soils such as young alluvium and other surficial deposits, which likely occur in areas throughout the Project area. As the clay and organic matter content of these soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion. However, while clays have a tendency to resist erosion, once eroded, they are easily transported by water. Clean, well-drained, and well-graded gravels and gravel-sand mixtures are usually the least erodible soils. Soils with high infiltration rates and permeabilities reduce the amount of runoff.

Corrosivity of soils is generally related to the following key parameters: soil resistivity; presence of chlorides and sulfates; oxygen content; and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. High sulfate soils are corrosive to concrete and may prevent complete curing, reducing its strength considerably. Low pH and/or low resistivity soils could corrode buried or partially buried metal structures.

Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay. Linear extensibility is the method used by the NRCS to determine the shrink-swell potential of soils. Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. The volume change is reported as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed in areas with expansive soils.

2.2.3 Mineral Resources

Metallic and non-metallic mineral deposits occur within the study area. Metallic mineral deposits are restricted primarily to the areas of exposed igneous and metamorphic bedrock in mountain areas. Gold, copper, and iron are the predominant metallic minerals mined in California; however, no active metallic-mineral deposits mines are located in the Project vicinity. Non-metallic mineral resources consisting of sand, clay, gravel, rock products, and petroleum are important mineral resources in California and are still activity mined in the Project vicinity (Kohler, 2002).

Both metallic and non-metallic mineral resources are located in the vicinity of the proposed Project ROW. Mineral resources in the area of Kern County near the Project ROWs consist primarily of limestone and dolomite deposits, primarily being quarried for production of cement (CGS, 1962). In Los Angeles County the principal mineral commodities in the Project area are sand, gravel, and crushed and broken stone. Metallic mineral deposits are present in both counties in varying amounts and are primarily restricted to bedrock areas in the mountainous regions; gold, copper, and tungsten were the predominant metallic minerals (ores) mined in these counties (CGS, 1987). However, no active metallic mines are currently located in the vicinity of the Project ROWs.

Table 2-1. Major Soil Units along the Proposed TRTP Alignments

TRTP Segment(s)	Soil Series	Description	Hazard of Erosion		Shrink/Swell (Expansion) Potential	Corrosion Potential[3]	
			Off-Road or Off-Trail	On Roads and Trails		Uncoated Steel	Concrete
All Segments except Segments 8B & 8C	Hanford	Very deep soil formed in alluvium derived from granite and found on stream bottoms, flood plains, and alluvial fans with slopes of 0 to 15 percent. Consists primarily of fine sandy to sandy loam.	Slight	Moderate to Severe	Low	Low to Moderate	Low to Moderate
Segment 10	Adelanto	Very deep soils formed in granitic material on alluvial fans and alluvial plains with slopes ranging from 0 to 5 percent. Consists primarily of loamy sand to sandy loam[1] with minor coarse sand and fine gravel.	Slight	Slight to Moderate	Low	High	Low
Segment 10	Garlock	Very deep soils formed in mixed alluvium on old stream terraces and alluvial fans in the Mojave Desert. Soil formed on slopes ranging from 2 to 9 percent. Consists primarily of sand, loamy sand, and sandy loam and has slight to moderate alkalinity.	Slight	Moderate	Low to Moderate	High	Low
Segments 10 & 4	Cajon	Very deep, soils formed in sandy alluvium primarily derived from granitic rocks on alluvial fans, fan skirts, and river terraces. Found on slopes ranging from 0 to 15 percent. Typically the soil texture ranges from coarse to loamy to fine sand.	Slight	Slight	Low	Moderate	Low
Segments 10 & 4	Hesperia	Very deep soils formed in alluvium derived from granite and related rocks on alluvial fans, valley plains, and stream terraces with slopes of 0 to 9 percent. Consists primarily of fine sandy loam with calcareous layers at depth,	Slight	Slight to Moderate	Low	High	Low
Segment 4	Rosamond	Deep soils formed in material weathered mainly from granitic alluvium on the lower margins on alluvial fans with slopes ranging from 0 to 2 percent. Consists primarily of fine sandy loam, very fine sandy loam, and silty clay loam.	Slight	Slight	Low to Moderate	High	Low
Segments 4, 5, & 6	Greenfield	Deep soil formed in alluvium derived from granitic and mixed rock sources on alluvial fans and terraces with slopes of 0 to 30 percent. Consists primarily of sandy to coarse sandy loam.	Slight	Slight to Severe	Low	Low to High	Low
Segments 4, 5, 6, and 11	Vista	Moderately deep soils formed in material weathered from decomposed granitic rocks on hills and mountainous uplands with slopes of 2 to 75 percent. Primarily composed of coarse sandy loam to sandy loam.	Moderate to Very Severe	Severe	Low	Low to Moderate	Low to Moderate
Segments 4, 5, 7, 11, and 8A	Ramona	Soils formed in alluvium derived primarily from granitic and related rock types on nearly level to moderately steep terraces and fans. Consists of primarily fine sandy loam, sandy loam, and sandy clay loam.	Slight to Moderate	Moderate to Severe	Low	Moderate	Moderate
Segment 5	Amargosa	Sandy loam to rocky coarse sandy loam on 9 to 55 percent slopes, eroded in places. Formed in material weathered from granite.	Moderate	Severe	Low	Moderate	Low
Segment 5	Anaverde	Deep soils formed in material weathered from metamorphic rocks and found on mountain uplands with slopes of 15 to 75 percent. Consists of loam, clayey loam, and gravelly loam with abundant mica.	Severe to Very Severe	Severe	Low	Moderate	Low
Segment 5	Godde	Shallow soils formed in material weathered from schist, found on uplands with slopes of 15 to 75 percent. Fine sandy loam to loam with some rock fragments.	Moderate to Severe	Severe	Low	Moderate	Moderate

Table 2-1. Major Soil Units along the Proposed TRTP Alignments

TRTP Segment(s)	Soil Series	Description	Hazard of Erosion		Shrink/Swell (Expansion) Potential	Corrosion Potential[3]	
			Off-Road or Off-Trail	On Roads and Trails		Uncoated Steel	Concrete
Segment 5	Las Posas	Moderately deep soil formed in material weathered from basic igneous rocks on mountainous uplands with slopes of 5 to 50 percent. Consists of loam, clay loam, and clay with varying amounts of gravel.	Moderate to Severe	Severe	Low to High	Moderate to High	Low
Segment 5	Toomes	Very shallow to shallow soils formed in material weathered from tuff breccia, basalt, and andesite on ridges and plateaus with slopes of 2 to 75 percent. Typical texture is loam, silt loam, and clay loam with varying amounts of gravel, pebbles and cobbles.	Severe	Severe	Low	Moderate	Low to Moderate
Segment 5	Wyman	Deep soil formed in alluvium from andesitic and basaltic rocks on old stream terraces and old alluvial fans with slopes of 0 to 15 percent. Consist of clay and silt loam.	Slight	Moderate	Low to Moderate	Low to High	Low
Segment 6	Modesto	Soils formed in alluvium primarily derived from granitic sources and occur on nearly level alluvial fans in areas with slow drainage. Typically consists of loam to clay loam.	Very Severe	Severe	Low to High	High	Low
Segment 6	Pacifico	Shallow soil formed in material weathered from granitic and anorthosite rocks on uplands with slopes of 15 to 75 percent. Typically loamy sand with 5 to 15 percent coarse fragments.	Moderate to Very Severe	Severe	Low	Moderate	Moderate
Segment 6	Supan	Soils occur on sloping, plateau-like areas formed in material weathered from the underlying andesitic rock, basaltic tuff-breccia or similar rocks. Typically comprised of loam, clay loam, and gravelly loam.	Severe	Severe	Low to Moderate	Moderate	Low
Segment 6	Capistrano	Very deep soils formed in alluvium from sedimentary or granitic sources on alluvial fans and flood plains with slopes of 0 to 15 percent. Consists primarily of sandy loam.	Slight	Moderate	Low	Low to Moderate	Low to Moderate
Segment 6	Preston	Very deep soil formed in eolian sands on lake terraces and terrace escarpments with slopes ranging from 0 to 60 percent. Consists of fine sand that is moderately calcareous in places.	Moderate	Severe	Low	High	Moderate
Segment 6	Green Bluff	Deep soils formed in glaciofluvial deposits with mixed mineralogy and a component of volcanic ash and loess. Formed on outwash plains over basalt plateaus with slopes of 0 to 15 percent. Consists primarily of ashy silt loam.	Severe	Severe	Low to Moderate	Moderate	Low
Segment 6	Hohmann	Soil formed on steep to very steep mountainous uplands in material weathered from basic metavolcanic rocks. Consists primarily of gravelly clay loam.	Severe	Severe	Low to Moderate	Moderate	Moderate
Segments 6 & 11	Etsel	Very shallow to shallow soil formed in material weathered from sandstone or shale on mountains with slopes ranging from 15 to 85 percent. Consists primarily of slightly acidic gravelly to very gravelly loam.	Very Severe	Severe	Low	Moderate	Moderate
Segments 6 & 11	Kilburn	Very deep soils formed in alluvium and colluvium derived primarily from gneiss, schist, and quartzite on fan, lake, and stream terraces. Consists primarily of very gravelly to gravelly sandy loam.	Very Severe	Severe	Low	High	Moderate

Table 2-1. Major Soil Units along the Proposed TRTP Alignments

TRTP Segment(s)	Soil Series	Description	Hazard of Erosion		Shrink/Swell (Expansion) Potential	Corrosion Potential[3]	
			Off-Road or Off-Trail	On Roads and Trails		Uncoated Steel	Concrete
Segments 6 & 11	Shortcut	Shallow soils formed in material weathered from granodiorite, anorthosite, and gneissic granitic rocks on mountain sides and ridges at slopes of 25 to 85 percent. Typically consists of gravelly loamy sand.	Very Severe	Severe	Low	Moderate	Moderate
Segments 6 & 11	Stukel	Shallow soils formed in residual material weathered from tuff, diatomite, and other volcanic rocks on hills, lava plains, and rock benches with slopes of 0 to 40 percent. Primarily composed of loam.	Very Severe	Severe	Low	Moderate	Low
Segments 6 & 11	Caperton	Shallow soils formed in material weathered from granodiorite and quartz diorite on upland slopes of 2 to 50 percent. Consists primarily of gravelly coarse sandy loam.	Very Severe	Severe	Low	Moderate	Moderate
Segments 6 & 11	Chilao	Shallow soil formed in material weathered from anorthosite, granodiorite, or metamorphic rocks on slopes from 20 to 70 percent. Typically consist of gravelly loam.	Severe to Very Severe	Severe	Low	Moderate	Moderate
Segments 6 & 11	Modjeska	Deep soil formed in mixed alluvium on coastal plain terraces consisting of gravelly to cobbly loam.	Slight to Moderate	Slight to Severe	Low	Moderate	Moderate
Segments 6 & 11	Olete	Formed on strongly sloping to steep uplands in colluvium derived from basalt. Typically consists of gravelly to very gravelly silt loam.	Moderate to Very Severe	Moderate to Severe	Low	Moderate	Low
Segments 6 & 11	Pismo	Shallow soils formed in residual material weathered form soft sandstone on uplands of 9 to 75 percent slope. Consists primarily of loamy sand.	Very Severe	Severe	Low	Low	Moderate
Segments 6 & 11	Trigo	Shallow soils formed in consolidated alluvium from mixed sources on dissected terraces with slopes of 2 to 60 percent. Typically consists of fine sandy loam to loam.	Moderate to Very Severe	Severe	Low	Moderate	Moderate
Segments 6, 7, and 11	Exchequer	Shallow soil formed in material weathered from hard andesitic breccia, schist, and metamorphosed granitic rocks on undulating to steep uplands. Composed primarily of silt loam and loam	Very Severe	Severe	Low	Low to Moderate	Moderate
Segments 6, 8A, 8B, and 8C	Tujunga	Very deep soil formed in alluvium weathered mostly from granitic sources on alluvial fans and flood plains with slopes of 0 to 9 percent. Primarily consists of sand or loamy sand.	Slight	Slight to Moderate	Low	Low to Moderate	Low
Segments 7 & 11	Cieneba	Very shallow to shallow soil formed in material weathered from granitic rock on uplands with slopes of 9 to 85 percent. Consists of coarse sandy loam, gravelly sandy loam, gravelly loam, and loam.	Moderate to Severe	Severe	Low to Moderate	Low	Low
Segments 7 &11	Sobrante	Moderately deep soil formed in material weathered from basic igneous and metamorphic rocks on hills with slopes from 2 to 75 percent. Consists of material ranging from loam, silt loam, clay loam, gravelly loam, or gravelly clay loam.	Moderate to Severe	Severe	Low to Moderate	Moderate	Moderate
Segments 7, 11, and 8A	Sorrento	Very deep soils formed in alluvium derived mostly from sedimentary rocks on alluvial fans and floodplains with slopes of 0 to 15 percent. Consists of loam, sandy loam, clay loam, sandy clay loam, and silty clay loam.	Slight	Slight to Moderate	Low to Moderate	High	Low

Table 2-1. Major Soil Units along the Proposed TRTP Alignments

TRTP Segment(s)	Soil Series	Description	Hazard of Erosion		Shrink/Swell (Expansion) Potential	Corrosion Potential[3]	
			Off-Road or Off-Trail	On Roads and Trails		Uncoated Steel	Concrete
Segments 7, 11, and 8A	Zamora	Soils formed in alluvium derived from mixed sedimentary rocks on nearly level to strongly sloping fans and terraces with slopes of 0 to 9 percent. The texture is typically fine sandy loam, loam, silt loam, silty clay loam, and clay loam.	Slight	Moderate to Severe	Low to Moderate	High	Low
Segment 11	Sur	Moderately deep soils formed in residuum in material weathered from schist, sandstone, shale, gneiss, and granitic rocks. Formed on uplands with slopes of 30 to 85 percent. Consists primarily of stony sandy loam with surface outcrops of boulders and stones in variable amounts.	Very Severe	Severe	Low	Moderate	Moderate
Segment 11	Winthrop	Very deep soils formed in mixed alluvium on alluvial fans, terraces, and terrace escarpments with slopes of 0 to 45 percent. Primarily comprised of gravelly loamy sand.	Very Severe	Severe	Low	Moderate	Low
Segment 11	Wrenthan	Moderately deep soils formed in loess mixed with colluvium weathered from basalt on canyon slopes of 35 to 70 percent. Consists primarily of silt loam and gravelly silt loam.	Very Severe	Severe	Low	Moderate	Low
Segment 11	Knutsen	Very deep soils formed in alluvium derived from igneous and sedimentary rocks. Formed on lake terraces and outwash fans with slopes of 1 to 30 percent. Typically consists of gravelly coarse sandy loam.	Severe	Severe	Low	High	Moderate
Segment 11	Tollhouse	Shallow soils formed in material weathered from granitic rocks on strongly sloping to steep mountain slopes. Consists of coarse sandy loam and sandy loam.	Very Severe	Severe	Low	Moderate	Moderate
Segment 11	Lodo	Consists of shallow soils that formed in material weathered from hard shale and fine grained sandstone on mountainous uplands with slopes of 5 to 75 percent. The soil consists of sandy loam, loam, silt loam, or clay loam with about 18 to 35 percent clay. May also contain rock fragments which make up 5 to 35 percent of the soil.	Very Severe	Severe	Moderate	Low	Moderate
Segment 8A	Gaviota	Very shallow to shallow soil formed in material weathered from hard sandstone or meta-sandstone on hills and mountains with slopes of 2 to 100 percent. Consists of sandy loam, fine sandy loam, loam, gravelly sandy loam, and gravelly loam.	Moderate to Severe	Severe	Low	Low to Moderate	Low
Segment 8A	Chualar	Very deep soil formed in alluvial material weathered from mixed rock sources on terraces and fans with slopes of 0 to 9 percent in coastal areas. Predominantly consists of sandy loam and sandy clay loam.	Slight	Slight to Severe	Low to Moderate	High	Low
Segment 8A	Merrill	Soil formed in silty material from granitic sources on nearly level floodplains. Consists primarily of silt loam and loam.	Slight	Slight	Low to Moderate	High	Low
Segment 8A	Soper	Moderately deep soil formed in material weathered form conglomerate and sandstone on hill and uplands with slopes of 15 to 50 percent. Comprised of gravelly loam, cobbly loam, gravelly or cobbly clay loam, and gravelly or cobbly sandy clay loam.	Moderate to Severe	Severe	Low to Moderate	Moderate	Moderate

Table 2-1. Major Soil Units along the Proposed TRTP Alignments

TRTP Segment(s)	Soil Series	Description	Hazard of Erosion		Shrink/Swell (Expansion) Potential	Corrosion Potential[3]	
			Off-Road or Off-Trail	On Roads and Trails		Uncoated Steel	Concrete
Segment 8A	Anaheim	Moderately deep soils formed in material weathered from fine grained sandstone and shale on moderately steep to steep foothills. Consists primarily of clay loam.	Moderate to Very Severe	Severe	Moderate	Moderate	Low
Segment 8A	Fontana	Soils formed on hilly, moderately steep to steep uplands in material weathered from calcareous shale and fine grained sandstone. Consists primarily of clay loam.	Moderate to Severe	Severe	Moderate	High	Low
Segments 8A, 8B, and 8C	Delhi	Very deep soils formed in wind modified material weathered from granitic rocks on floodplains, alluvial fans, and terraces with slopes of 0 to 15 percent. Consists of sand, fine sand, loamy fine sand, or loamy sand.	Slight	Slight to Moderate	Low	Low to Moderate	Low to Moderate
Segments 8A & 8B	Chino	Chino soils are formed in alluvium derived from granitic sources. They are found in basins and flood plains and consist primarily of silt loam and silty clay loam.	Slight	Slight	Low to Moderate	High	Low
Segments 8A, 8B, and 8C	Grangeville	Very deep soils formed in alluvium derived predominantly from granitic sources, found on alluvial fans and floodplains with slopes of 0 to 2 percent. Consists of sandy loam, loam, silt loam, and clay loam.	Slight	Slight	Low	High	Low
Segments 8A, 8B, and 8C	Hilmar	Soils are found in nearly level basins at elevations of 300 to 900 feet and are formed in alluvium derived largely from granitic rock sources. Consists primarily of sand, loamy sand, and loamy fine sand over silt loam.	Slight	Slight	Low	High	Low

Sources: Soil Surveys of Kern County, Southeastern Part; Antelope Valley Area; Angeles National Forest Area; NRCS Official Soil Series Descriptions,; and California STATSGO GIS database (NRCS 1970, 1980, 1981, 2007 and, 2008)

Loam soil is composed of a mixture of sand, silt, clay, and organic matter in evenly mixed particles of various sizes.

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GIS data from the U.S. Geological Service (USGS) Mineral Resource Data System (MRDS) for the Project area was reviewed to determine the potential for mine or quarries along the Project ROWs (USGS, 2006). To be conservative, mining locations within 1,000 feet of either side of the route were researched to allow for identification of mineral resource sites that may be within or infringing on the Project ROWs. Additionally, a 1,000-foot buffer was used because mapped locations commonly represent only one point at a mineral resource site which actually may be a much larger site. Further, the location and presence of mineral resource sites were verified using aerial photos.

Ten sites with either mineral occurrences or past or current mining activities are identified in the MRDS within 1,000 feet of the proposed TRTP route, which include six sites along Segment 6, two sites along Segment 7, and two sites along Segment 11. No mineral resource sites were identified by the MRDS along the remaining segments. The sites along Segments 6, 7, and 11 are discussed in further detail below in Section 2.3.2.

The geology and structure of the Los Angeles basin has resulted in numerous oil and gas fields; currently there are over 30 active oil and/or gas fields in operation and many small abandoned oil/gas fields in the Los Angeles area. A review of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) online maps indicates that several active and abandoned oil or gas fields are located in the vicinity of the TRTP alignments The Montebello oil field is located immediately adjacent to Segment 7 and 11 near Mesa Substation. Segment 8A and Alternative 4 traverse near the Brea-Olinda and Chino-Soquel oil fields.

2.2.4 Seismic Hazards

Faults and Seismicity

The seismicity of southern California is dominated by the intersection of the north-northwest trending San Andreas Fault system and the east-west trending Transverse Ranges fault system. Both systems are responding to strain produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, left-lateral strike slip on the Garlock fault, and by vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. The effects of this deformation include mountain building, basin development, deformation of Quaternary marine terraces, widespread regional uplift, and generation of earthquakes. Both the Transverse Ranges and northern Los Angeles County area are characterized by numerous geologically young faults. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999a):

- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit aseismic fault creep are defined as Historically Active.
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as Active.
- Faults that show geologic evidence of movement during the Quaternary time (approximately the last 1.6 million years) are defined as Potentially Active.
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as Inactive.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Blind thrust faults do not intersect the ground surface, and thus they are not classified as active or potentially active in the same manner as faults that are present at the earth's surface. Blind thrust faults are seismogenic structures with no surface expression and thus the activity classification of these faults is predominantly based on geologic data from deep oil wells, geophysical profiles, historic earthquakes, and microseismic activity along the fault.

Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area through the lifetime of the proposed Project, the effects of strong groundshaking and fault rupture are of primary concern to safe operation of the proposed transmission line and associated facilities.

The Project area will be subject to ground shaking associated with earthquakes on faults of the San Andreas, Garlock, and Transverse Ranges fault systems. Active faults of the San Andreas system are predominantly strike-slip faults accommodating translational movement. Active reverse or thrust faults in the Transverse Ranges include blind thrust faults responsible for the 1987 Whittier Narrows Earthquake and 1994 Northridge Earthquake, and the range-front faults responsible for uplift of the Santa Susana and San Gabriel Mountains. The Transverse Ranges fault system consists primarily of blind, reverse, and thrust faults accommodating tectonic compressional stresses in the region. Blind faults have no surface expression and have been located using subsurface geologic and geophysical methods. This combination of translational and compressional stresses gives rise to diffuse seismicity across the region.

Figure 2-2 (Regional Active Faults and Historic Earthquakes) shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults within 50 miles of the Project alignments that are significant potential seismic sources are presented in Table 2-2.

Table 2-2. Significant Active and Potentially Active Faults in the Project Area

Name	Closest Distance to TRTP (miles)[1]	Closest Segment(s)	Estimated Max. Earthquake Magnitude[2]	Fault Type and Dip Direction[3]	Slip Rate (mm/yr)[3, 4]
Anacapa-Dume	33.4	Segment 11	7.2	Reverse Left Lateral Oblique, 45° N	3.0
Big Pine	30.1	Segment 4	6.9[3]	Left Lateral Strike Slip, 90°	0.8
Chino	0	Segment 8A	6.7	Right Lateral Reverse Oblique, 65° SW	1.0
Clamshell-Sawpit	0	Segment 6	6.7	Reverse, 45° NW	0.5
Cucamonga	9.6	Segment 8B	6.7	Reverse, 45° N	5.0
Elsinore - Glen Ivy Segment	8.1	Segment 8A	6.9	Right Lateral Strike Slip, 90°	5.0
Garlock	4.7	Segment 10	7.3	Left Lateral Strike Slip, 90°	6.0
Helendale	36.7	Segment 10	7.4	Right Lateral Strike Slip, 90°	0.6
Hollywood	8.7	Segment 11	6.7	Left Lateral Reverse Oblique, 70° N	1.0
Lenwood-Lockhart-Old Woman Springs	31.1	Segment 10	7.5	Right Lateral Strike Slip, 90°	0.6
Malibu Coast	29.7	Segment 11	6.7	Left Lateral Reverse Oblique, 75° N	0.3
Newport-Inglewood	12.3	Segment 11	7.2	Right Lateral Strike Slip, 90°	1.0
Northridge	12.8	Segment 11	6.9	Blind Thrust, 42° S	1.5
Oak Ridge	29.8	Segment 5	7.2	Reverse, 65° S	4.0
Palos Verdes	20.5	Segment 11	7.3	Right Lateral Strike Slip, 90°	3.0

Table 2-2. Significant Active and Potentially Active Faults in the Project Area

Name	Closest Distance to TRTP (miles)[1]	Closest Segment(s)	Estimated Max. Earthquake Magnitude[2]	Fault Type and Dip Direction[3]	Slip Rate (mm/yr)[3, 4]
Plieto Thrust	23.2	Segment 10	7.1	Reverse, 45° S	2.0
Puente Hills Blind Thrust	0	Segments 7, 11 and 8A	7.1	Blind Thrust, 25° N	0.7
Raymond	0	Segment 11	6.8	Left Lateral Reverse Oblique, 75° N	1.5
San Andreas – Carrizo Segment	12.4	Segment 4	7.2	Right Lateral Strike Slip, 90°	34.0
San Andreas – Mojave Segment	0	Segment 5	7.4	Right Lateral Strike Slip, 90°	30.0
San Andreas – San Bernardino Segment	17.7	Segment 8A	7.2	Right Lateral Strike Slip, 90°	24.0
San Cayetano	30.3	Segment 5	7.2	Reverse, 60° N	6.0
San Gabriel	0	Segments 6 and 11	7.3	Right Lateral Strike Slip, 90°	1.0
San Jacinto	11.3	Segment 8A	7.1	Right Lateral Strike Slip, 90°	12.0
San Jose	5.2	Segment 8A	6.7	Left Lateral Reverse Oblique, 75° NW	0.5
Santa Monica	16.9	Segment 11	6.6	Left Lateral Reverse Oblique, 75° N	1.0
Santa Susana	14.7	Segment 11	6.9	Reverse, 55° N	5.0
Santa Ynez	32.3	Segment 4	7.1[3]	Left Lateral Strike Slip, 90°	2.0
Sierra Madre	0	Segments 7 and 11	7.2	Reverse, 45° N	2.0
San Fernando	6.3	Segment 11	6.7	Reverse, 45° N	2.0
Simi-Santa Rosa	25.3	Segment 11	6.9	Left Lateral Reverse Oblique, 60° N	1.0
Upper Elysian Park Thrust	0.8	Segment 11	6.7	Blind Thrust, 50° NE	1.3
Verdugo	5.0	Segment 11	6.9	Reverse, 45° NE	0.5
White Wolf	24.1	Segment 10	7.2	Reverse Left Lateral Oblique, 60° S	2.0
Whittier	0	Segment 8A	7.0	Right Lateral Strike Slip, 90°	2.5

Notes:
1) Fault distances obtained from CGS GIS data.
2) Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF08-1128 (Documentation for the 2008 Update of the United States National Seismic Hazard Maps) unless otherwise noted.
3) Fault parameters from the CGS Revised 2002 California Probabilistic Seismic Hazard Maps report, Appendix A - 2002 California Fault Parameters (CGS, 2002b).
4) References to fault slip rates are traditionally presented in millimeters per year.

Strong Groundshaking

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a Moment Magnitude (M) scale because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than M 7.0, the Moment and Richter Magnitude scales are nearly identical. For earthquake magnitudes greater than M 7.0, readings on the Moment Magnitude scale are slightly greater than a corresponding Richter Magnitude.

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the Project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the Project area. Earthquakes occurring on faults closest to the Project area would most likely generate the largest ground motion.

The intensity of earthquake induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). GIS data based on the USGS National Seismic Hazard Maps was used to estimate peak ground accelerations (PGAs) along the Project alignment (USGS, 2009). The maps used depict peak ground accelerations with a 10 percent probability of exceedance in 50 years, this corresponds to a return interval of 2,475 years for a maximum considered earthquake. Peak ground acceleration is the maximum acceleration experienced by a particle on the Earth's surface during the course of an earthquake, and the units of acceleration are most commonly measured in terms of fractions of g, the acceleration due to gravity (980 cm/sec^2). Peak ground accelerations along the TRTP alignment range from 0.5 to 1.6 g (USGS, 2009), the PGA ranges for each transmission Segment and for the substation locations in Segment 9 of the proposed Project are presented in Table 2-3.

Table 2-3. Peak Ground Accelerations along Project Segments

Segment	Total Length of Segment (miles)	Range of Peak Ground Accelerations along Segment
Segment 10	16.9	0.5 – 0.8 g
Segment 4	19.6	0.6 – 1.2 g
Segment 5	14.3	0.8 - 1.6 g
Segment 11	36.2	0.6 – 1.2 g
Segment 6	26.9	0.6 – 1.2 g
Segment 7	15.8	0.6 – 1.2 g
Segment 8A	33	0.5 – 1.2 g
Segment 8B	6.8	0.5 – 0.8 g
Segment 8C	1.2	0.5 – 0.8 g
Segment 9	Substation Name	Approximate PGA
	Whirlwind	0.6 g
	Antelope	0.9 g
	Vincent	0.9 g
	Gould	1.0 g
	Mesa	0.9 g
	Mira Loma	0.6 g

A review of historic earthquake activity from 1800 to 2005 indicates that ten earthquakes that resulted in substantial damage have occurred within 50 miles (80 kilometers) of the proposed Project alignment (CGS, 2006). Included in the table is the 1857 Fort Tejon Earthquake. The location of this earthquake is uncertain due to lack of seismic instrumentation at the time and due to the widespread damage and long rupture length; however, this very large earthquake produced surface rupture on the local strands of the San Andreas Fault. A summary of each of these earthquake events is presented in Table 2-4.

Table 2-4. Significant Historic Earthquakes

Date	Approximate Closest Distance (miles) and Closest Project Segment	Earthquake Magnitude[1]	Name, Location, or Region Affected	Comments[2]
December 8, 1812	Uncertain, epicenter assumed on the San Andreas Fault near Wrightwood	7.5?	Wrightwood Earthquake	Resulted in as much as 106 miles of surface rupture near Wrightwood. Sometimes referred to as the San Juan Capistrano Earthquake because it resulted in the collapse of the Mission at San Juan Capistrano resulting in the death of 40 people.
July 11, 1855	1 mile west of Segment 11	6.0	Los Angles Region	The bells at San Gabriel Mission Church were thrown down and twenty-six buildings in Los Angeles were damaged.
January 9, 1857	Unknown, epicenter currently assumed in the San Luis Obispo area.	Estimated from 7.9 to 8.25	Fort Tejon Earthquake	One of the largest earthquakes ever reported in the US. This earthquake caused damage from Monterey to San Bernardino and caused a surface rupture of greater than 220 miles in length. Due to sparse population of the time in it only resulted in 2 deaths. Average displacement along the fault was 15 feet, with a maximum displacement of 30 feet in the Carrizo Plain area.
July 29, 1894	20 miles north of Segments 8A & 8C and 21 miles east of Segment 6	6.2	Lytle Creek region	Felt from Bakersfield to San Diego. Minor damage in the Mojave and Los Angeles areas.
March 10, 1933	19 miles south of Segment 8A	6.3	Long Beach Earthquake	This earthquake resulted in 120 deaths and more than $50 million in property damage. Many school buildings were destroyed, which led to the passage of the Field Act, which gave the State Division of Architecture authority and responsibility for approving design and supervising construction of schools. Building codes were also improved as a result of this earthquake.
July 21,1952	31 miles northwest of the northern end of Segment 4	7.3	Kern County Earthquake	Resulted in the death of 12 people and over $50 million in property damage. It was responsible for damaging hundreds of buildings in Kern County. Felt as far away as Reno and San Diego.
February 9, 1971	14.5 miles west of Segment 11	6.6	San Fernando (Sylmar) Earthquake	This earthquake caused over $500 million in damage and resulted in 65 deaths. As A result of the damage from this earthquake, building codes were strengthened and the Alquist-Priolo Special Studies Zone Act of 1972 was passed.
October 1, 1987	Less than 0.1 mile east of Segment 11	5.9	Whittier Narrows Earthquake	Resulted in eight deaths and $358 million in property damage. This earthquake occurred on a previously unknown blind thrust fault, the Puente Hills Fault.
June 28, 1991	1.6 miles east of Segment 6	5.8	Sierra Madre Earthquake	Occurred on the Clamshell-Sawpit fault and triggered numerous rockslides and landslides in the nearby mountains. Two deaths resulted from the earthquake and approximately $40 million in property damage in the San Gabriel Valley.
January 17, 1994	20 miles west of Segment 11	6.7	Northridge Earthquake	Resulted in 60 deaths and approximately $15 billion in property damage. Damage was substantial and widespread, including collapsed freeway overpasses and more than 40,000 damaged buildings in Los Angeles, Ventura, Orange, and San Bernardino Counties.

Notes: 1) Earthquake magnitudes and locations before 1932 are estimated based on reports of damage and felt effects.
2) Earthquake damage information compiled from the Southern California Data Center (SCEDC, 2007a and 2007b) and National Earthquake Information Center (NEIC, 2007) websites.

Many of these earthquakes also had numerous aftershocks, some measuring greater than M6.0, which caused further damage in the affected areas. Figure 2-2 shows locations of historic earthquakes in the Project area and surrounding region.

Another commonly used measure of earthquake intensity is the Modified Mercalli Scale, which is a subjective measure of the strength of an earthquake at a particular place as determined by its effects on persons, structures, and earth materials. The Modified Mercalli Scale for Earthquake Intensity is presented in Table 2-5, along with a range of approximate average peak accelerations associated with each intensity value.

Table 2-5. Modified Mercalli Scale For Earthquake Intensity

<table>
<tr><th>Intensity Value</th><th>Intensity Description</th><th>Average Peak Acceleration</th></tr>
<tr><td>I</td><td>Not felt except by a very few persons under especially favorable circumstances.</td><td><0.0017 g</td></tr>
<tr><td>II</td><td>Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.</td><td rowspan="2">0.0017-0.014 g</td></tr>
<tr><td>III</td><td>Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.</td></tr>
<tr><td>IV</td><td>During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation is like a heavy truck striking building. Standing motor cars rocked noticeably.</td><td>0.014-0.039 g</td></tr>
<tr><td>V</td><td>Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.</td><td>0.039–0.092 g</td></tr>
<tr><td>VI</td><td>Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.</td><td>0.092–0.18 g</td></tr>
<tr><td>VII</td><td>Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.</td><td>0.18–0.34 g</td></tr>
<tr><td>VIII</td><td>Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.</td><td>0.34–0.65 g</td></tr>
<tr><td>IX</td><td>Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.</td><td>0.65–1.24 g</td></tr>
<tr><td>X</td><td>Some well built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.</td><td rowspan="3">>1.24 g</td></tr>
<tr><td>XI</td><td>Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.</td></tr>
<tr><td>XII</td><td>Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.</td></tr>
</table>

Source: Bolt, 1988; Wald, 1999 (from USGS website: http://pasadena.wr.usgs.gov/shake/pubs/regress/node3.html).

Fault Rupture

Perhaps the most important single factor to be considered in the seismic design of electric transmission lines and underground cables crossing active faults is the amount and type of potential ground surface displacement. The Project alignments cross several known significant active faults, including the: San

Andreas, San Gabriel, Sierra Madre, Raymond, and Whittier faults. All of these faults have mapped Alquist-Priolo zones. Although the Project will not be subject to the regulations and guidelines related to the Alquist-Priolo Special Studies Zones Act because there will be no occupied structures constructed in the Earthquake Fault Zones as part of this Project, the presence of these mapped zones indicates substantial potential for fault rupture in the areas the Project crosses the "zones."

Fault rupture has occurred historically within the Project area. The 1857 Fort Tejon Earthquake caused rupture of the Leona Valley strands of the San Andreas Fault measuring greater than 8 feet and the 1971 Sylmar Earthquake which caused 6 feet of displacement along approximately 12 miles of surface rupture on the nearby San Fernando fault. Although future earthquakes could occur anywhere along the length of the San Andreas and Transverse Range faults, only regional strike-slip earthquakes of magnitude 6.0 or greater are likely to be associated with surface fault rupture and offset (CGS, 1996). It is also important to note that earthquake activity and resulting ground rupture from unmapped subsurface faults is a possibility that is currently not predictable.

Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong groundshaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur.

In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of groundshaking; and (c) the depth to groundwater. Portions of the TRTP ROW would meet the criteria for liquefaction in areas underlain by young alluvial deposits, including areas in the Leona Valley, and San Gabriel Valley, and in the alluvial and creek deposits of intervening drainages. Locations of these potentially liquefiable alluvial materials are described in more detail in Tables 2-8, 2-10, 2-11, and Table 2-12. Older consolidated sedimentary deposits, fine or coarse grained deposits, and/or well-drained sedimentary materials are less susceptible to liquefaction. Alluvial deposits underlying the portions of Segments 10, 4, and 5 that cross the Antelope Valley areas are not expected to be liquefiable due to deep groundwater levels in these areas.

Seismic Slope Instability

Other forms of seismically-induced ground failures which may affect the Project area include ground cracking, shattered ridgetops, and seismically-induced landslides. Landslides triggered by earthquakes have been a considerable cause of earthquake damage; in southern California large earthquakes such as the 1971 San Fernando and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. Areas that are underlain by landslide prone units, such as the Pelona schist and Puente Formation (located along Segments 5 and 8A, respectively), with moderate to steep slopes, and previously existing landslides, both mapped and unmapped, are particularly susceptible to this type of ground failure. Shattered ridgetop features consist of fractures, fissures, and minor slumps that are concentrated on narrow ridgelines. Studies suggest that amplification of ground motion at ridge tops is frequency dependent, potentially leading to differential motion at the top of the ridge, which produces cracks and fissures at the crest.

2.2.5 Paleontology

Significant California fossils consist of fossils of late Quaternary and Tertiary age and include invertebrate, vertebrate, and plant fossils. Older fossils are also found in the southern California area but are not as prevalent. The age of the geologic units, their terrestrial origin, and the discovery of vertebrates in late Quaternary and Tertiary-aged units in the region indicates that there is a likelihood that significant fossils may be found during excavation for new tower footings in locations along the Project route. Locations where metamorphic or crystalline rocks occur have no potential for paleontological resources (Zero sensitivity).

A paleontologic resource inventory for the Tehachapi Renewable Transmission Project was conducted for SCE by Dr. E. Bruce Lander, Dr, C. Thomas Williams, and Dr. Hugh M. Wagner (Paleo Environmental Associates, Inc. (PEAI), 2007). This report indicates that late Tertiary to late Pleistocene (Ice Age) marine vertebrates and invertebrates, land mammals, and land plants are present throughout the northern (Segments 4, 5. and 10) and southern (Segments 7, 8 and 11) parts of the Project. Although several known fossil localities are located in the western Antelope Valley, San Gabriel Valley, Chino Valley and Chino Hills, all are located more than 1,000 feet from the proposed Project. Segment 6 is located within the igneous and metamorphic rock terrane of the San Gabriel Mountains where no paleontological resources occur.

Segment 5 crosses small outcrops of the late Miocene-Pliocene lacustrine Anaverde Formation in the San Andreas Rift zone. The paleontologic resource inventory indicates that there is a high potential for scientifically highly important plant fossil remains being encountered in the Upper Member of the Anaverde Formation and this unit is considered paleontologically highly important (PEAI, 2007).

The Miocene age marine Puente Formation , which underlies a large portion of Segment 8A, contains marine microfossils (benthic foraminifers); fossilized fish scales; the fossilized remains of extinct species of marine algae, clams, crabs, fishes, sharks, and mammals (whales, desmostylids); the fossilized wood and leaves of land plants; fossilized coral remains; fragments of mollusk shells and marine vertebrate bones; and shark teeth and fish scales in the Chino Hills. The Pliocene age Fernando Formation in Chino Hills, Puente Hills, and Montebello Hills contains marine snails, clams, and brachiopods; and at least eight species of marine fishes; and baleen whales. The Fernando Formation underlies portions of the southern ends of Segments 11 and 7, and the western end of Segment 8A; see tables 2- 10, 2-11, and 2-12, respectively for detailed locations of these units along these segments. Both the Puente Formation and the Fernando Formation are considered paleontologically highly sensitive (PEAI, 2007).

Along the San Andreas Fault at the southern margin of the western Antelope Valley, Older Alluvium includes the Harold Formation where several known fossil sites are reported northeast of Segment 5 (PEAI, 2007). These sites yielded fossilized bones and teeth representing a taxonomically diverse faunal assemblage that includes mostly extinct species of Pleistocene land mammals including a jackrabbit, a cottontail, a deermouse, the California vole, a harvest mouse, possibly the dire wolf, the American mastodon, a mammoth, possibly the western horse, and the western camel (PEAI, 2007). Older Alluvium along the western edge of Antelope Valley area (Segment 5) is considered paleontologically highly important (PEAI, 2007). Older Alluvium mantles the lower slopes of Antelopes Buttes, the San Gabriel and Tehachapi Mountains, and the Montebello, Puente, and Chino Hills. A fossil site in the Older Alluvium of the San Gabriel Valley yielded the fossilized bones and teeth of a Pleistocene mammoth and ground sloth. The occurrence of only two recorded fossil sites near the Project area suggests that the Older Alluvium in these areas (Segments 14, 4, 7, 11, and 8A) is considered to be of undetermined (but no more than moderate) paleontological importance locally (PEAI, 2007).

Holocene age Younger Alluvium underlies the floors of the western Antelope, San Gabriel, and Chino Valleys, and occurs along major drainages in the San Gabriel Mountains and the Puente and Chino Hills. At and very near the surface (e.g., less than 3 to 5 feet below present ground surface), the Younger Alluvium probably is too young to contain remains old enough to be considered fossilized. Correspondingly, there probably is only a low potential for scientifically important fossil remains being encountered by very shallow ground-disturbing activities in the Antelope, San Gabriel, and Chino Valleys where the Project area is underlain by Younger Alluvium (PEAI, 2007). The Younger Alluvium in the western Antelope Valley and San Gabriel Valley is considered to be of undetermined (but probably no more than moderate) paleontologic importance locally. The Younger Alluvium in the Puente and Chino Hills is considered to be of undetermined (but possibly high) importance locally. The Younger Alluvium in the Chino Valley (Segment 8) is considered paleontologically highly important locally due to the discovery of mammoth remains at a depth of 5 feet less than 2 miles from the Segment 8 terminus (Mira Loma Substation) (PEAI, 2007).

2.3 Alternative 2: SCE's Proposed Project

2.3.1 Previous Geotechnical Studies

Geotechnical investigations, including associated reports and memos, which were previously prepared for the existing Midway–Vincent No. 3 500-kV Transmission Line, were reviewed for the purpose of assessing the existing geotechnical conditions in the proposed Project area. The proposed Project would run generally parallel and/or adjacent to the existing Midway-Vincent No. 3 transmission line from milepost S4-0 to S4-15.8, past the Antelope Substation, and parallel to Segment 5 from S5-0 to approximately S5-9.8. As such, findings of geotechnical investigations conducted for the Midway-Vincent No. 3 transmission line are directly relevant to the portions of the proposed Project which parallel this line. Geotechnical investigations prepared for the existing Antelope and Vincent Substations were also reviewed for the purpose of assessing existing geotechnical conditions in the proposed Project area. Geotechnical studies conducted for the proposed Segments 2 and 3A of the TRTP were reviewed as the proposed alignments of these transmission lines parallel portions of the current Project: Segment 3A parallels Segment 10 from S10 MP 0 to S10 MP 8 and Segment 4 from approximately S4 MP 15.5 to MP 19.6, and Segment 2 parallels Segment 5 for its entire length except between S5 MP 8 to MP 11. These studies (Midway-Vincent No. 3 500-kV Transmission Line, Antelope Substation, Vincent Substation, and Tehachapi Renewable Transmission Project Segments 2 and 3A) are discussed in detail below, as they relate to the proposed Project.

Midway – Vincent No. 3 500-kV Transmission Line

- Design Report: No. 3 Midway – Vincent 500-kV Transmission Line, Tower Foundation Design Data, Report No. 232; Engineering Department, Southern California Edison, Rosemead, California, November 18, 1971.

This report summarizes the findings of a soil condition investigation conducted for the construction of the No. 3 Midway – Vincent 500-kV Transmission Line and includes soil boring data for approximately 46 soil borings along its alignment at sporadic locations adjacent to planned tower locations. These borings, depths ranging from 20 to 35 feet, are along the portion of the alignment that is parallel to Segment 4 and a portion of Segment 5, from the southern edge of the Tehachapi Mountains to the southwestern edge of the San Andreas Rift Zone. Soil materials in these borings correlate with the mapped geology. Near surface and subsurface materials encountered in the borings located in the Antelope Valley consisted primarily of alluvium of loose to dense silty sands with varying amounts of gravel and silt. Borings across Portal and Ritter Ridges revealed igneous (granitic) and metamorphic (Pelona Schist) rocks which were weathered at the surface and moderately hard at depth, with a thin layer of alluvium/colluvium on the surface in some areas. On the west side of the Leona Valley, within and along the base of the Sierra Pelona, Pelona Schist in varying stages of weathering and schist derived colluvium were encountered in the borings. Groundwater was not noted in any of the borings along this segment except for one boring within the Anaverde Creek drainage, which had perched groundwater at about 16 feet below ground surface (bgs).

Antelope Substation

- Letter Report: Antelope Substation – Pile Design Data; T.M. Leps, Chief Civil Engineer, April 25, 1952
- Memorandum: Antelope Substation, Foundation Investigation; E.E. Chandler, Assistant Civil Engineer, July 19, 1957
- Antelope Substation Boring Logs and Soil Test Results; December 1996
- Letter Report: Foundation Design Recommendations, Antelope Substation Additions, Los Angeles County, California; Engineering and Technical Services Geotechnical Group, January 9, 1997

The reports and data reviewed for the Antelope Substation indicate that the materials underlying the site consist of Recent Alluvium, composed primarily of loose to medium dense silty sand with gravel, with local gravelly, cobbly, and clayey layers. No groundwater was encountered in any of the borings conducted for these investigations; the borings were conducted to a maximum depth of 40 feet.

Vincent Substation

- Geotechnical Report: Report of Foundation Investigation, Proposed Vincent Substation, Angles Forest Highway, Vincent, California, August 28, 1963; by LeRoy Crandall & Associates.

This report indicates that materials underlying the Vincent Substation site consist of alluvial deposits, composed of medium dense to dense interbedded silty sand and sand, with local lenses of gravelly and clayey sand and sandy silt. Groundwater was not encountered in any of the borings to a total depth of 35 feet below ground surface.

Tehachapi Renewable Transmission Project Segments 2 and 3A

- Geotechnical Engineering Report, Tehachapi Renewable Project (TRTP), Segment 2, Lancaster Vicinity, Los Angeles County, California, April 18, 2008; by Terracon Consultants, Inc.
- Geologic Fault Evaluation Report, Southern California Edison Tehachapi Renewable Transmission Project, Segment 2, Leona Valley, California, June 30, 2008; by Zeiser Kling Consultants, Inc.
- Geotechnical Engineering Report, Tehachapi Renewable Project (TRTP), Segment 3A, Mojave Vicinity, California, May 2, 2008; by Terracon Consultants, Inc.

The geotechnical report for the Segment 2 transmission line, located between Antelope and Vincent Substations, presents findings and recommendations of a subsurface investigation conducted for the construction of TRTP Segment 2 Transmission Line and includes soil boring data for approximately 39 soil borings along its alignment at sporadic locations adjacent to planned tower locations with depths ranging from 15 to 50.5 feet. TRTP Segment 2 is parallel to the Segment 5 alignment for its full length, except between S5 MP 8 to MP 11, where Segment 2 deviates to the west. Soil materials in these borings correlate with the mapped geology. Near surface and subsurface materials encountered in the borings located in the Antelope Valley consisted primarily of alluvium and older surficial deposits of loose to dense silty sands with varying amounts of gravel and silt. Borings across Portal and Ritter Ridges revealed igneous (granitic) and metamorphic (Pelona Schist) rocks which were weathered at the surface and moderately hard at depth, with a thin layer of alluvium/colluvium on the surface in some areas. Groundwater was not noted in any of the borings along this segment to a total depth of 50 feet. Landslide surveys conducted for the portions of the Segment 2 alignment crossing moderately to steeply sloping terrain identified landslides at or near to several proposed tower sites within the San Andreas Fault zone that are underlain by Anaverde Formation or Pelona Schist.

A fault evaluation investigation was conducted for six tower locations for Segment 2 proposed to be located in the Andreas Fault Zone where the alignment crosses Ritter Ridge and Leona Valley. This investigation consisted of six trenches excavated to depths ranging from 12 to 26.5 feet deep and 120 to 171 feet long. Material encountered in the trenches consisted of topsoil, colluvium, older alluvium, Anaverde Formation, and Pelona Schist. Based on data from these trenches, it was recommended that one of the tower locations be moved due to the presence of a fault splay in the trench and footing on two towers be deepened due to close proximity to fault splays.

The geotechnical report for Segment 3A presents findings and recommendations of a subsurface investigation conducted for the construction of TRTP Segment 3A Transmission Line and includes soil boring data for approximately 36 soil borings along its alignment at sporadic locations adjacent to planned tower locations with depths ranging from 25.5 to 51.5 feet. TRTP Segment 3A is parallel to Segment 10 from S10 MP 0 to S10 MP 8 on its north end and Segment 4 from approximately S4 MP 15.5 to MP 19.6 along its southern end. Soil materials in these borings correlate with the mapped geology and consisted primarily of alluvium of medium dense to very dense silty sands with varying amounts of gravel, sand, silt, and clay.

2.3.2 Windhub Substation to Vincent Substation (Segments 10, 4, and 5)

Geology

The proposed Segment 10, 4, and 5 routes primarily traverse alluvial fans/terraces and plains of the Antelope Valley. The southern end of Segment 5 traverses the San Andreas Fault Zone, and hills, mountains, and valleys of the southern Sierra Pelona and the northern San Gabriel Mountains. Geologic units crossed by these segments of the Project are younger alluvium, older alluvium, nonmarine terrace deposits, nonmarine sandstone of the Anaverde Formation, granitic, and metamorphic. Figure 2-3 (Regional Geologic Map A) presents the geology along Segments 10, 4, and 5.

Geologic conditions likely to be encountered during construction of Segments 10, 4, and 5 of the proposed Tehachapi Renewable Transmission Project are summarized in below in Tables 2-6, 2-7, and 2-8, respectively. The tables includes: the geologic symbol for the formation; the feature or formation's name; a description and comments about the geologic features and the formation's general rock type, lithology, and susceptibility to specific geologic hazards as appropriate; and general excavation characteristics of the unit related to excavation or drilling for tower and structure foundations.

Descriptions of geologic units in the Project area are based on published geologic maps by the CGS (1964 and 1969), Dibblee (1967, 1996, 1997, 2001c), and Dibblee and Louke (1970).

Table 2-6. Geology along Segment 10 of Proposed Project Route

Segment 10 Mileposts (S10-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 3.5	Qa	Alluvium	Alluvial gravels, sand and silt	Easy
3.5 – 4.2	Qc	Pleistocene nonmarine	Unconsolidated alluvial gravels, sand and silt	Easy
4.2 – 4.6	Qa	Alluvium	Alluvial gravels, sand and silt	Easy
4.6 – 5.1	Qc	Pleistocene nonmarine	Unconsolidated alluvial gravels, sand and silt	Easy
5.1 – 16.8	Qa	Alluvium	Alluvial gravels, sand and silt	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-23 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-3 (Regional Geologic Map A) for approximate Milepost locations along Segment 10; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Table 2-7. Geology along Segment 4 of Proposed Project Route

Segment 4 Mileposts (S4-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 2.7	Qc	Pleistocene nonmarine	Unconsolidated alluvial gravels, sand and silt, representing an ancient alluvial fan surface	Easy
2.7 – 10.9	Qa	Alluvium	Alluvial gravels, sand and silt	Easy
10.9 – 11.3	Qc	Pleistocene nonmarine	Unconsolidated alluvial gravels, sand and silt	Easy
11.3 – 11.7	Qa	Alluvium	Alluvial gravels, sand and silt	Easy
11.7 – 12.6	gr	Granitic Rocks	Granitic rocks; fractured, variably weathered crystalline rock	Difficult
12.6 – 19.6	Qa	Alluvium	Alluvial gravels, sand and silt	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-1 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-3 (Regional Geologic Map A) for approximate Milepost locations along Segment 4; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Slope Stability

The Project ROW through the Antelope Valley crosses flat to gently sloping terrain and is not likely to experience landslides or other slope failures. Most of the proposed Segment 10, 4, and 5 alignments do not cross any areas identified as an existing landslide, except along Segment 5 where it crosses the landslide prone Pelona Schist between S5 MP 4.4 to 7.6 and MP 7.9 to 12.5. A large landslide is mapped immediately south of Lake Elizabeth Road beneath the Project alignment between S5 MP 7.9 to 8.5 (CGS, 2003e). East of the proposed alignment the Pelona Schist is characterized by numerous, large landslides (CGS, 2003e; Dibblee, 1997). Unmapped landslides and areas of localized slope instability may also be encountered in the hills traversed by the proposed Project alignment, principally in Segment 5.

Table 2-8. Geology along Segment 5 of Proposed Project Route

Segment 5 Mileposts (S5-)[1, 2]	Geologic Symbol[1]	Formation/Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 4.2	Qa	Alluvium	Antelope Substation: Alluvial gravels, sand and silt	Easy
4.2 – 4.4	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
4.4 – 4.5	Qa	Alluvium	Railroad Canyon; Unconsolidated alluvial gravels, sand and silt	Easy
4.5 – 4.9	gr	Granitic Rocks	Granitic rocks; fractured, variably weathered crystalline rock	Difficult
4.9	Fault	San Andreas Fault	Branch fault off San Andreas rift zone; fault rupture hazard	NA
4.9 – 6.4	psp, psq	Pelona Schist	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
6.4 – 7.6	psp	Pelona Schist	Mica schist, into-slope dipping foliation	Difficult
7.7	Fault	Un-named	Fault crossing	NA
7.8	Fault	San Andreas Fault zone, Mojave Section	Fault crossing	NA
7.6 – 7.9	Fault Zone, Tas, Qos, Qa	San Andreas Fault, Anaverde Formation, Older and younger Alluvium	San Andreas rift zone with fault bounded Anaverde Formation (sandstone), and older and younger alluvial deposits; identified liquefaction potential in alluvial deposits; active right-slip fault, significant fault rupture hazard	Easy to Moderate
8	Fault	Nadeau	Concealed fault, existence is uncertain; potential fault rupture hazard as coseismic with movement on San Andreas Fault	NA
7.9 – 8.5	Qls	Landslide	(Qls) Landslide (CGS, 2003e) in Pelona Schist	Moderate to Difficult
8.5 – 9.0	Qos, ps	Older Alluvium, Pelona Schist	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Moderate to Difficult
9.0 – 12.5	Qa, ps	Alluvium, Pelona Schist	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Moderate to Difficult
12.5 – 12.6	gr	Granitic Rocks	Granitic rocks; fractured, variably weathered crystalline rock	Difficult
12.6 – 12.7	gnb	Gneiss	Banded gneiss	Difficult
12.7 – 13.3	gr, Qa	Granitic Rocks, Alluvium	Granitic rocks, variable weathering profile; overlain by alluvial deposits in drainages	Difficult
13.3 – 13.5	di	Dioritic Rocks	Mafic granitic rocks; fractured, variably weathered crystalline rock	Difficult
13.5 – 14.5	sy	Syenite	Granitic rocks, variable weathering profile	Difficult
13.65	Fault	Unnamed fault	Likely inactive, indefinite location, no significant fault rupture hazard	NA
14.5 – 15.4	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
15.4 – 15.5	di	Dioritic Rocks	Mafic granitic rocks; fractured, variably weathered crystalline rock	Difficult
15.5 – 15.6	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
15.6 – 15.7	lgbd	Lowe Granodiorite	Granitic rocks; fractured, variably weathered crystalline rock	Difficult
15.7 – 16.3	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
16.3 – 17.2	Qa	Alluvium	Soledad Pass: Alluvial sand and clay	Easy
17.2 – 17.3	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
17.4 – 17.8	Qoa	Older Alluvium	Vincent Substation: Sand and gravel fan deposits	Easy

Notes:
1) Information in these columns is primarily derived from Table 4.7-5 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-3 (Regional Geologic Map A) for approximate Milepost locations along Segment 5; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Soils

Segment 10. Five main soil units/associations are mapped along the Segment 10 Project route (Garlock, Cajon, Adelanto, Hesperia, and Hanford), listed in order of approximate first occurrence along the alignment from north to south. Each soil unit/association may occur numerous times along the Segment 10 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. These soils are all formed in areas underlain by alluvium and colluvium on alluvial plains and fans. Locations of the soil associations along Segment 10 are listed in Appendix A.

Hazard of erosion for these soils for off-road or off-trail is slight and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential varies from low to moderate. The corrosive potential of soils along Segment 10 ranges from low to high for uncoated steel and from low to moderate for concrete.

Segment 4. Seven main soil units/associations are mapped along the Segment 4 Project route (Ramona, Cajon, Hesperia, Rosamond, Hanford, Greenfield, and Vista), listed in order of approximate first occurrence along the alignment from north to south. Each soil unit/association occurs numerous times along the Segment 4 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. All of these soils, except the Vista soils, are formed in alluvium and colluvium on alluvial fans, plains, and terraces. The Vista soils are formed in material weathered from underlying and nearby granitic rocks. Locations of the soil associations along Segment 4 are listed in Appendix A.

Hazard of erosion for these soils for off-road or off-trail ranges from slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils along Segment 4 ranges from low to high for uncoated steel and from low to moderate for concrete.

Segment 5. Ten main soil units/associations are mapped along the Segment 5 Project route (Greenfield, Hanford, Vista, Amargosa, Godde, Wyman, Anaverde, Las Posas-Toomes, Ramona, and Las Posas), listed in order of approximate first occurrence along the alignment from north to south. Each soil unit/association occurs numerous times along the Segment 5 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. Greenfield and Hanford soils are formed in alluvium derived primarily from granitic sources, with the Greenfield soils mapped primarily along the northern end of the alignment and the Hanford mapped numerous placed along the entire alignment. Ramona soils are also formed in primarily alluvium derived primarily from granitic sources, but are only mapped along the southern end of the alignment. The remaining soil types, Vista, Amargosa, Godde, Wyman, Anaverde, Las Posas-Toomes, and Las Posas, are formed in material weathered from the underlying or nearby bedrock units consisting of miscellaneous granitic, volcanic, and schist rock types and are mapped in various locations along the southern three-fourths of the alignment. Locations of the soil associations along Segment 5 are summarized in Appendix A.

Hazard of erosion for these soils for off-road or off-trail ranges from slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to high. The corrosive potential of soils along Segment 5 ranges from low to high for uncoated steel and from low to moderate for concrete.

Seismic Hazards

Fault Rupture. Segments 10 and 4 do not cross any active faults and would not be subject to primary fault-related ground surface rupture. Segment 5, however, crosses several strands of the San Andreas Fault. All of the fault strands are within the Alquist-Priolo zone for the San Andreas Fault where the proposed Segment 5 Project route crosses the fault, as shown in Figure 2-4 (Segment 5 Active Fault Crossing). There is a substantial potential for surface rupture where Segment 5 crosses the State-designated Earthquake Fault Zone between MPs S5-7.4 and S5-8.6. This portion of the fault ruptured in the 1857 earthquake and had reported mean and maximum displacement along the fault of 15 and 30 feet, respectively (SCEC web site). General characteristics of the fault are presented in above in Table 2-2.

Groundshaking. As shown in Table 2-2, Segments 10, 4, and 5 are in close proximity to the Garlock Fault Zone (about 5 miles from Segment 10) and the San Andreas Fault Zone (crossed by the proposed Segment 5 route) for most of its length. Moderate to strong groundshaking from an earthquake on any of the faults in the vicinity of these segments should be expected. Very strong to severe groundshaking may be experienced near where Segment 5 crosses the San Andreas Fault Zone. The expected ranges of peak horizontal ground accelerations for these segments are presented in Table 2-3.

Liquefaction. Potential for liquefaction in the areas crossed by Segments 10, 4, and the northern portion of Segment 5 is low due to anticipated depths of groundwater in the Antelope Valley area of greater than 100 feet (2003c). Where Segment 5 crosses the Leona Valley, it crosses potentially liquefiable alluvial deposits between mileposts S5-7.6 to S5-7.9 (CGS, 2003d). There is little to no potential for liquefaction for most of the remaining portion of Segment 5, where it crosses the Sierra Pelona and upper Soledad basin, as these areas are primarily underlain by granitic and metamorphic rocks. However, during large storms or a wet season, sections of the proposed segments that are underlain by alluvium near to and/or crossing active river washes and streams may become susceptible to liquefaction if a strong earthquake were to occur while these sediments are saturated due to a temporary/seasonal water table rise.

Earthquake-Induced Landslides. The topography along Segments 10 and 4 is relatively flat and not likely to experience landsliding or slope failures due to earthquakes. Portions of Segment 5 that cross or are in the vicinity of the landslide prone Pelona Schist, primarily between S5 MPs 4.9 to 7.6 and S5 MPs 7.9 to 12.5, could experience earthquake induced slope failures and landslides. Additionally portions of Segment 5 that cross moderate to steep hill slopes could experience minor slope failures in areas with over-steepened slopes or weathered geologic materials.

Mineral Resources

No mineral resource sites were identified by the MRDS within 1,000 feet of the proposed route segments.

Paleontology

The proposed Project alignment in the western Antelope Valley and near the Vincent Substation is underlain mostly by Holocene Younger alluvium underlying the valley floor and Pleistocene Older Alluvium mantling the lower slopes of the Tehachapi and San Gabriel Mountains, and Antelopes Buttes, which border the valley. The Younger Alluvium is generally considered to have low sensitivity and the Older Alluvium has primarily low sensitivity, with local high sensitivity along the San Andreas Fault Zone. The late Miocene - Pliocene Anaverde Formation continental deposits occur along the southern margin of the western Antelope Valley in Leona Valley and have high to moderate sensitivity. The metamorphic Pelona Schist underlying Portal Ridge and the Sierra Pelona and the igneous rocks of the Antelope Buttes are non-fossil bearing and have zero sensitivity.

The Upper Member (Clay Shale) of the Anaverde Formation has yielded fossilized leaves representing a taxonomically diverse floral assemblage consisting of twenty-one extinct species of late Miocene land plants (PEAI, 2007). The species represented include pine, palm, poplar, willow, oak, avocado, sycamore, sumac, and California lilac. The leaves from the Anaverde Formation are scientifically important because their respective species have allowed the paleoenvironmental and paleoclimatic reconstructions of the western Antelope Valley and vicinity during the late Miocene Epoch (PEAI, 2007).

Older Alluvium along the San Andreas Fault Zone includes the Harold Formation, along Segment 5, which locally contains fossilized bones and teeth representing a taxonomically diverse faunal assemblage that includes mostly extinct species of Pleistocene land mammals. These species include a jackrabbit, a cottontail, a deermouse, the California vole, a harvest mouse, possibly the dire wolf, the American mastodon, a mammoth, possibly the western horse, and the western camel (PEAI, 2007). Based on the presence of the packrat (Neotoma Teanopus "prefuscipes") the assemblages from the Harold Formation are considered to be late Irvingtonian (early Pleistocene) and approximately 800,000 years in age (PEAI, 2007). Elsewhere in the Antelope Valley area, Older Alluvium adjacent to exposures of granitic and metamorphic (basement) rocks of the San Gabriel and Tehachapi Mountains and Antelope Buttes (Segments 10 and 4) and is probably too coarse grained to contain identifiable fossil specimens. In these areas, there probably is no more than a low potential for any identifiable and, therefore, scientifically important fossil remains being encountered locally by ground-disturbing activities, although locally finer grained facies may contain scientifically important fossil specimens (PEAI, 2007).

2.3.3 Vincent Substation to Mesa Substation (Segments 6, 7, and 11)

Geology

Segment 6 and the northern portion of Segment 11 traverse moderate to steep slopes of the mountains, hills, and valleys of the San Gabriel Mountains. The southern end of Segment 11 and Segment 7 primarily traverse alluvial fans, plains, and terraces of the San Gabriel Valley. Geologic units crossed by these segments of the Project are younger alluvium, older alluvium, nonmarine sandstone and conglomerate of the Fernando Formation, mixed igneous rocks, and metamorphic rocks. Figure 2-5 (Regional Geologic Map B) presents the geology along Segment 6, 7, and 11.

Geologic conditions likely to be encountered during construction of the transmission lines for the proposed Tehachapi Renewable Transmission Project, Segments 6, 7, and 11, are summarized below in Tables 2-9, 2-10, and 2-11, respectively. The tables includes: name of the geologic formation or feature; the geologic symbol for the formation; the feature or formations name; a description and comments about the geologic features and the formation's general rock type, lithology, and susceptibility to specific geologic hazards as appropriate; and general excavation characteristics of the unit related to excavation or drilling of tower and structure foundations. Descriptions of geologic units in the Project area are based on published geologic maps by Dibblee (1989, 1996, 1998, 1999, 2001c. 2002a, and 2002c).

Table 2-9. Geology along Segment 6 of Proposed Project Route

Segment 6 Mileposts (S6-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 0.1	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
0.1 – 0.2	Qg, Qa	Alluvium	Stream channel deposits of gravel, sand and silt	Easy
0.2 – 0.3	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy

Table 2-9. Geology along Segment 6 of Proposed Project Route

Segment 6 Mileposts (S6-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.3 – 0.4	Hdg, Qoa	Hornblende Diorite Gabbro (Hdg), Older Alluvium (Qoa)	(Hdg) Mafic plutonic and gneissic rock, dark gray to nearly black, hard, but fractured, massive to slightly gneissoid/(Qoa) sand and gravel fan deposits	Easy to Difficult
0.4 – 0.7	Qoa	Older Alluvium (Qoa)	Sand and gravel fan deposits.	Easy
0.7 – 0.9	hdg	Hornblende Diorite Gabbro (hdg)	Mafic plutonic and gneissic rock, dark gray to nearly black; hard, but fractured, massive to slightly gneissoid	Difficult
0.9 – 1.5	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
1.5 – 2.1	hdg, Qoa	Hornblende Diorite Gabbro (hdg), Older Alluvium (Qoa)	(hdg) Mafic plutonic and gneissic rock, dark gray to nearly black; hard, but fractured, massive to slightly gneissoid/(Qoa) sand and gravel fan deposits	Easy to Difficult
2.1 – 2.5	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt	Easy
2.5 – 3.2	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
3.3 – 4.2	Igd	Lowe Granodiorite	Plutonic igneous rock; undivided, leucocratic (nearly white), hard but much fractured	Difficult
4.6 – 5.2	Igd	Lowe Granodiorite	Plutonic igneous rock; undivided, hard but much fractured	Difficult
5.2 – 5.3	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
5.3 – 5.8	Idg	Lowe Granodiorite	Plutonic igneous rock; undivided, leucocratic (nearly white), hard but much fractured	Difficult
5.8 – 5.9	Qoa	Older Alluvium	Sand and gravel fan deposits	Difficult
5.9 – 6.4	Igd, Qoa, Qg	Older Alluvium (Qoa), Alluvium Fan (Qg), Lowe Granodiorite (Igd)	(Qoa) Sand and gravel fan deposits/(Qg) stream channel deposits of gravel, sand and silt/(Igd) plutonic igneous rock; hard but much fractured	Easy to Difficult
6.4 – 6.5	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
6.5 – 6.7	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
6.7 – 7.0	Igd	Lowe Granodiorite	Plutonic igneous rock; undivided, hard but much fractured	Difficult
7.0 – 7.4	Igdp	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
7.4 – 8.0	Qls	Landslide	(Qls) Landslide (Dibblee)	
8.0 – 8.6	Igdp	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
8.6 – 8.7	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
8.7- 8.8	Igdh	Lowe Granodiorite	Plutonic Igneous rock, light gray	Difficult
8.8 – 9.0	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult
9.1 – 9.5	an, agb	Anorthosite Gabbro complex	Plutonic complex of plagioclase feldspar enriched rock; Light steel gray, but weathered white	Difficult
9.5 – 9.8	hgb, Qls	(Qls), (hgb) Anorthosite Gabbro complex	(Qls) Landslide (Dibblee)/(hgb) plutonic complex; Light steel gray, but weathered white	Difficult
9.8 – 12.2	hgb, an, agn, gba	Anorthosite Gabbro complex	Plutonic complex; light steel gray, but weathered white	Difficult
12.2 – 13.0	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult
13.0 – 13.4	Igdh	Lowe Granodiorite	Plutonic igneous rock, light gray	Difficult
13.4 – 13.5	Qoa, Qg	Older Alluvium (Qoa), Alluvium Fan (Qg)	Sand and gravel fan deposits	Easy
13.5 – 15.6	Igdp	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
15.6 – 15.7	Qoa, Qg	Older Alluvium (Qoa), Alluvium Fan (Qg)	Sand and gravel fan deposits	Easy
15.7 – 16.0	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
16.0 – 16.5	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult

Table 2-9. Geology along Segment 6 of Proposed Project Route

Segment 6 Mileposts (S6-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
16.5 – 18.7	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult
18.7 – 18.8	Qoa, Qg	Older Alluvium (Qoa), Alluvium Fan (Qg)	Sand and gravel fan deposits; stream channel deposits of gravel, sand and silt	Easy
18.8	Fault	North Branch of the San Gabriel Fault	Fault crossing, active fault	NA
18.8 – 19.0	qd	Quartz Diorite	Plutonic Rock, light to medium gray	Difficult
19.0 – 19.1	gn, qd	Gneissic Rock (gn), Quartz Diorite (qd)	Gneissic rock metamorphosed from sedimentary or igneous protoliths (gn)/plutonic rock, light to medium gray(qd)	Difficult
19.1 – 19.3	gr	Granitic Rocks	Plutonic Rock, white to tan, hard, coherent but severely fractured	Difficult
19.3 – 19.5	Qls	Landslide Complex	(Qls) Landslide (CGS, 1998b)	Moderate to Difficult
19.5 -19.6	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
19.6 – 19.8	Qls	Landslide Complex	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
19.8 – 20.0	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
20.0 – 20.1	Qls	Landslide	(Qls) Landslide (Dibblee, 1998)	Moderate to Difficult
20.1 – 20.3	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
20.3 – 20.5	Qls	Landslide, Complex	(Qls) Landslide (Dibblee, 1998 and CGS, 1998f)	Moderate to Difficult
20.5 – 21.3	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
21.3 – 21.5	Qls	Landslide	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
22.2 – 22.5	qd	Quartz Diorite	Plutonic rock, light to medium gray	Difficult
22.5 – 23.5	Qls	Landslide, Complex	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
23.5 – 23.3	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
23.3 – 24.2	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
24.2 – 24.5	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult
24.5	Fault	Clamshell-Sawpit Fault	Fault crossing – active fault	NA
24.5 – 24.9	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
24.9 – 25.0	Qls	Landslide	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
25.0 – 25.2	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
25.2 – 25.4	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult
25.4 – 25.6	Qls	Landslide	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
25.6 – 25.8	gn, gr	Gneissic Rock (gn), Granitic Rocks (gr)	Gneissic rock metamorphosed from sedimentary or igneous protoliths (gn)/plutonic rock, white to tan, hard (gr)	Difficult
25.8 – 25.9	Qls	Landslide Complex	(Qls) Landslide (CGS, 1998f)	Moderate to Difficult
25.9 – 26.7	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous protoliths	Difficult

Table 2-9. Geology along Segment 6 of Proposed Project Route

Segment 6 Mileposts (S6-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
26.7 – 26.9	Qls	Landslide	(Qls) Landslide (Dibblee, 1998)	Moderate to Difficult

Notes: 1) Information in these columns is primarily derived from Table 4.7-9 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-5 (Regional Geologic Map B) for approximate Milepost locations along Segment 6; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Table 2-10. Geology along Segment 7 of Proposed Project Route

Segment 7 Mileposts (S7-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 0.1	Qls	Landslide	(Qls) Landslide in weathered rock (Dibblee, 1998)	Moderate to Difficult
0.1 – 0.3	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous sources	Difficult
0.3 – 0.5	qd	Quartz Diorite	Plutonic rock; gray, medium-grained, incoherent where weathered	Difficult
0.5 – 0.7	Qls	Landslide	(Qls) Landslide in weathered rock (Dibblee, 1998)	Moderate to Difficult
0.7 – 1.0	Qog, qd	Quartz Diorite (qd), Old alluvium (Qog)	Plutonic Rock, light to medium gray, medium grained with older alluvial gravel, sand and silt	Difficult
1	Fault	Sierra Madre Fault	Crosses two adjacent fault strands, fault crossing, one of multiple strands in active fault zone	NA
1.1	Fault	Sierra Madre Fault	Fault crossing, one of multiple strands in active fault zone	NA
1.3	Fault	Sierra Madre Fault	Fault crossing, one of multiple strands in active fault zone	NA
1.0 – 1.5	Qa	Alluvium	Gravels, sands, and silts	Easy
1.5 – 12	Qg	Channel alluvium	Stream channel deposits of gravel, sand and silt. With localized artificial fill (af)	Easy
1.7	Fault	Sierra Madre Fault	Fault crossing, one of multiple strands in active fault zone	NA
12.0 – 13.5	Qa	Alluvium	Gravels, sands, and silts	Easy
13.5 – 13.6	Qg	Channel alluvium	Stream channel deposits of gravel, sand and silt.	Easy
13.6 – 13.7	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
13.7 – 13.9	Qg	Channel alluvium	Stream channel deposits of gravel, sand and silt.	Easy
13.9 – 14.1	Qls	Landslide	(Qls) Landslide (CGS, 1998b)	Easy
14.1 – 15.8	Tfsc	Fernando Formation	Nonmarine sandstone and conglomerate; light gray to tan, crudely bedded	Easy to Moderate

Notes: 1) Information in these columns is primarily derived from Table 4.7-13 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-5 (Regional Geologic Map B) for approximate Milepost locations along Segment 7; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Table 2-11. Geology along Segment 11 of Proposed Project Route

Segment 11 Mileposts (S11-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 0.4	Qg, Qoa	Older Alluvium (Qoa), Alluvium Fan (Qg)	Sand and gravel fan deposits	Easy
0.4 – 2.4	hdg	Hornblende Diorite Gabbro	Mafic Plutonic and Gneissic rock, Dark gray to nearly black	Difficult
2.4 – 2.7	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
2.7 – 2.8	gr	Granitic Rocks	Granitic rock, white to tan, hard, coherent but severely fractured	Difficult
2.8 – 3.5	Igdp, Igdh	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
3.5 – 3.6	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt	Easy
3.6 – 3.8	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
3.8 – 4.3	dgn	Dioritic Gneiss	Gneissic rock metamorphosed from igneous sources	Difficult
4.3 – 4.4	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
4.4	Fault	Lonetree Fault	Minor fault crossing, not considered active	NA
4.4 – 4.6	Igdp, Igdh, Igdd	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
4.6 – 5.0	Qls	Landslide	(Qls) Landslide (CGS, 2003f)	Moderate to Difficult
5.0 – 7.9	Igdp, Igdh, Igdd	Lowe Granodiorite	Plutonic igneous rock, grey	Difficult
7.9 – 8.0	dgn	Dioritic Gneiss	Gneissic rock metamorphosed from igneous sources	Difficult
8.0 – 8.1	Igd	Lowe Granodiorite	Plutonic igneous rock; hard but much fractured	Difficult
8.1 – 8.6	an, agb	Anorthosite Gabbro complex	Plutonic complex, light steel gray, but weathered white	Difficult
8.6	Fault	Fox Creek Fault	Minor fault crossing, not considered active	NA
8.6 – 8.85	agb, an	Anorthosite Gabbro complex	Plutonic complex, light steel gray, but weathered white	Difficult
8.8 – 9	Igd	Lowe Granodiorite	Plutonic igneous rock; hard but much fractured	Difficult
9.0 – 11.4	an, agb	Anorthosite Gabbro complex	Plutonic complex; light steel gray, but weathered white	Difficult
11.4 – 11.5	grd	Granitic Rock	Leucocratic plutonic rock; nearly white; massive	Difficult
11.5	Fault	Mill Creek Fault	Fault crossing, not considered active	NA
11.5 – 14.6	grd	Granitic Rock	Leucocratic plutonic rock; nearly white; massive.	Difficult
14.6	Fault	Maple Canyon Fault	Fault crossing, not considered active	NA
14.6 – 14.8	grd	Granitic Rock	Leucocratic plutonic rock; nearly white; massive.	Difficult
14.8	Fault	North Branch of San Gabriel Fault	Fault crossing, active fault	NA
14.8 – 15.2	qd	Quartz Diorite	Plutonic rock; gray, medium-grained, incoherent where weathered	Difficult
15.2 – 15.5	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous sources	Difficult
15.5 – 15.6	qd	Quartz Diorite	Plutonic rock; gray, medium-grained, incoherent where weathered	Difficult
15.6 – 15.9	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous sources	Difficult
15.9 – 16.0	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
16.0 – 16.1	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered.	Difficult
16.1 – 16.2	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
16.2 – 16.3	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous sources	Difficult
16.3 – 16.4	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
16.4 – 16.6	gn	Gneissic Rock	Gneissic rock metamorphosed from sedimentary or igneous sources	Difficult
16.6 – 16.9	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
16.9	Fault	Vasquez Creek fault	Fault crossing	NA

Table 2-11. Geology along Segment 11 of Proposed Project Route

Segment 11 Mileposts (S11-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
16.9 – 17.3	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
17.3 – 17.5	hd	Hornblende Diorite	Mafic plutonic rock; dark gray to black	Difficult
17.5 – 17.9	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
17.9	Fault	Sierra Madre fault zone	Fault crossing, one of many mapped strands, significant active fault	NA
17.9 – 18.0	Qls	Landslide	(Qls) Landslide (CGS, 1998b)	Moderate to Difficult
18.0 – 18.2	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
18.2 – 18.4	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
18.4	Fault	Sierra Madre fault zone	Fault crossing, one of many mapped strands, significant active fault	NA
18.5	Fault	Sierra Madre fault zone	Fault crossing, one of many mapped strands, significant active fault	NA
18.6	Fault	Sierra Madre fault zone	Fault crossing, one of many mapped strands, significant active fault	NA
18.4 – 18.7	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered.	Difficult
18.7 – 18.9	af	Artificial Fill	Artificial fill	Easy
18.9 – 19.7	qd, Qg	Quartz Diorite(qd), Alluvium Fan(Qg)	Plutonic rock; gray, incoherent where weathered (qd)/Sand and gravel fan and channel deposits (Qg).	Easy to Difficult
19.7 – 20.0	Qd, Qoa	Quartz Diorite(qd), Older Alluvium (Qoa)	Plutonic rock; gray incoherent where weathered (qd) with minor sand and gravel fan deposits (Qoa)	Easy to Difficult
20.0 – 20.5	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
20.5 – 21.0	Qls	Landslide	(Qls) Landslide (CGS, 1998b)	Moderate to Difficult
21.0 – 21.3	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
21.3 – 21.6	Qls	Landslide	(Qls) Landslide (CGS, 1998b)	Moderate to Difficult
21.6 – 21.8	qd	Quartz Diorite	Plutonic rock; gray, incoherent where weathered	Difficult
21.8 – 22.0	gr	Granitic Rocks	Plutonic rock, white to tan, hard, coherent but severely fractured	Difficult
22.0 – 22.2	Qls	Landslide	(Qls) Landslide (CGS, 1998b 05)	Moderate to Difficult
22.2 – 24.9	gr, hd	Hornblende Diorite(hd), Granitic Rocks(gr)	Mafic plutonic rock; dark gray to black, medium-grained diorite(hd)/plutonic rock, white to tan, hard, coherent but severely fractured (gr).	Difficult
22.8 – 24.4	Fault	Sierra Madre fault zone	Multiple oblique fault crossing of closely spaced fault strands, significant active fault	NA
24.2 – 24.3	Qls	Landslide	(Qls) Landslide (Dibblee, 1998)	Moderate to Difficult
24.6- 25.4	Fault Zone Qa	Sierra Madre fault zone Alluvium	Fault crossing of multiple fault strands gravels, sands, and silts between fault strands	NA Easy
24.9 -25.4	Qog	Older Gravels	Older fan, channel and colluvial gravels with sand and silt.	Easy
25.4 – 25.8	Qof	Older Alluvium	Uplifted remnants of alluvial gravel	Easy
25.8 – 26.0	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
26.0 – 26.1	af	Artificial Fill	Artificial fill	Easy
26.1 – 28.3	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
28.3 – 28.9	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
28.9 & 31.1	Fault	Raymond Fault	Crosses two fault strands, significant active Alquist-Priolo zoned fault	NA
28.9 – 29.1	Qa	Alluvium	Gravels, sands, and silts	Easy
29.1 – 31.8	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy

Table 2-11. Geology along Segment 11 of Proposed Project Route

Segment 11 Mileposts (S11-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
31.8 – 34.1	Qa	Alluvium	Gravels, sands, and silts	Easy
34.1	Fault	East Montebello Hills Fault	Active fault crossing, has Alquist-Priolo zone where crossed	NA
34.1 – 34.4	Qae	Alluvium	Slightly elevated and locally dissected alluvium gravels and sands	Easy
34.4 – 34.7	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
34.7 – 34.8	Qae	Alluvium	Slightly elevated and locally dissected alluvium gravels and sands	Easy
34.8 – 34.9	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
34.9 – 36.0	Tfsc, Tfp	Fernando Formation (Tfsc) and (Tfp)	Nonmarine sandstone and conglomerate (Tfsc)/claystone; gray micaceous silty claystone or siltstone.	Easy to Moderate
36.0 – 36.2	Qog	Older Alluvium	Uplifted remnants of alluvial gravel	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-27 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.
2) Refer to Figure 2-5 (Regional Geologic Map B) for approximate Milepost locations along Segment 11; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).
3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Helicopter construction techniques will be use for construction of portions of Segment 6 (17 towers) and Segment 11(16 towers. Twelve helicopter staging sites would be constructed along the segments to facilitate construction activities for these 33 towers. Each of these 12 helicopter staging areas is located within the San Gabriel Mountains proper or within the adjacent foothills/alluvial slopes, and the sites are primarily underlain by igneous and metamorphic bedrock. Geologic units expected to be encountered at the helicopter staging areas are listed below (see Tables 2-9 and 2-11 for summary descriptions of these units):

- SCE#0 - Older alluvium over Lowe Granodiorite
- SCE#1 - Lowe Granodiorite
- SCE#2 – Anorthosite Gabbro Complex, primarily anorthosite and gabbro diorite
- SCE#3 - Anorthosite Gabbro Complex, primarily anothosite
- SCE#3B - Artificial fill from dredging of Big Tujunga Reservoir of unknown depth over granitic rocks
- SCE#4 and SCE#5 – Quartz Diorite
- SCE#6 - Gneiss and intrusive granitic rocks
- SCE#6B - Gneiss
- SCE#7 - Granitic rocks
- SCE#8 - Gneissic rocks
- SCE#9 – Stream channel deposits of sand, gravel, and cobbles
- SCE#10 - Artificial fill from dredging of Cogswell Reservoir of unknown depth over granitic rocks

Slope Stability

The Project alignment along Segments 6, 7, and 11 traverses the San Gabriel Mountains and is characterized by steep to very steep terrain underlain by igneous and metamorphic bedrock before reaching the gently sloping alluvial plain of San Gabriel Valley. Small to large landslides are mapped in the steep mountain terrain along most of the mountainous portions of the proposed Segment 6, 7, and 11 alignments. Landslides underlie the proposed alignments at several locations as identified in Tables 2-9, 2-10, and 2-11. Several landslides are mapped along Segment 6 from MP 7.4 to 26.9. One small landslide is mapped along Segment 7 at MP 0.1. Large landslide complexes in sheared granitic and metamorphic rock along the Sierra Madre fault underlie Segment 11at MP 20.5 to 21.6 (CGS, 1998e) and at MP 24.0 to 25.3 (CGS, 1998a), and although no new towers would be constructed along Segment 11 south of MP 19, ground disturbance would occur for grading and/or regrading of access roads and work areas. Unmapped landslides and areas of localized slope instability may also be encountered throughout the San Gabriel Mountains, which are traversed by the proposed Project alignment, at the proposed helicopter staging areas, and adjacent to the proposed helicopter staging areas. Portions of Segments 7 and 11 located in the San Gabriel Valley (south of approximate mileposts S7-1 and S11-26) are relatively flat and would not be subject to slope stability issues.

Helicopter staging areas SCE#0, SCE#5, and SCE#9 are located along flat to gently sloping stream terraces along the edges of the San Gabriel Mountains and are not subject to slope stability issues. Sites SCE #4, SCE#6 and SCE#7, although located in hilly terrain of the San Gabriel Mountains, are located at preexisting, gently sloping, graded sites. Sites SCE#4 and SCE#7 are on graded gently sloping ridge/hill top sites and would likely not require additional grading for use as staging areas. Site SCE #6 is located at the existing facilities at Barton Flats, which already includes a helicopter landing area, and would not require further grading for use as a helicopter staging area.

Helicopter staging areas SCE#1, SCE#2, SCE#3, SCE#6B, and SCE#8 are located on or along ridges, hilltops, and in saddles of the San Gabriel Mountains with sloping terrain which would require moderate to extensive grading (cut and fill) to create suitable, relatively flat sites for helicopter landings and staging of construction supplies and equipment. Site SCE#3B is located in Maple Canyon southeast of Big Tujunga Reservoir on terraced fill slopes created from material dredged from the reservoir. The SCE#3B helicopter staging area is located near the top of the terraced fill in the canyon with moderately sloping hills above and on either side of the site and would require moderate grading to create a suitable staging area. Site SCE#10 is located near Cogswell Reservoir on terraced fill slopes created from material dredged from the reservoir and placed in an adjacent canyon. The SCE#10 helicopter staging area consists of two adjacent graded sites located near the top of the terraced fill in the canyon with moderately sloping hills above and on either side of the site. Although no landslides are mapped at these staging sites, small to large landslides and debris slides are mapped along the steep mountain terrain near to the staging sites indicating potential slope stability issues in the area.

Soils

Segment 6. Eighteen main soil associations/complexes are mapped along the Segment 6 Project route (Hanford, Vista, Greenfield, Pismo-Trigo-Exchequer, Pacifico, Pacifico-Preston, Olete-Kilburn-Etsel, Chilao, Pismo-Chilao-Shortcut, Trigo-Modjeska, Green Bluff-Hohmann, Trigo-Green Bluff-Supan, Caperton-Trigo, Stukel-Sur-Wintrop, Stukel-Olete, Trigo-Exchequer-Rock Outcrop, Trigo, and Vista-Trigo-Modesto; listed in order of approximate first occurrence along the segment from north to south). Each soil association/complex may occur numerous times along the Segment 6 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. These soils are primarily either formed in alluvium or colluvium weathered from granitic or metamorphic bedrock, or formed in material weathered from the underlying bedrock (primarily granitic, metamorphic, and volcanic rocks in the Project area). Locations of the soil associations along Segment 6 are listed in Appendix A.

Hazard of erosion for soils along the Segment 6 alignment for off-road or off-trail is slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential varies primarily from low to moderate with some high potential in areas underlain by the Trigo-Modesto complex. The corrosive potential of soils along Segment 6 ranges from low to high for uncoated steel and from low to moderate for concrete.

Segment 7. Three main soil units/associations are mapped along the Segment 7 Project route (Cieneba-Exchequer-Sobrante, Urban Land-Ramona-Zamora, and Urban Land-Hanford-Sorrento), listed in order of approximate first occurrence along the alignment from north to south. Each soil unit/association may occur numerous times along the Segment 7 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. The Cieneba-Exchequer-Sobrante soils are primarily formed in material weathered from the underlying igneous and metamorphic bedrock. The Urban Land-Ramona-Zamora and Urban Land-Hanford-Sorrento soils are formed in alluvium and colluvium on alluvial fans, plains, and terraces. Locations of the soil associations along Segment 7 are listed in Appendix A.

Hazard of erosion for these soils for off-road or off-trail ranges from slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils along Segment 7 ranges from low to high for uncoated steel and from low to moderate for concrete.

Segment 11. Segment 11 has numerous soil units/associations mapped along its alignment, sixteen total, with the largest number of soil types where the alignment crosses the San Gabriel Mountains. The main soil associations along the Segment 11 Project route, listed in order of approximate first occurrence along the alignment, from north to south, are: Hanford, Vista, Pismo-Trigo-Exchequer, Tollhouse-Stukel-Wrentham, Tollhouse-Knutsen-Stukel, Pismo-Chilao-Shortcut, Rock Outcrop-Chilao, Olete-Kilburn-Etsel, Trigo-Modjeska, Stukel-Sur-Winthrop, Chilao-Trigo, Trigo, Caperton-Trigo, Cienba-Exchequer-Sobrante, Urban Land-Ramona-Zamora, and Urban Land-Hanford-Sorrento. Each soil unit/association may occur numerous times along the Segment 11 alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. These soils are primarily either formed in alluvium or colluvium weathered from granitic or metamorphic bedrock, or formed in material weathered from the underlying bedrock (primarily granitic, metamorphic, and volcanic rocks in the Project area). The Hanford, Vista, Trigo-Modjeska, TrigoUrban Land-Ramona-Zamora and Urban Land-Hanford-Sorrento soils are formed in alluvium and colluvium on alluvial fans, plains, and terraces. The remaining soil types are primarily either formed in alluvium or colluvium weathered from the adjacent bedrock, or formed in material weathered from the underlying bedrock (primarily igneous, metamorphic, and volcanic rocks in the Project area). Locations of the soil associations along Segment 11 are summarized in Appendix A.

Hazard of erosion for these soils for off-road or off-trail ranges from slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to high. The corrosive potential of soils along Segment 11 ranges from low to high for uncoated steel and from low to moderate for concrete.

Helicopter Staging Areas. The soils associations located at the helicopter staging areas are the same or similar to soils located along the nearby Segments 6 and 11 routes. Soil associations mapped at the helicopter staging areas are as follows:

- SCE#0 - Hanford

- SCE#1 – Tollhouse-Stukel-Wrentham
- SCE#2 and SCE#3 –Pismo-Chilao-Shortcut
- SCE#3B – this site is mapped as underlain by Chilao soils, however because this site is on dredged fill the 'soil characteristics' of the material of the site is dependent on the type and grain size of the fill material.
- SCE#4 and SCE#5–Cienba-Exchequer-Sobrante
- SCE#6 and SCE#6B – Trigo-Green Bluff-Supan
- SCE#7 – Stukel-Sur-Winthrop
- SCE#8 and SCE#9 – Ramona-Zamora
- SCE#10 - site is mapped as underlain by Stukel-Olete soils, however because this site is on dredged fill the 'soil characteristics' of the material at the site is dependent on the type and grain size of the fill material.

These soils are primarily either formed in alluvium or colluvium weathered from granitic or metamorphic bedrock, or formed in material weathered from the underlying bedrock (primarily granitic and metamorphic, rocks in this part of the Project area). A summary of the basic characteristics of these soils is presented in Table 2-1. Hazard of erosion for soils at the helicopter staging areas for off-road or off-trail is slight to very severe; this hazard ranges from slight to severe for on roads and trails. Shrink/swell (expansive) potential of the soils varies primarily from low to high. The corrosive potential of soils for the helicopter staging areas ranges from low to high for uncoated steel and from low to moderate for concrete.

Mineral Resources

Ten sites with either mineral occurrences or past or current mining activities are identified in the MRDS within 1,000 feet of the proposed TRTP route, six sites along Segment 6, two sites along Segment 7, and two sites along Segment 11. The sites consist of three metallic mineral (ore) mines, one mapped ore occurrences, two ore prospects, three sand and gravel quarries, and one crushed/broken stone quarry. The six sites along Segment 6 are all inactive and range from approximately 50 to 850 feet from the Project ROW; the sites consist of one ore occurrence, two ore prospects, and three past ore (gold) producers. The two sites along Segment 11 are also inactive, ranging from 250 to 500 feet from the Project ROW, consist of a past gravel quarry and a past crushed/broken rock quarry, both of which have been reclaimed and the sites are currently occupied by buildings and parking lots. None of these sites is listed by the CGS (CGS, 1999f) as an active mine.

The two mapped MRDS sites along Segment 7 consist of sand and gravel quarries located in the Irwindale area, ranging from 0 to 50 feet from the Project ROW and are identified as the Duarte and Irwindale Pits. The Irwindale Pit consists of three adjacent pits (commonly known as Irwindale Pits #1, #2, and #3), owned by the United Rock Products Corp, and of which two are currently in operation (CGS, 2004). The Project ROW crosses a portion of the eastern most pit, however based on aerial photo review the towers for the existing transmission line are located outside of the existing quarry boundaries and it is assumed that any new towers would be at similar tower spacing.

Given the distance of these sites from the ROW and the ability of mining-related equipment and vehicles to cross the ROW if necessary, construction and operation of the TRTP transmission line is not expected to interfere with future access to any mineral resources. If any of the inactive mine or mineral resource sites were to be mined in the future during the Project's construction or operation, the height and spacing of the transmission lines would provide adequate clearance for vehicles and equipment to cross the ROW under the lines if necessary.

Mineral resources in the vicinity of the helicopter staging areas consist primarily of metallic minerals (ores) such as gold and titanium and no active mines are located at or adjacent to any of the staging sites. This results in no potential for inference with access to known mineral resources from construction and use of these sites for helicopter staging activities associated with construction of towers along Segments 6 and 11.

Seismic Hazards

Fault Rupture. Segments 6, 7, and 11 cross several active faults: the San Gabriel fault, Clamshell-Sawpit fault, Sierra Madre fault, Raymond fault, and East Montebello Hills fault. All of these faults, with the exception of the East Montebello fault are part of the Transverse Ranges Southern Boundary fault system, a west-trending system of reverse, oblique-slip, and strike-slip faults that extends for >200 km along the southern edge of the Transverse Ranges. One additional fault crossed by the Project alignment, the southern portions of Segments 7 and 11, is the Puente Hills Blind Thrust. Although this fault underlies several miles of these segments, as shown in Figure 2-2, it is a buried blind thrust fault and is not expected to generate primary surface fault rupture, however minor surface cracking could be associated with an earthquake on this fault. None of the helicopter staging areas are crossed by or immediately adjacent to any active faults with the exception of helicopter staging area SCE#4, which is crossed by a segment of the Sierra-Madre fault. However, because this site is temporary and will only be in use for a short duration during helicopter construction along Segment 11, the potential for an earthquake resulting in ground rupture to occur at this site during this time is remote.

The general physical characteristics of these faults are summarized below and seismic characteristics of these faults are presented in above in Table 2-2.

- The San Gabriel Fault is approximately 87 miles long (140 kilometers) and traverses the southwestern boundary of the San Gabriel Mountains. The fault is primarily right-lateral strike-slip but transitions to oblique right reverse slip to the east, and has varying slip rates and recurrence intervals along its length, with the northwestern end being the most recently active (Holocene). In the vicinity of the proposed Project, where the San Gabriel fault is traversing the San Gabriel Mountains, it is considered less active.
- The Clamshell-Sawpit fault is an approximately 11-mile-long (18 kilometer) reverse fault along the southern edge of the San Gabriel Mountains. The Clamshell-Sawpit fault is postulated as the source of the Sierra Madre earthquake of 1991, and although it was a sizable earthquake, the depth of this quake prevented the rupture from reaching the surface (SCEDC, 2007a).
- The Sierra Madre fault is a 34-mile-long, complex reverse fault structure that extends east-west across the range front of the San Gabriel Mountains in the Project area. The zone is often divided into five main segments, with each segment also consisting of complex systems of parallel and branching fault strands. Trenching performed in Altadena area revealed evidence for two large earthquake events in the last 15,000 years with displacements on the order of 15 to 20 feet or greater and magnitude Mw 7.2 to 7.6 earthquakes (Rubin, et al, 1998).
- The Raymond fault is a 20-km-long, north dipping left-lateral strike-slip fault that extends east-northeastward through the San Gabriel Valley, northeast of downtown Los Angeles. The Raymond fault is part of east-west fault system (also including the Anacapa-Dume, Malibu Coast, Santa Monica, and Hollywood faults) that formed to accommodate the clockwise rotation of the western Transverse Ranges and forms the northern limit of the Los Angeles Basin. D Trenching studies conducted on the Raymond fault indicate that the most recent fault surface rupture occurred approximately on to two thousand years ago (ka) (Weaver and Dolan, 2000).
- The East Montebello Hills Fault is a northwest trending, north dipping right-lateral strike-slip fault with an apparent substantial reverse component that is considered to be the northern most extension of the Whittier Fault zone (Yeats, 2004). The East Montebello Hills Fault is approximately 4 miles long and generally traverses the northern edge of the Montebello Hills. Activity along this fault is considered less than that of

the other portions of the Whittier fault, approximately only 0.2 mm/year, as slip/strain in this area is being distributed to the underlying blind thrusts and folds.

- The Puente Hills Blind Thrust is approximately 25 miles long, and extends in a northwest-southeast direction in the Los Angeles Basin underlying downtown Los Angeles and east to Brea in northern Orange County (see Figure 2-2). Geophysical research conducted on this fault indicate that it is divided into three segments and that single segment earthquakes of M6.5 could occur about every 400 to 1300 years and multiple segment earthquakes of M7.1 could have recurrence intervals of 780 to 2600 years. This fault was responsible for the Whittier Narrows M6.0 earthquake which caused substantial damage in the Los Angeles area. (Shaw et. al., 2002).

The Segment 6 Project route crosses both the San Gabriel and Clamshell-Sawpit faults, at approximate mileposts S6-18.9 and S6-24.5, respectively. Neither one of these faults are within the Alquist-Priolo zones where the alignment crosses them, however these faults are known seismic sources, resulting in a potential for surface rupture in the event of a large earthquake on the corresponding fault. Locations of these fault crossings along segment are shown in Figure 2-6 (Segment 6 Active Fault Crossings).

Segment 7 crosses five fault strands associated with the active Sierra Madre fault zone, three strands between mileposts S7-1 to S7-1.1, and at approximate mileposts S7-1.3 and S7-1.7. The Sierra Madre fault zone is active through this region and capable of large magnitude earthquakes with large displacements and could cause significant surface rupture in the Project area. The Segment 7 route passes approximately 650 feet south of the southern end of the Alquist-Priolo zone for the East Montebello Hills fault, with the projection of the fault crossing the route at approximately milepost S7-13.6. Because of the short length of this fault and the very low slip rate, significant primary surface fault rupture would not be expected along the projection of this fault. Locations of these fault crossings along segment are shown in Figure 2-7 (Segment 7 Active Fault Crossings).

Segment 11 crosses four active faults along its route between mileposts S11-14 and S11-35, the San Gabriel fault, the Sierra Madre fault zone, the Raymond fault, and the East Montebello Hills fault. The alignment crosses the San Gabriel fault at approximately milepost S11-14.9. The Segment 11 route traverses parallel to and across the active Sierra Madre fault, crossing several fault strands associated with the zone: one strand is crossed three times between mileposts S11-18.4 and S11-18.6, and five strands between mileposts S11-24.7 to S11-24.4, at approximate mileposts S11-24.7, S11-25.1, S11-25.2, and two strands between S11-25.35 and S11-25.4. The alignment crosses two strands of the Alquist-Priolo zoned Raymond fault between mileposts S11-28.9 and S11-29.1 and crosses the Alquist-Priolo zoned East Montebello Hills fault at approximately milepost S11-34.15. However, construction along Segment 11 south of S11 MP 19, where the majority of these fault crossings occur, would not include construction of any new towers, only restringing a vacant position on existing towers; therefore, fault rupture impacts would not be relevant along this portion of Segment 11. Locations of these fault crossings along segment are shown in Figures 2-8a and 2-8b (Segment 11 Active Fault Crossings).

Groundshaking. As shown in Table 2-2, Segments 6, 7, and 11 are in close proximity to numerous active faults of the Transverse Ranges, and cross several significant large active faults. Additionally, the southern portions of Segments 7 and 11 overlie and are in close proximity to the Puente Hills Blind Thrust and the Upper Elysian Park Thrust, respectively, as shown in Figure 2-2. These blind thrust faults are capable of producing large earthquakes and very strong groundshaking, as demonstrated by the Whittier Narrows M6.0 earthquake which occurred on the Puente Hills Blind Thrust and caused substantial damage in the Los Angeles area. Moderate to very strong groundshaking should be expected from an earthquake on any of the faults in the vicinity of Segments 6, 11, and 7, and at the nearby associated helicopter staging areas. The expected ranges of peak horizontal accelerations for these segments are presented in Table 2-3. Expected peak horizontal accelerations at the helicopter staging areas are similar to the nearby Project segments, Segments 6 and 11, ranging from 0.6 to 1.2g.

Liquefaction. Potential for liquefaction in the mountainous areas crossed by Segments 6 and 11 is low to nonexistent due to the presence of non-liquefiable bedrock underlying the alignments in this area. Where Segment 11 and Segment 7 cross young alluvial deposits of the San Gabriel Valley, near the Rio Hondo and San Gabriel Rivers, and in the Whittier Narrows area the underlying sediments are potentially liquefiable (CGS, 1999b, 1999c, 1999d, 1999e). Additionally, during large storms or a wet season, other sections of the proposed segments that are underlain by alluvium near to and/or crossing smaller river washes and streams may become susceptible to liquefaction if a strong earthquake were to occur while these sediments are saturated due to a temporary/seasonal water table rise.

Liquefaction potential at all of the helicopter staging areas is low to nonexistent. Eleven of the helicopter staging areas have no liquefaction potential due to the presence of non-liquefiable underlying granitic and metamorphic bedrock. Site SCE#0 is underlain by older alluvium near to a stream channel; and although the area is mapped as potentially liquefiable by the CGS (2003b), the potential for liquefaction is low at this site due to the expected coarse nature of the deposits and shallow depth to bedrock. Site SCE#9 is underlain by stream channel deposits of sand, gravel, and cobbles and although the area is mapped as potentially liquefiable by the CGS (1999b), the coarse nature of the deposits and shallow depth to bedrock near the mountain front reduces the potential for liquefaction at this site to low.

Earthquake-Induced Landslides. The topography along Segments 6, 7, and 11 in the San Gabriel Mountains is steep and is likely to experience landsliding or slope failures due to earthquakes. The CGS has mapped much of the mountainous and hillside terrain crossed by these Segments and the associated helicopter staging areas as having potential for earthquake-induced landslides (CGS, 1999b, 1999c, 1999d, 1999e). Historic earthquake induced ground failures are known to have occurred in the mountains of near the Project alignments due to the 1971 San Fernando Earthquake, 1991 Sierra Madre Earthquake, and the 1994 Northridge Earthquake. The steep mountain slopes could experience slope failures in areas with over-steepened slopes or with weathered and sheared bedrock.

Paleontology

In the San Gabriel Mountains the proposed Project alignment is underlain mostly by igneous and metamorphic rocks, with Quaternary alluvial rock units occurring along the major drainages, where they underlie the valley and canyon floors. Older Alluvium occurs at the base of the mountains and near the Montebello Hills (Mesa Substation). Course alluvial fans dominate Segment 7 in the Duarte area. Younger Alluvium blankets the floor of the San Gabriel Valley and underlies much of Segment 7 south of Duarte and underlies Segment 11 from east Pasadena to Rosemead. The igneous and metamorphic rocks of the San Gabriel Mountains are non-fossil bearing due to origin of the rock.

Generally the Older Alluvium and alluvial fan deposits at the base of the San Gabriel Mountains are too coarse grained to contain identifiable fossil specimens. Any such remains would have been destroyed or heavily damaged by deposition of the cobbles and boulders that comprise this rock unit (PEAI, 2007). Two fossil sites in the Older Alluvium of the San Gabriel Valley (San Dimas and West Covina) have yielded teeth of a Pleistocene mammoth and ground sloth remains (PEAI, 2007). The occurrence of only two recorded fossil site near the Project area suggests that there is an undetermined (but probably no more than a moderate) potential for additional, similar, scientifically important fossil remains being encountered locally by ground-disturbing activities in the San Gabriel Valley (PEAI, 2007).

The Younger Alluvium in the San Gabriel Valley has locally yielded late Pleistocene mammoth (Pasadena and Eagle Rock) and fossilized bones and teeth of late Pleistocene land mammals (downtown Los Angeles) (PEAI, 2007). These occurrences indicate that there is an undetermined (but probably no more than a moderate) potential for additional, similar, scientifically important fossil remains being encountered locally in Younger Alluvium in the San Gabriel Valley. The alluvial deposits along streams and valleys within the San Gabriel Mountains are unlikely to contain identifiable fossil specimens due to the high energy depositional environment that would damage the specimens.

2.3.4 Mesa Substation to Mira Loma Substation (Segments 8A, 8B, and 8C)

Geology

Segment 8A primarily traverses moderate to steep slopes of the Puente and Chino Hills, the western and eastern ends of Segment 8A cross alluvial deposits in the Whittier Narrows area and the Chino Basin, respectively. Segments 8B and 8C traverse alluvial fans, plains, and terraces of the Chino Basin. Geologic units crossed by these segments of the Project are younger alluvium, older alluvium, sandstone and conglomerate of the Fernando Formation, and sandstone, shale, siltstone, and conglomerate of the Puente Formation. Figure 2-9 (Regional Geologic Map C) presents the geology along Segment 8A, 8B, and 8C.

Geologic conditions likely to be encountered during construction of the proposed Tehachapi Renewable Transmission Project, Segments 8A, 8B, and 8C are summarized below in Tables 2-12, 2-13, and 2-14, respectively. The tables includes: name of the geologic formation or feature; the geologic symbol for the formation; the feature or formations name; a description and comments about the geologic features and the formation's general rock type, lithology, and susceptibility to specific geologic hazards as appropriate; and general excavation characteristics of the unit related to excavation or drilling of tower and structure foundations. Descriptions of geologic units in the Project area are based on published geologic maps by the CGS (1997, 1998c, 1999d, 2000b, 2005), Dibblee (1999, 2001a, 2001b), Durham and Yerkes, 1964, and Yerkes (1972).

Table 2-12. Geology along Segment 8A of Proposed Project Route

Segment 8A Mileposts (S8A)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 1.6	Tfsc	Fernando Formation	Nonmarine sandstone and conglomerate; light gray to tan, crudely bedded; conglomerate composed of pebbles and cobbles	Easy to Moderate
1.6 – 1.8	Qls	Landslide	(Qls) Landslide (CGS, 1998c)	Moderate to Difficult
1.8 – 2.1	Qg	Surficial Sediment	Stream channel deposits of gravel, sand and silt.	Easy
2.1 – 2.2	Qoa	Older Alluvium	Sand and gravel fan deposits	Easy
2.2 – 2.5	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
2.5 – 3.6	Qa	Alluvium	Gravels, sands, and silts	Easy
3.6 – 3.9	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
3.9 – 4.8	Qa	Alluvium	Gravels, sands, and silts (Oil Field at 4.0)	Easy
4.8 – 5.0	Qls	Landslide	(Qls) Landslide (CGS, 1998c)	Easy to Moderate
5.0 – 5.6	Tfp, Tfs, Tfr	Fernando Formation	Fine grained sedimentary rock from fine-medium grained sand to claystone or siltstone; gray, weathers brown.	Easy to Moderate
5.6 – 6.4	Qls	Landslide Complex	(Qls) Landslide (Dibblee and CGS, 1998c)	Easy to Moderate
6.4 – 6.7	Tfp, Tfs, Tfr	Fernando Formation	Fine grained sedimentary rock from fine-medium grained sand to claystone or siltstone; gray, weathers brown.	Easy to Moderate
6.7 – 7.1	Qls	Landslide Complex	(Qls) Landslide (CGS, 1998c)	Easy to Moderate

Table 2-12. Geology along Segment 8A of Proposed Project Route

Segment 8A Mileposts (S8A)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
7.1 – 7.6	Tfr, Tscg, Tsc	Fernando Formation (Tfr), Puente Formation (Tscg) and (Tsc)	Claystone; gray micaceous silty claystone or siltstone (Tfr); Sycamore Canyon Member conglomerate sandstone unit (Tscg); Sycamore Canyon Member gray silty clay shale (Tsc)	Easy to Moderate
7.6 – 8.0	Qls	Landslide Complex.	(Qls) Landslide (CGS, 1997)	Easy to Moderate
8	Fault	East Montebello Hills Fault	Fault crossing, northern extension of the Whittier fault	NA
8.0 – 8.1	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
8.1 – 8.4	Qls	Landslide Complex.	(Qls) Landslide (CGS, 1997)	Easy to Moderate
8.4 – 8.5	Tps	Puente Formation	Soquel Sandstone member; weather to tan, medium grained could be coarse to pebbly	Easy to Moderate
8.5 – 8.7	Qls	Landslide Complex.	(Qls) Landslide (CGS, 1997	Easy to Moderate
8.7 – 9.0	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
9.0 – 9.1	Tps	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
9.1 – 10.3	Fault Zone	Whittier Fault, Puente Formation	T/L route traverses fault zone obliquely. Yorba shale member; light gray, thin bedded, diatomaceous, semi-siliceous to clay shale, siltstone, minor sandstone; fish scales	Easy to Moderate
9.3 – 9.6	Qls	Landslide Complex	(Qls) Landslide (CGS, 1997)	Easy to Moderate
9.7 – 10.5	Qls	Landslide Complex	(Qls) Landslide (CGS, 1997)	Easy to Moderate
10.5 – 10.7	Tsc	Puente Formation	Sycamore Canyon Member (Tsc) Silty claystone; gray, micaceous, weakly bedded to locally thinly bedded	Easy to Moderate
10.7 – 11.0	Qls	Landslide Complex	(Qls) Landslide (Dibblee and CGS, 1997)	Easy to Moderate
11.0 – 11.1	Tscs	Puente Formation	Sycamore Canyon Member (Tscg)Conglomerate sandstone unit, gray to rusty-brown conglomerate, crudely bedded, composed of cobbles and pebbles	Easy to Moderate
11.1 – 11.3	Tpy	Puente Formation	Yorba shale member; light gray, thin bedded, semi-siliceous to clay shale, siltstone, minor sandstone; fish scales	Easy to Moderate
11.3 – 11.5	Tps	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
11.5 – 12.2	Qls	Landslide Complex	(Qls) Landslide (Dibblee and CGS, 1997)	Easy to Moderate
12.2 – 12.4	Tpss, Tps, Tpy, Tp	Puente Formation	Soquel Sandstone Member (Tpss & Tps), Yorba shale Member (Tpy), Unassigned Member (Tp); fine-medium sedimentary unit from sand, clay to siltstone shale	Easy to Moderate
12.4 – 12.6	Qls	Landslide	(Qls) Landslide (CGS, 1997)	Easy to Moderate
12.6 – 13.5	Tpss, Tps, Tpy, Tp	Puente Formation	Soquel Sandstone Member (Tpss & Tps), Yorba shale Member (Tpy), Unassigned Member (Tp); fine-medium sedimentary unit from sand, clay to siltstone shale	Easy to Moderate
13.5 – 13.6	Qa	Alluvium	Gravels, sands, and silts	Easy
13.6 – 14.0	Qae, Tpss, Tplv	Puente Formation (Tpss & Tplv), Alluvium	Soquel Sandstone Member (Tpss) & La Vida Shale Member (Tplv); fine-medium sedimentary unit from sand, clay to siltstone shale./Alluvium; Slightly elevated and locally desiccated alluvium gravels and sands (Qae)	Easy to Moderate
14.0 – 14.3	Qls	Landslide Complex	(Qls) Landslide (CGS, 1997)	Easy to Moderate
14.3 – 15.8	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate

Table 2-12. Geology along Segment 8A of Proposed Project Route

Segment 8A Mileposts (S8A)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
15.8 – 16.5	Tpss	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
16.5 – 16.7	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
16.7 – 16.8	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
16.8 – 17.0	Qa	Alluvium	Gravels, sands, and silts	
17.0 – 17.3	Qls	Landslide Complex	(Qls) Landslide (CGS, 2005)	Easy to Moderate
17.3 – 17.4	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
17.4 – 17.5	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
17.5 – 17.8	Tpss	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
17.8 – 18.4	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
18.4 – 18.5	Qa	Alluvium	Gravels, sands, and silts	Easy
18.5 – 18.6	Tplv	Puente Formation	La Vida Shale Member; white, weathered; thin bedded, platy, siliceous shale, clay shale, and siltstone	Easy to Moderate
18.6 – 18.8	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
18.8 – 19.1	Tpss	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
19.1 – 19.4	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
19.4 – 19.6	Tpss	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
19.6 – 19.8	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
19.8 – 21.4	Tpss	Puente Formation	Soquel Sandstone Member; Bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
21.4 – 21.8	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
21.8 – 22.0	Tpss	Puente Formation	Soquel Sandstone Member; bedded sandstone, light gray, weather tan, medium grained could have coarser grains to pebbles	Easy to Moderate
22.0 – 22.1	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
22.1 – 22.2	Tp	Puente Formation	Unassigned shale; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
22.2 – 22.4	Qa	Alluvium	Gravels, sands, and silts	Easy
22.4 – 22.9	Tp	Puente Formation	Unassigned shale; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
22.9 – 23.1	Tp, Qoa	Puente Formation, Old alluvium	Unassigned shale; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone (Tp)/gravel, sands, and silts (Qoa)	Easy to Moderate
23.1 – 23.2	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
22.9 – 23.3	Tp, Qoa	Puente Formation, Old alluvium	Unassigned shale; white, weathered; thin bedded, platy, siliceous shale, clay shale, and siltstone (Tp)/gravel, sands, and silts (Qoa)	Easy to Moderate
23.3 – 23.5	Qls	Landslide	(Qls) Landslide (CGS, 2005)	Easy to Moderate
23.5 – 23.6	Tp	Puente Formation	Unassigned shale; white, weathered; thin bedded, siliceous shale, clay shale, and siltstone	Easy to Moderate
23.6	Fault	Arnold Ranch Fault	Fault crossing, likely inactive fault	NA

Table 2-12. Geology along Segment 8A of Proposed Project Route

Segment 8A Mileposts (S8A)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
23.6 – 23.9	Tp	Puente Formation	Yorba shale member; light gray, thin bedded, semi-siliceous to clay shale, siltstone, minor sandstone; fish scales	Easy to Moderate
23.9 – 24.0	Qa	Alluvium	Gravels, sands, and silts	Easy
24.0 – 24.5	Tp	Puente Formation	Yorba shale member; light gray, thin bedded, semi-siliceous to clay shale, siltstone, minor sandstone; fish scales	Easy to Moderate
24.5 – 24.8	Qa	Alluvium	Gravels, sands, and silts	Easy
24.8 – 25.1	Tp	Puente Formation	Yorba shale member; light gray, thin bedded, semi-siliceous to clay shale, siltstone, minor sandstone; fish scales	Easy to Moderate
25.1 – 25.9	Qa	Alluvium	Gravels, sands, and silts	Easy
25.9 – 26.1	Qg	Alluvium Fan	Stream channel deposits of gravel, sand and silt.	Easy
26.1 – 26.9	Qa	Alluvium	Gravels, sands, and silts	Easy
26.9	Fault	Chino-Central Avenue Fault	Fault crossing, Central Ave segment of the fault	NA
26.9 – 35.2	Qa	Alluvium	Gravels, sands, and silts	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-17 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.

2) Refer to Figure 2-9 (Regional Geologic Map C) for approximate Milepost locations along Segment 8A; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).

3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Table 2-13. Geology along Segment 8B of Proposed Project Route

Segment 8B Mileposts (S8B4-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 4.1	Qa	Young Alluvium	Gravels, sands, and silts	Easy
4.1 – 4.8	Qf	Very Young Alluvium	Gravels, sands, and silts	Easy
4.8 – 6.8	Qye	Alluvium	Gravels, sands, and silts	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-17 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.

2) Refer to Figure 2-9 (Regional Geologic Map C) for approximate Milepost locations along Segment 8B; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).

3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Table 2-14. Geology along Segment 8C of Proposed Project Route

Segment 8C Mileposts (S8C-)[1, 2]	Geologic Symbol[1]	Formation/ Feature Name[1]	Description/Comments[1]	Excavation Characteristics[3]
0.0 – 4.5	Qa	Young Alluvium	Gravels, sands, and silts	Easy
4.5 – 4.7	Qf	Very Young Alluvium	Gravels, sands, and silts	Easy
4.7 – 6.4	Qye	Alluvium	Gravels, sands, and silts	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-17 of the PEA (SCE, 2007). Project mile measurements were assumed to be accurate and not re-measured.

2) Refer to Figure 2-9 (Regional Geologic Map C) for approximate Milepost locations along Segment 8C; actual Mileposts for the alignment measured from Dibblee geologic maps (SCE, 2007).

3) Excavation characteristics are defined as "easy," "moderate," or "difficult" based on estimates of rock strength of the each unit. Excavation characteristic definitions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions. NA – Not Applicable.

Slope Stability

The Project alignment along Segment 8A traverses the Puente Hills where moderate to locally steep slopes are underlain by Tertiary marine and nonmarine sedimentary rock. Segments 8B and 8C cross the nearly flat Chino Valley underlain by alluvial deposits where no landslides occur. Numerous small to large landslides are mapped in the hillside areas of the Puente Hills where the Puente Formation is distinctly prone to landslides and slope failure. Mapped landslides underlie the proposed Segment 8A alignment from MP 5.6 to 23.5 at several locations as identified in Tables 2-12, 2-13, and 2-14. Several landslides are mapped as complexes consisting of several slides and underlie 0.3 to 0.8 mile long portions of the proposed alignment. Unmapped landslides and areas of slope instability may be encountered throughout the Puente Hills traversed by the proposed Project alignment.

Soils

Segment 8A. Segment 8A has numerous soil units/associations mapped along its alignment, thirteen in total. The main soil associations along the Segment 8A Project route, listed in order of approximate first occurrence along the alignment, from west to east, are: Urban Land-Ramona-Zamora, Urban Land-Hanford-Sorrento, Anaheim-Soper-Fontana, Gaviota-Rock Outcrop, Fontana, Chualar, Sorrento, Chino, Grangeville, Merrill, Hilmar, Tujunga, and Dehli. Each soil unit/association may occur numerous times along the Segment 8A alignment. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. The Urban Land-Ramona-Zamora, Urban Land-Hanford-Sorrento, Anaheim-Soper-Fontana, Gaviota-Rock Outcrop, Fontana, Chualar, and Sorrento soils are primarily formed on hills or sloping terrain in material weathered from the sedimentary bedrock of the Puente and Chino Hills. The Sorrento, Chino, Grangeville, Merrill, Hilmar, Tujunga, and Dehli soils are along the portion of the alignment in the Chino Basin, and are formed in alluvium and colluvium on alluvial fans, plains, and terraces derived primarily from granitic sources. Milepost locations of the soil associations along Segment 8A are summarized in Appendix A.

Hazard of erosion for these soils for off-road or off-trail ranges from slight to very severe and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils along Segment 8A ranges from low to high for uncoated steel and from low to moderate for concrete.

Segments 8B and 8C. Both of these segments are underlain by the same five main soil associations along their Project routes. The soil associations listed in order of approximate first occurrence along the alignments, from west to east, are: Chino, Grangeville, Hilmar, Tujunga, and Dehli. Each soil unit/association may occur numerous times along the Segment 8B and 8C alignments. Soil associations with only small or limited occurrences along the alignment are not discussed. A summary of the basic characteristics of these soils is presented in Table 2-1. These soils are are formed in alluvium and colluvium on alluvial fans, plains, and terraces in the Chino Basin which are derived primarily from granitic sources. Milepost locations of the soil associations along Segment 8B and Segment 8C are summarized in Appendix A.

Hazard of erosion for these soils for off-road or off-trail is slight and for on roads and trails ranges from slight to moderate. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils along Segment 8C ranges from low to high for uncoated steel and from low to moderate for concrete.

Seismic Hazards

Fault Rupture. The Segment 8A route traverses parallel to and across the Alquist-Priolo zoned Whittier fault between mileposts S8A-8.9 and S8A-10.3. In addition, the projected traces of the Alquist-Priolo zoned East Montebello and Chino faults cross Segment 8A. Segment 8A is located less that 0.25 miles south of the mapped active trace of the Montebello Hills fault and its associated Alquist-Priolo zone, which projects south crossing the Segment 8A alignment between S8A MPs 2.3 and 2.4, as shown in Figure 3.7-6. The mapped active trace of the Chino fault and its associated Alquist-Priolo zone are located just less than a mile south of the alignment, with the fault projecting northwest towards S8A MP 25.5. Segment 8A also crosses the potentially active Central Avenue segment of the Chino fault zone between S8A MP 26.8 and 26.9. The locations of these faults relevant to Segment 8A are shown in Figure 3.7-9 (Segment 8A Fault Crossings). Segments 8B and 8C do not cross any active faults and thus would not be subject to surface fault rupture. The Whittier fault is capable of large magnitude earthquakes with moderate to large displacements and could cause significant surface rupture in the Project area. The general physical characteristics of these faults are summarized below and seismic characteristics of the faults listed above are presented in above in Table 2-2.

- The East Montebello Hills Fault is a northwest trending, north dipping right-lateral strike-slip fault with an apparent substantial reverse component that is considered to be the northern most extension of the Whittier Fault zone (Yeats, 2004). The East Montebello Hills Fault is approximately 4 miles long and generally traverses the northern edge of the Montebello Hills. Activity along this fault is considered less than that of the other portions of the Whittier fault, approximately only 0.2 mm/year, as slip/strain in this area is being distributed to the underlying blind thrusts and folds.
- The Whittier fault is a primarily right-lateral strike-slip north dipping fault at the northern end of the Elsinore fault system and is approximately 25 miles (40 kilometers) long extending through the Chino Hills to Whittier. This fault is an active Alquist-Priolo zoned fault which is considered capable of producing moderate to large earthquakes of up to magnitude M 7.0 (USGS, 2008).
- The Chino fault is also a primarily right-lateral strike-slip fault at the northern end of the Elsinore fault system and extends approximately 13 miles (21 kilometers) from Chino Hills to Corona. A magnitude M4.1 earthquake in February, 1989, had an epicenter located southwest of the surface trace of the fault, consistent with fault plane solutions for the Chino fault (SCEC, 2001). This fault is an active Alquist-Priolo zoned fault, and is considered capable of producing earthquakes of up to magnitude M 6.7.
- The Central Avenue Fault is a potentially active strand of the Chino-Central Avenue fault zone. This fault is primarily located based the presence of groundwater barriers and vegetation lineaments and limited oil well data.

One additional fault crossed by the Segment 8A alignment is the Puente Hills Blind Thrust. Although this fault underlies many miles of this segment, as shown in Figure 2-2, it is a buried blind thrust fault and is not expected to generate primary surface fault rupture; however, surface cracking could be associated with an earthquake on this fault. This fault is described in more detail above under the Fault Rupture section for Segments 6, 7, and 11.

Groundshaking. As shown in Table 2-2, Segments 8A, 8B, and 8C are in close proximity to numerous active faults of the southern Transverse Ranges and San Andreas Fault system, and cross significant active faults of the Elsinore Fault system (Whittier and Chino faults). Additionally, the eastern portion of Segment 8A overlies and is in close proximity to the Puente Hills Blind Thrust and the Upper Elysian Park Thrust, respectively, as shown in Figure 2-2. These blind thrust faults are capable of producing large earthquakes and very strong groundshaking, as demonstrated by the Whittier Narrows M6.0 earthquake which occurred on the Puente Hills Blind Thrust and caused substantial damage in the Los Angeles area. Moderate to very strong groundshaking should be expected from an earthquake on any of the faults in the vicinity of these segments. The expected ranges of peak horizontal accelerations for these segments are presented in Table 2-3.

Liquefaction. Potential for liquefaction in the Puente and Chino Hills area crossed by Segment 8A is low to nonexistent due to the presence of non-liquefiable bedrock underlying the alignment in this area. Where Segment 8A crosses young alluvial deposits in the Whittier Narrows area, the underlying sediments are potentially liquefiable (CGS, 1999d). Alluvial sediments located where Segment 8A crosses alluvial fan deposits near the confluence of Little Chino Creek and an unnamed creek from the northwest that are located along the eastern edge of the Chino Hills/western edge of the Chino Basin are mapped as having high liquefaction susceptibility (City of Chino Hills,1994). Although Segments 8A, 8B, and 8C cross potentially liquefiable young alluvial sediments in the main portion of the Chino Basin, anticipated depths to groundwater are greater than 70 feet (CBWM, 2008) resulting in a generally low liquefaction potential; areas with localized shallow seasonal and perched groundwater may have greater liquefaction susceptibility.

Earthquake-Induced Landslides. The topography along Segment 8A in the Puente and Chino Hills is locally steep and is likely to experience landsliding or slope failures due to earthquakes. Historic earthquake induced ground and slope failures are known to have occurred in the mountains and hills of southern California. Moderate to steep slopes throughout the Puente and Chino Hills could experience slope failures in areas with over-steepened slopes or with bedding planes oriented in the downslope direction.

Mineral Resources

No mineral resource sites are identified in the MRDS within 1,000 feet of the proposed TRTP Segment 8 route. Segment 8 does traverses near the Brea-Olinda oil field near Brea and Tonner Canyons north of the City of Brea, and Segment 8 about three miles north of the small Chino-Soquel oil field (DOGGR, 2008). However, the alignments do not cross through active oil well/field areas.

Paleontology

The proposed Project alignment in the Puente, Chino, and Montebello Hills traverses mostly late Tertiary marine sedimentary rock of the Puente Formation and Fernando Formation that form the hills. Quaternary Older and Younger Alluvium comprise the valley areas at San Gabriel River, Chino Valley and small stream channels within the Puente and Chino Hills.

The Miocene age Puente Formation is subdivided into four members: the La Vida Shale Member, the Soquel Sandstone Member, the Yorba Shale Member, and the Sycamore Canyon Member. Each member is known to contain scientifically important fossil assemblages and specimens (PEAI, 2007). The La Vida Shale Member has yielded the tests of marine microfossils (benthic foraminifers) of the late Miocene, lower Mohnian Stage, and fossilized fish scales; the fossilized remains of extinct species of marine algae, clams, crabs, fishes, sharks, and mammals (whales, desmostylids); and the fossilized wood and leaves of land plants (PEAI, 2007). These occurrences indicate that there is a high potential for additional, similar, scientifically important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the La Vida Shale Member. Moreover, there is a potential that some of the remains might represent new species or species previously not recorded from the member. For these reasons, the La Vida Shale Member is considered paleontologically highly important PEAI, 2007).

The Soquel Sandstone Member has yielded the tests of marine microfossil (benthic foraminifera) species of the late Miocene, upper Mohnian Stage; fossilized coral remains; fragments of mollusk shells and marine vertebrate bones; and shark teeth and fish scales in the Chino Hills (PEAI, 2007). In the Chino Hills at Laband Village, the member yielded fossilized remains representing at least fourteen species of marine and land plants and marine mollusks and vertebrates, including fishes and mammals, and additional such remains representing 19 species were recovered from the transitional zone between the Soquel Sandstone and Yorba Shale Members. Fossil localities also in the Chino Hills have yielded fossil fish and porpoise remains. These occurrences indicate that there is a high potential for similar scientifically highly important fossil remains being encountered in the Soquel Sandstone Member and there is a potential that some of the remains might represent new species or species previously not recorded from the member. For these reasons, the Soquel Sandstone Member is considered paleontologically highly important (PEAI, 2007).

The Yorba Shale Member has yielded the tests of marine microfossil (benthic foraminiferal) species of the late Miocene, upper Mohnian Stage in the Chino Hills, including the very rare, fossil remains of the paper nautilus, and 50 species of marine algae, land plants, and marine invertebrates and vertebrates at Laband Village (PEAI, 2007). The benthic foraminiferal species from Laband Village are characteristic of the late Miocene to early Pliocene lower Delmontian Stage, an age assignment that is slightly younger than previously reported for the Yorba Shale Member. These occurrences indicate that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the Yorba Shale Member and this unit is also considered paleontologically highly important (PEAI, 2007).

The Sycamore Canyon Member has yielded the tests of marine microfossil (benthic foraminiferal) species of the late Miocene to early Pliocene, upper Mohnian and lower Delmontian Stages in the Chino Hills (PEAI, 2007). Fossilized remains representing over 40 species, including marine and land plants, sea turtles, sharks, marine fishes, birds, and baleen whales, from a number of localities in this formation at the Robert O. Townsend Junior High School site in the Chino Hills. Numerous localities in the Puente Hills near Segment 8 yielded specimens representing six species of marine snails, clams, crabs, and echinoids; fossilized remains of baleen whales, sharks, fishes, porpoises, and sea lions from the Sycamore Canyon Member (PEAI, 2007). These occurrences indicate that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the Sycamore Canyon Member and this unit is considered paleontologically highly important (PEAI, 2007).

The Fernando Formation in the Puente, Chino, and Montebello Hills is subdivided into two members: the Lower or "Repetto" Member and the Upper or "Pico" Member. The Lower Member of the Fernando Formation has yielded the fossilized remains of Pliocene marine snails, clams, brachiopods, barnacles, crabs, sand dollars, heart urchins, sharks, marine fishes, and baleen whales at a fossil site in the Chino Hills and the Puente Hills (PEAI, 2007). These occurrences indicate that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the Lower Member of the Fernando Formation and this unit is considered paleontologically highly important (PEAI, 2007).

The Upper Member of the Fernando Formation has yielded fossil remains representing approximately 50 species of marine invertebrates, including snails, clams, scaphopods (tusk shells), and sand dollars, at 40 fossil sites in the Chino Hills PEAI, 2007. Whale remains were found in the Puente Hills approximately 1 mile from Segments 7 and 8 (PEAI, 2007). These occurrences indicate that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the Upper Member of the Fernando Formation and this formation is considered paleontologically highly important (PEAI, 2007).

Continental deposits at the top of the Fernando Formation have yielded the fossilized remains of a horse in Monterey Park (PEAI, 2007). In part because of the limited aerial extent of this unit, the latter occurrence indicates that there is an undetermined (but probably no more than a moderate) potential for additional, similar, scientifically highly important fossil remains being encountered locally by ground-disturbing activities in the Montebello Hills, where Segments 7, 8, and 11 and the Mesa Substation site are underlain by nonmarine unit of the Upper Member (PEAI, 2007).

In the Puente and Chino Hills, Segment 8 crosses canyons whose floors are underlain by Younger Alluvium. This rock unit yielded the fossilized remains of a late Pleistocene bison in Tonner Canyon (PEAI, 2007). There is an undetermined (but possibly high) potential for additional, similar, scientifically highly important fossil remains being encountered locally by ground-disturbing activities in the Chino and Puente Hills (Segment 8) where the Project area is underlain by Younger Alluvium and this unit is considered to be of undetermined (but possibly high) importance locally (PEAI, 2007).

Younger Alluvium 1.5 miles east of Mira Loma Substation in the Chino Valley yielded late Pleistocene ground sloth and camel remains and depths of 11 to 15 feet below the present ground surface, and mammoth remains at a depth of 5 feet (PEAI, 2007). Numerous other localities, mostly unpublished, occur in the Chino Valley where shallow depths (about 3 feet) have yielded additional remains representing a taxonomic diversity of late Pleistocene land mammal species (PEAI, 2007). The remains Younger Alluvium in the Chino Valley are scientifically highly important because of their taxonomic diversity and because they have demonstrated that Pleistocene land mammal remains can occur at very shallow depths in areas underlain by younger alluvium. These occurrences indicate that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered locally by ground-disturbing activities in the Chino Valley (Segment 8) where the Project area is underlain by Younger Alluvium and this unit is considered locally paleontologically highly important (PEAI, 2007).

2.3.5 Segment 9 – Substations

Whirlwind Substation

Geology

The proposed Whirlwind Substation site is entirely underlain by Quaternary alluvial fan deposits formed by streams transporting sand and gravel east from the Tehachapi Mountains.

Slope Stability

The proposed Whirlwind Substation is located on a flat to gently sloping alluvial fan, and would not be subject slope failures.

Soils

The site is underlain by the Hesperia soil association which consists primarily of fine sandy loam with calcareous layers at depth. Hazard of erosion for these soils for off-road or off-trail is slight and for on roads and trails ranges from slight to moderate. Shrink/swell (expansive) potential of the soil is low, and the corrosive potential is high for uncoated steel and low for concrete.

Mineral Resources

Although potential sand and gravel and limestone resources exist in the substation area, no active mineral resource sites were identified by the MRDS within 1,000 feet of the proposed site. This results in no potential for construction of the Whirlwind Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Whirlwind Substation site is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Whirlwind Substation is near the Garlock Fault Zone (about 10 miles northwest) and the San Andreas Fault Zone (about 11 miles southwest). Moderate to strong groundshaking from an earthquake on any of the faults in the vicinity of the Whirlwind Substation should be expected. The expected range of peak horizontal accelerations for the Whirlwind Substation is 0.6g (Table 2-3).

Liquefaction. Liquefaction potential at Whirlwind Substation is low due to groundwater depth greater than 100 feet in western Antelope Valley.

Earthquake-Induced Landslides. The topography at Whirlwind Substation is very gently sloping and will not experience landslides or slope failures due to earthquakes.

Paleontology

The proposed Whirlwind Substation is underlain by Holocene Younger alluvium. The Younger Alluvium is generally considered to have low sensitivity for paleontological resources.

Antelope Substation

Geology

The proposed Antelope Substation improvements site is underlain by Quaternary alluvium and alluvial fan deposits transported northeast from Portal Ridge.

Slope Stability

The proposed improvements at the Antelope Substation are located on a nearly flat alluvial plain, and would not be subject slope failures.

Soils

The Antelope Substation site is underlain by the Greenfield soil association which consists of sandy to coarse sandy loam. Hazard of erosion for these soils is slight to severe for on roads and trail use. Shrink/swell (expansive) potential of the soil is low, and the corrosive potential is low to high for uncoated steel and low for concrete.

Mineral Resources

Although potential sand and gravel resources exist in the substation area, no active mineral resource sites were identified by the MRDS within 1,000 feet of the proposed site. There is no potential for construction at the Antelope Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Antelope Substation site is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Antelope Substation is about 3.8 miles northwest of the San Andreas Fault Zone and moderate to strong groundshaking from an earthquake on this fault or any of the faults in the vicinity should be expected. The expected range of peak horizontal accelerations for the Antelope Substation is 0.9g (Table 2-3).

Liquefaction. Liquefaction potential at Antelope Substation is low due to groundwater depth greater than 100 feet in western Antelope Valley.

Earthquake-Induced Landslides. The topography at Antelope Substation is nearly flat and will not experience landslides or slope failures due to earthquakes.

Paleontology

The proposed Antelope Substation expansion area is underlain by Holocene Younger alluvium. The Younger Alluvium is generally considered to have low sensitivity for paleontological resources.

Vincent Substation

Geology

The proposed expansion area at the Vincent Substation is underlain by Quaternary Older Alluvium comprised of sand and gravel deposits.

Slope Stability

The Vincent Substation is located on a level graded pad that is about 10 to 20 feet above dry stream washes on the north and south sides. The Older Alluvium is generally stable at moderate slope inclinations but the poorly consolidated materials are susceptible to erosion.

Soils

The Hanford soil association underlies the Vincent Substation site. These soils consist of fine sandy to sandy loam. Hazard of erosion for these soils is moderate to severe for on roads and trail use. Shrink/swell (expansive) potential of the soil is low, and the corrosion potential is low to moderate for uncoated steel and for concrete.

Mineral Resources

Although potential sand and gravel resources exist in the substation area, no active mineral resource sites were identified by the MRDS within 1,000 feet of the proposed substation improvements. There is no potential for construction at the Antelope Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Vincent Substation site is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Vincent Substation is about 3.6 miles southwest of the San Andreas Fault Zone and moderate to very strong groundshaking from an earthquake on this fault or any of the faults in the vicinity should be expected. The expected range of peak horizontal accelerations for the Vincent Substation is 0.9g (Table 2-3).

Liquefaction. Liquefaction potential at Vincent Substation is low due to estimated groundwater depths greater than 50 feet in the area and the alluvium is generally medium dense to dense (Leroy Crandall, 1963).

Earthquake-Induced Landslides. The topography at Vincent Substation consists of a graded flat ridge elevated about 20 feet above wide, west-draining, flat-floored dry stream beds and will not experience landslides or slope failures due to earthquakes.

Paleontology

The proposed Vincent Substation expansion area is underlain by Quaternary Older alluvium. The Older Alluvium is generally considered to have high sensitivity for paleontological resources.

Mesa Substation

Geology

The proposed expansion area at the Mesa Substation is underlain by Older Alluvium composed of unconsolidated silt, sand and gravel, and Pleistocene Fernando Formation comprised of semi-consolidated sandstone, conglomerate, siltstone and claystone.

Slope Stability

Terrain at Mesa Substation is nearly flat to gently sloping and would not be subject slope failures.

Soils

The site is underlain by Urban Land-Ramona-Zamora soils, which are formed on alluvium and colluvium on alluvial fans, plains, and terraces. Hazard of erosion for these soils is slight to moderate for off roads and trails and moderate to severe for on roads and trails. Shrink/swell (expansive) potential of the soil is low and the corrosion potential is moderate to high for uncoated steel and moderate for concrete.

Mineral Resources

There is limited potential for sand and gravel resources at the substation area, and the Mea Substation is about 0.7-mile northwest of the active Montebello Hills oil field. There are no other active mineral resource sites identified by the MRDS within 1,000 feet of the proposed site. There is no potential for construction at the Mesa Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Mesa Substation site is located only 1.7 miles southwest of the East Montebello Hills fault but is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Mesa Substation is about 4 miles west of the Whittier fault, 2 miles southeast of the Upper Elysian Park blind thrust, and lies directly above the north-dipping thrust plane of the Puente Hills blind thrust fault. Moderate to strong groundshaking from an earthquake on any of the faults in the vicinity should be expected. The expected range of peak horizontal accelerations for the Mesa Substation is 0.9g (Table 2-3).

Liquefaction. Liquefaction potential at Mesa Substation is low due to estimated groundwater depths greater than 50 feet and the older alluvium and underlying Fernando Formation is medium dense to dense.

Earthquake-Induced Landslides. The topography at Mesa Substation is flat to gentle slopes and will not experience landslides or slope failures due to earthquakes.

Paleontology

The proposed Mesa Substation expansion area is underlain by older alluvium and nonmarine Fernando Formation. Both of these units are generally considered to have moderate sensitivity for paleontological resources.

Gould Substation

Geology

The proposed expansion area at the Gould Substation is underlain by artificial fill and quartz diorite.

Slope Stability

Terrain at Gould Substation consists of the nearly flat graded area at the facility and in the immediate vicinity surrounded by moderately inclined slopes. The natural slopes are underlain by quartz diorite and generally would not be subject slope failures.

Soils

The Gould Substation is underlain by the Cienba-Exchequer-Sobrante soil complex, which is formed on mafic and felsic weathered igneous rock, and are comprised of coarse sandy loam, gravelly sandy loam, gravelly loam, and loam. Hazard of erosion for these soils is severe for on roads and trail use. Shrink/swell (expansive) potential of the soil is low and the corrosion potential is low to moderate for uncoated steel and for concrete.

Mineral Resources

There are no active mineral resource sites identified by the MRDS within 1,000 feet of the proposed site. There is no potential for construction at the Gould Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Gould Substation site is located 3.5 miles south of the San Gabriel fault and is within the Sierra Madre fault zone only 0.2 and 0.5 miles from two mapped traces. The Gould Substation is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Gould Substation is near the right-lateral strike slip San Gabriel fault and the reverse dip-slip Sierra Madre fault. Both faults are capable of large earthquakes. Moderate to strong groundshaking from an earthquake on these faults or any of the faults in the vicinity should be expected. The expected range of peak horizontal accelerations for the Gould Substation is 1.0g (Table 2-3).

Liquefaction. There is no liquefaction potential at Gould Substation due to the underlying consolidated igneous bedrock.

Earthquake-Induced Landslides. The moderately inclined slopes immediately surrounding Gould Substation are composed of thin colluvium over quartz diorite bedrock resulting in a low to moderate potential for earthquake-triggered landslides or slope failures. However, nearby steep slopes and locally sheared bedrock in the San Gabriel Mountains are likely to experience landslides or slope failures due to earthquakes.

Paleontology

The proposed Gould Substation expansion area is underlain by igneous rock with no potential for paleontological resources.

Mira Loma Substation

Geology

The proposed Mira Loma Substation improvements site is underlain by Quaternary alluvium deposited on a very broad alluvial plain.

Slope Stability

The Mira Loma Substation is located on a flat plain with no potential for landslides or slope failures.

Soils

Soil at the Mira Loma Substation belong to the Delhi soil series, are very deep soils formed in wind-modified alluvial deposits, and are comprised of sand, fine sand, loamy fine sand, or loamy sand. Hazard of erosion for these soils is slight to moderate for on roads and trail use. Shrink/swell (expansive) potential of the soil is low and the corrosion potential is low to moderate for uncoated steel and for concrete.

Mineral Resources

Although potential sand and gravel resources exist in the substation area, no active mineral resource sites were identified by the MRDS within 1,000 feet of the proposed site. There is no potential for construction at the Mira Loma Substation to interfere with access to known mineral resources.

Seismicity

Fault Rupture. The Mira Loma Substation site is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The Mira Loma Substation is about 7 miles east of Central Avenue fault and 11.3 miles southwest of the San Jacinto fault. Moderate to strong groundshaking from an earthquake on any of the faults in the vicinity should be expected. The expected range of peak horizontal accelerations for the Mira Loma Substation is 0.6g (Table 2-3).

Liquefaction. Liquefaction potential at Mira Loma Substation is low due to estimated groundwater depths greater than 50 feet.

Earthquake-Induced Landslides. The topography at Mira Loma Substation is almost level and will not experience landslides or slope failures due to earthquakes.

Paleontology

Younger Alluvium 1.5 miles east of Mira Loma Substation yielded late Pleistocene ground sloth and camel remains at depths of 11 to 15 feet below the present ground surface, and mammoth remains at a depth of 5 feet (PEAI, 2007). Numerous other localities, mostly unpublished, occur in the Chino Valley where shallow depths (about 3 feet) have yielded additional remains representing a taxonomic diversity of late Pleistocene land mammal species (PEAI, 2007). The remains in Younger Alluvium in the Chino Valley are scientifically highly important because of their taxonomic diversity and because they have demonstrated that Pleistocene land mammal remains can occur at very shallow depths in areas underlain by younger alluvium and these units are generally considered to have moderate sensitivity for paleontological resources.

2.4 Alternative 3: West Lancaster Alternative

Alternative 3 is identical to the proposed Project, except for one deviation. It would re-route the new 500-kV T/L in Segment 4 along 115th Street West rather than 110th Street West. This Alternative would deviate from the proposed route at approximately S4 MP 14.9,where the new 500-kV T/L would turn south down 115th Street West for approximately 2.9 miles and turn east for approximately 0.5 mile, rejoining the proposed route at S4 MP 17.9. This re-route traverses through undeveloped land with scattered residential use along West Avenue I and J and would increase the overall distance of Segment 4 by approximately 0.4 mile.

Geology

The minor reroute of the West Lancaster Alternative traverses Younger Alluvium like the equivalent portion of Segment 4 of the proposed Project.

Slope Stability

The proposed Alternative 3 alignment is located on a nearly flat alluvial plain and would not be subject to slope failures.

Soils

Soils units encountered along Alternative 3 are the same as for the proposed Project, and thus have the same characteristics.

Mineral Resources

There are no known quarries along the minor reroute of Alternative 3 alignment, although the alluvial deposits contain sand and gravel resources. The mineral resources along the remainder of the Alternative 3 alignment are identical to the proposed Project.

Seismic Hazards

Fault Rupture. The proposed Alternative 3 reroute is not crossed by any active faults and therefore would not be subject to surface fault rupture.

Groundshaking. The proposed Alternative 3 reroute does not pass across or nearer to major faults and the level of groundshaking would be identical to the proposed Project.

Liquefaction. Liquefaction potential along the Alternative 3 reroute is low due to groundwater depth greater than 100 feet in western Antelope Valley. The liquefaction hazard along the remainder of Alternative 3 is identical to the proposed Project.

Earthquake-Induced Landslides. The minor reroute of the West Lancaster Alternative traverses relatively level to gently sloping alluvial plains like the equivalent portion of Segment 4 of the proposed Project and has no potential for earthquake-induced slope failure. The remainder of Alternative 3 is identical to the proposed Project and has low to high potential to encounter areas of known or potential landslides and unstable slopes (as described in Section 2.3).

Paleontology

The minor reroute of the West Lancaster Alternative traverses Younger Alluvium like the proposed Project. The Younger Alluvium to shallow depths of three to five feet is probably too young to contain remains old enough to be considered fossilized. Correspondingly, there probably is only a low potential for scientifically important fossil remains being encountered (PEAI, 2007) along the reroute portion of Alternative 3. The remainder of Alternative 3 is identical to the proposed Project and has low to high potential to encounter scientifically important fossil remains.

2.5 Alternative 4: Chino Hills Route Alternatives

Alternative 4 consist of five route options (designated Route A, Route B, Route C, Route C Modified and Route D) passing through and around Chino Hills State Park. Alternative 4 is identical to the proposed Project, except for the eastern end of the alignment where it deviates from Segment 8. Therefore the environmental setting is identical except where it deviates from the proposed Project alignment, therefore only the setting for the portion of Alternative 4 that deviates from the proposed Project is discussed below. Environmental setting of the proposed Project is discussed in Section 2.3.

Geology

Where Alternative 4 deviates from the proposed Project route, it is entirely underlain by the Puente Formation (Soquel and Yorba members).

Slope Stability

All of the Alternative 4 route options (Route A, Route B, Route C, Route C Modified and Route D) pass through moderate to steep terrain with mapped landslides, potentially unstable slopes, and narrow alluvium-filled valleys. Alternative 4 would reduce the total length of the Project and not pass through the Chino Valley/Basin. Within Chino Hills (eastern Puente Hills) each of the five route options traverses Miocene age Puente Formation which is prone to landslides. Alternative 4 diverges from the proposed Project 0.5 miles east of Tonner Canyon, at approximately MP S8A-19.2, where additional landslides are mapped and continue along the proposed Project alignment to the east in the Puente Hills. Unmapped landslides and areas of slope instability may be encountered throughout the Alternative 4 alignment in the eastern Puente Hills. Alternative 4 has similar impacts for potential landslides and unstable slopes as the comparable portion of Segment 8A as they both cross hillside areas underlain by the landslide prone Puente Formation. However, all of the Alternative 4 routes cross a slightly longer length through the Puente Formation than the proposed Project (ranging from 6.2 to 12.4 miles versus 5.9 miles for the comparable portion of Segment 8A), resulting in a slightly increased potential for impacts from landslides and unstable slopes along Alternative 4 compared to the proposed Project.

Soils

All of the Alternative 4 routes are underlain by one soil association, the Anaheim-Soper-Fontana association. This soil association is formed in material weathered from sandstone, shale, and conglomerate on moderate to steep hills. Hazard of erosion for these soils is moderate to very severe for off road or trail and severe for on roads and trails. Shrink/swell (expansive) potential of the soil is low to moderate and the corrosion potential is moderate to high for uncoated steel and low to moderate for concrete.

Mineral Resources

There are no known mines or quarries along the Alternative 4 alignment. The Alternative 4, portions of the Route C Modified switching station and the portions of associated connecting and nearby transmission lines near the switching station are located with the southern boundary of the Chino-Soquel oil field, but are not located in or near any active oil field areas. Route D alignment traverses adjacent and east of the Chino-Soquel oil field boundary, but does not cross the active field. The Alternative 4, Route C Raptor Ridge Reroute of the existing 500-kV and 220-kV transmission lines would pass approximately 1800 feet south and southeast of the Chino-Soquel oil field, but is not near any mapped active or inactive oil wells. The proposed switching station for Alternative 4 Route B and Route D is located only about 800 feet north of the inactive Mahala oil field but is not in the vicinity of any mapped inactive oil wells.

Seismic Hazards

Fault Rupture. Neither Route A, Route C, nor Route C Modified of Alternative 4 cross active or potentially active faults, resulting in no potential for surface fault rupture along these routes. However, both the eastern ends of Routes B and D and their associated new switching station would cross and be located on the Alquist-Priolo zoned Chino Fault, as shown in Figure 2-11, which results a potential for damage from surface fault rupture.

Groundshaking. Moderate to strong ground shaking of 0.8 – 1.2g is anticipated in the eastern Puente and Chino Hills. The closest active faults to the Alternative 4 routes are the Whittier and Chino fault. The Whittier fault approximately parallels the Alternative 4 alignments 2 miles to the southwest. and the Chino fault is located approximately 3, 2.5, and 1.5 miles east of the eastern end of Alternative 4 Routes A , C Modified, and C, respectively, and underlies the eastern end and switching station of Alternative 4 Routes B and C.

Liquefaction. The Alternative 4 routes are all underlain by Puente Formation bedrock, which is not susceptible to liquefaction.

Earthquake-Induced Landslides. The topography along Alternative 4 in the Chino Hills is locally steep and is likely to experience landsliding or slope failures due to earthquakes. Historic earthquake induced ground and slope failures are known to occur in the mountains and hills of southern California. Moderate to steep slopes throughout the Chino Hills could experience slope failures in areas with over-steepened slopes or with bedding planes oriented in the downslope direction.

Paleontology

Alternative 4 would reduce the total length of the Project and not pass through the Chino Valley/Basin. Within Chino Hills each of the five route options traverses Miocene age Yorba and Soquel Members of the Puente Formation; Routes B and D extend east into areas underlain by the late Miocene – early Pliocene age Sycamore Canyon Member of the Puente Formation. Alternative 4 joins the proposed Project 0.5 miles east of Tonner Canyon where the Soquel Member of the Puente Formation forms the hillsides. Alternative 4 crosses through the same units with the same paleontologic sensitivity as the equivalent portion of Segment 8A, therefore the same types of paleontologic resources may be found along the Alternative 4 alignment as these geologic units have several known fossil locations that have yielded scientifically important fossil remains. However, each of the Alternative 4 route options is within the paleontologic-rich Puente Formation (high sensitivity) and is longer than the comparable portion of the proposed Project within these same formations (0.3 to 6.5 miles longer). Despite these longer lengths of alignment in Puente Formation, the shorter overall lengths results in the following: Alternative 4 would eliminate approximately 3.6 to 9.2 miles of paleontologically sensitive Puente Formation and alluvium along Segment 8A, and 6.8 and 6.4 miles of paleontologically sensitive alluvium along Segments 8B and 8C, respectively.

2.6 Alternative 5: Partial Underground Alternative

This alternative would utilize underground construction in place of the proposed overhead line construction following the same routes as the proposed Project. The transmission line route for Alternative 5 would be the same as the proposed Project, with the exception that the line would be installed underground in a tunnel for approximately four miles through Chino Hills along Segment 8A. Under this alternative, the proposed transmission line would shift from overhead to underground at approximately MP 21.9 of Segment 8A and would continue underground through the City of Chino Hills to approximately MP 25.8 of Segment 8A, where the underground line would shift back to overhead. New underground facilities would replace the proposed aboveground facilities along the four miles through the Chino Hills, and transition stations would be required at each end of the underground segment to transfer the transmission lines from overheard to underground and vice versa. The geologic, seismic, and paleontologic setting along Alternative 5 would be identical to the proposed Project; therefore refer to Section 2.3 for discussions of setting along the proposed Project alignment.

2.7 Alternative 6: Maximum Helicopter Construction in the ANF Alternative

Alternative 6 is identical to the proposed Project (Alternative 2), except along Segment 6 and Segment 11 where helicopter construction would be used to the maximum extent feasible in the ANF portion of the route. This alternative would include construction of 11 helicopter staging areas in the ANF, several of which would require extensive grading (cut and fill). As a result of helicopter construction, some access and most spur roads would not be created and/or upgraded for ground access to towers along these portions of Segment 6 and Segment 11. However, many unpaved access roads would still require some upgrading and or re-grading for access by construction personnel. This alternative would result in approximately 69 fewer acres of temporary ground disturbance during construction in the ANF, 82 fewer acres of temporary ground disturbance during construction total, and approximately 47 fewer acres of permanent ground disturbance than Alternative 2. Despite the increased use of helicopter construction techniques for the ANF portions of Segment 6 and Segment 11, the transmission line route traversed by

Alternative 6 would be identical to that of Alternative 2 and thus the geologic, seismic, and paleontologic setting along the Alternative 6 transmission line route would be identical to the proposed Project (Alternative 2); therefore please refer to Section 2.3 for discussions of setting along the proposed Project alignment.

However, most of the helicopter staging areas to be used for Alternative 6 would be at locations not included or analyzed in any of the other alternatives and the geologic, seismic, and paleontologic setting for these sites are discussed below. Although four of the helicopter staging areas are located at approximately the same locations as those identified in Alternative 2, they are discussed below to include a full setting description for the helicopter staging areas. The sites that are the same in both alternatives are as follows:

- Alternative 6 Site #7 = Alternative 2 Site SCE#6B
- Alternative 6 Site #8 = Alternative 2 Site SCE#3B
- Alternative 6 Site #9 = Alternative 2 Site SCE#7
- Alternative 6 Site #11 = Alternative 2 Site SCE#8

Geology

Each of the 11 helicopter staging areas is located in the San Gabriel Mountains. The sites are primarily underlain by igneous and metamorphic bedrock. Geologic units expected to be encountered at the helicopter staging areas are listed below (see Tables 2-9 and 2-11 for summary descriptions of these units):

- Older alluvium over Hornblende Diorite Gabbro – Site #1
- Older alluvium over Lowe Granodiorite – Sites #2 and #3
- Anorthosite gabbro, primarily hornblende gabbro – Site #4
- Landslide and anorthosite gabbro complex – Site #5
- Lowe Granodiorite and gneiss – Site #6
- Gneiss – Site #7 (same as Alternative 2 Site SCE#6B)
- Artificial fill from dredging of Big Tujunga Reservoir of unknown depth over granitic rocks – Site #8 (same as Alternative 2 Site SCE#3B)
- Granitic rocks – Site #9 (same as Alternative 2 Site SCE#7)
- Granitic rocks – primarily quartz monzonite – Site #10
- Gneiss – Site #11 (same as Alternative 2 Site SCE#8)
- Lowe Granodiorite – Sites #12 and #13

Slope Stability

Sites #1, #2, and #3 are located along flat to gently sloping stream terraces along the northern edge of the San Gabriel Mountains and are not subject to slope stability issues. Site #7, although located in hilly terrain of the San Gabriel Mountains, is located at preexisting, gently sloping, graded facilities at Barton Flats, which already includes a helicopter landing area, and would not require further grading for use as a helicopter staging site. Site #8 is located in Maple Canyon southeast of Big Tujunga Reservoir on terraced fill slopes created from material dredged from the reservoir. The Site #8 helicopter staging area is located near the top of the terraced fill in the canyon with moderately sloping hills above and on either side of the site and would likely require moderate grading to create a suitable staging area. Site #12, although located in hillside terrain of the San Gabriel Mountains along a side canyon of Tie Canyon, is located at an existing graded roadside turnout along Angeles Forest Highway, and would not require further grading for use as a helicopter staging area. Helicopter staging Site #13 is located at an existing small helicopter landing area along Angeles Forest Highway southeast of Mill Creek Summit Station along a small ridge in hillside terrain of the San Gabriel Mountains; however, as the site is an existing graded helicopter landing site, it would likely not require much if any grading to create a suitable staging area.

The remaining five helicopter staging areas (Sites #4, #5, #6, #9, and #10) are located on or along ridges, hilltops, and in saddles of the San Gabriel Mountains with sloping terrain which would require moderate to extensive grading (cut and fill) to create suitable, relatively flat sites for helicopter landings and staging of construction supplies and equipment. Small to large landslides and debris slides are mapped along the steep mountain terrain adjacent to the staging sites in the project vicinity. Helicopter staging area #5 is located on a mapped landslide near the top of the landslide. Although many of the helicopter staging areas may be subject to construction triggered landslides, the need for fewer access roads in the steep terrain would result in less grading in steep, potentially landslide prone terrain than Alternative 2, thereby reducing the overall potential for construction triggered landslides as compared to the proposed Project.

Soils

The Alternative 6 helicopter staging areas are underlain by similar soil associations as the nearby Segment 6 and Segment 11 transmission line corridors. Soil associations mapped at the helicopter staging areas are as follows:

- Sites #1 and #2 - Hanford
- Site #3 – Pismo-Trigo-Exchequer
- Site #4 – Pismo-Chilao-Shortcut
- Site #5 – Vista
- Site #6 – Trigo-Modjeska
- Site #7 – Trigo-Green Bluff-Supan
- Site #8 – this site is mapped as underlain by Chilao soils, however because this site is on dredged fill the ‘soil characteristics’ of the material of the site is dependent on the type and grain size of the fill material.
- Site #9 – Stukel-Winthrop
- Site #10 – Rock Outcrop-Chilao
- Site #11 – Ramona-Zamora
- Site #12 - Pacifico-Xerothents complex
- Site #13 - Pacifico-Preston

These soils are primarily either formed in alluvium or colluvium weathered from granitic or metamorphic bedrock, or formed in material weathered from the underlying bedrock (primarily granitic and metamorphic, rocks in this part of the Project area). A summary of the basic characteristics of these soils is presented in Table 2-1. These soils are primarily either formed in alluvium or colluvium weathered from granitic or metamorphic bedrock, or formed in material weathered from the underlying metamorphic and igneous bedrock. The hazard of erosion for these soils for off-road or off-trail, ranges from slight to very severe. The hazard of erosion for these soils on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils at the staging sites ranges from low to high for uncoated steel and from low to moderate for concrete.

Mineral Resources

Mineral resources in the vicinity of the helicopter staging areas consist primarily of metallic minerals (ores) such as gold and titanium and no active mines are located at or adjacent to any of the staging sites. This results in no change in potential for inference with access to known mineral resources along the ANF portion of Alternative 6 compared to the equivalent portion of Alternative 2.

Seismic Hazards

Fault Rupture. None of the helicopter staging areas are crossed by active or potentially active faults, resulting in no potential for surface fault rupture at these sites. This results in no change in potential for fault rupture along the ANF portion of Alternative 6 compared to the equivalent portion of Alternative 2.

Groundshaking. Moderate to very strong ground shaking of 0.6 to 1.2gis anticipated in the San Gabriel Mountains near the helicopter staging areas.

Liquefaction. Although Sites SCE#1, #2, and #3 are underlain by older alluvium near to stream channels, the potential for liquefaction is low at these sites due to the expected coarse nature of the deposits and shallow depth to bedrock. Liquefaction potential is low to nonexistent at the remaining staging sites due to the presence of the non-liquefiable underlying granitic and metamorphic bedrock at these helicopter staging areas.

Earthquake-Induced Landslides. The topography at and near the helicopter staging areas is locally steep and is likely to experience landsliding or slope failures due to earthquakes. Historic earthquake induced ground and slope failures have occurred in the San Gabriel Mountains due to large regional earthquakes. The steep mountain slopes could experience slope failures in areas with over-steepened slopes or with weathered and sheared bedrock.

Paleontology

In the San Gabriel Mountains the staging areas are underlain mostly by non-fossiliferous igneous and metamorphic rocks. At sites SCE#1, #2, and #3, which are underlain by alluvial deposits along streams and valleys of the San Gabriel Mountains, the deposits are unlikely to contain identifiable fossil specimens due to the high energy depositional environment that would have destroyed or damaged any fossil specimens (PEAI, 2007).

2.8 Alternative 7: 66-kV Subtransmission Alternative

Alternative 7 is identical to the proposed Project (Alternative 2), except along Segments 7 and 8A where four 66-kV subtransmission line elements would be undergrounded or relocated. The four 66-kV subtransmission line elements include the following: (1) Undergrounding the 66-kV subtransmission line in Segment 7 through the River Commons or Duck Farm Project (between Valley Boulevard – S7 MP 8.9 and S7 MP 9.9); (2) Re-routing and undergrounding the 66-kV subtransmission line around the Whittier Narrows Recreation area in Segment 7 (S7 MP 11.4 to 12.025); (3) Re-routing the 66-kV subtransmission line through the Whittier Narrows Recreation area in Segment 7 (S7 MP 12 to 13.6) and (4) 2 options for re-routing the 66-kV subtransmission line around the Whittier Narrows Recreation Area in Segment 8A between the San Gabriel Junction (S8A MP 2.2) and S8A MP 3.8, Option 1 includes re-routing the line down Siphon road and Option 2 would instead continue the line along Durfee Avenue. Other than the minor 66-kV re-routes and underground construction described above for the fourelements of Alternative 7, this alternative would be identical to the proposed Project (Alternative 2) as discussed in Sections 2.2.3

through 2.2.9. All substation and information technology facilities would also be identical to the proposed Project as discussed in Sections 2.2.10 and 2.2.11, respectively. Therefore, with the exception of the minor differences in alignment for the four66-kV re-routes, the transmission line route traversed by Alternative 7 would be identical to that of Alternative 2 and thus the geologic, seismic, and paleontologic setting along the Alternative 7 transmission line route would be identical to the proposed Project (Alternative 2); therefore refer to Section 2.3 for discussions of setting along the proposed Project alignment. The geologic setting along the three 66-kV re-routes has slight differences than that of the proposed Project and is discussed below.

Geology

The geology of the 66-kV re-routes is nearly identical to the corresponding nearby portion of the proposed Project alignment. Geologic units expected to be encountered along the 66-kV re-route alignments are listed below (see Tables 2-10 and 2-12 for summary descriptions of these units) (Dibblee, 1999):

- Duck Farm 66-kV Underground – entirely underlain by channel deposits (Qg)
- Whittier Narrows 66-kV Underground Re-Route – underlain by alluvium (Qa) and channel deposits (Qg)
- Whittier Narrows 66-kV Overhead Re-Route (Segment 7) – underlain by Fernando Formation for the first half-mile and then by alluvium (Qa) and channel deposits (Qg)
- Whittier Narrows 66-kV Overhead Re-Route (Segment 8A) – Options 1 and 2: underlain by Fernando Formation for the first half-mile and then by alluvium (Qa) and channel deposits (Qg)

Slope Stability

The Duck Farm and Whittier Narrows Underground re-routes are both located on flat alluvial channel and valley topography and would not be subject to slope stability issues. The western end of all of the Whittier Narrows Overhead re-routes are located along the moderate to gently sloping eastern slopes of the Montebello Hills, and although the moderately sloping areas may be subject to minor landslides or debris slides, the area is developed and graded for roads and oil field work areas and is unlikely to experience significant slope stability issues. The remaining portion of the Whittier Narrows Overhead re-route crosses flat alluvial channel and valley topography and would not be subject to slope stability issues.

Soils

The 66-kV re-route alignments are underlain by similar soils as the nearby Segments 7 and 8A transmission line corridors, primarily the Urban Land-Hanford-Sorrento soil association. These soils are mainly formed either in alluvium or colluvium weathered from the underlying sedimentary formations, or in alluvium and colluvium on alluvial fans, plains, and terraces. Hazard of erosion for these soils for off-road or off-trail is slight and for on roads and trails ranges from slight to severe. Shrink/swell (expansive) potential of the soils varies from low to moderate. The corrosive potential of soils along the 66-kV re-routes ranges from low to high for uncoated steel and from low to moderate for concrete.

Mineral Resources

Mineral resources in the vicinity of the 66-kV re-routes consist primarily of aggregate resources near the San Gabriel River and oil and gas near the Montebello Hills. No active sand or gravel quarries are located in the vicinity of the re-routes; however, a portion of the Whittier Narrows 66-kV Overhead Re-Route (Segment 8A) Options 1 and 2 crosses the northern edge of the Montebello oil field. Although the alignment for these Options cross the edge of the oil field, it does not cross through any active well fields and construction within the existing ROW in this area is not expected to impact access to this resource.

This results in no change in potential for inference with access to known mineral resources along Alternative 7 as compared to Alternative 2.

Seismic Hazards

Fault Rupture. Two of the four re-routes are crossed by the southward projection of the East Montebello Hills fault, resulting in an additional potential for fault rupture damage along these new and re-routed subtransmission lines, as shown in Figure 2-12**.** The Whittier Narrows 66-kV Overhead Re-Route (Segment 7) passes approximately 650 feet south of the southern end of the Alquist-Priolo zone for the East Montebello Hills fault with the projection of the fault crossing the route at a location approximately equivalent to S7 MP 13.6. Both Options 1 and 2 of the Whittier Narrows 66-kV Overhead Re-Route (Segment 8A) are crossed by the southward projection of the East Montebello Hills fault passes approximately 0.8 miles south of the southern end of the Alquist-Priolo zone at a location approximately equivalent to the intersection of Siphon Road and Durfee Avenue. Neither the Duck Farm 66-kV Underground nor the Whittier Narrows 66-kV Underground Re-Routes (both along Segment 7) are crossed by active or potentially active faults, resulting in no potential for surface fault rupture along these alignments. This results in only a minor increasein potential for fault rupture along Alternative 7 as compared to Alternative 2 as the associated portions of Segments 7 and 8A are also crossed by the projections of this fault.

Groundshaking. Moderate to strong ground shaking of 0.6 to 1.2g is anticipated in the San Gabriel Valley, Montebello Hills, and Whittier Narrows areas along and near the 66-kV re-route alignments. This is the same range as for the associated portions of Segments 7 and 8A, and thus results in no change in potential for damage from strong groundshaking.

Liquefaction. Where the re-route alignments cross young alluvial and channel deposits of the San Gabriel Valley, near the Rio Hondo and San Gabriel Rivers, and in the Whittier Narrows area, the underlying sediments are potentially liquefiable (CGS, 1999d). Liquefaction potential is low to nonexistent along the portions of the both Options 1 and 2 of the Whittier Narrows 66-kV Overhead Re-Route (Segment 8 A)in the Montebello Hills (the western end) due to the presence of the non-liquefiable underlying consolidated sedimentary bedrock (Fernando Formation).

Earthquake-Induced Landslides. Only the portions of the Whittier Narrows 66-kV Overhead Re-Route (Segment 8A) Options 1 and 2 located within the gently to moderately sloping hills of the Montebello Hills are likely to experience landsliding or slope failures due to earthquakes. The remaining portion of these alignments and the other re-routes are located on flat topography and would not be subject to earthquake-induced landslides or other slope failures.

Paleontology

Where the 66-kV re-routes cross the Younger Alluvium in the San Gabriel Valley, which has locally yielded fossils of late Pleistocene mammoth (Pasadena and Eagle Rock) and land mammals (downtown Los Angeles), there is an undetermined (but probably no more than a moderate) potential for additional, similar, scientifically important fossil remains to be encountered locally by ground-disturbing activities in Younger Alluvium in the San Gabriel Valley (PEAI, 2007). In the area where the Whittier Narrows 66-kV Overhead Re-Route(Segment 8A) Options 1 and 2 cross the Montebello Hills, the alignment crosses the Fernando Formation, which has yielded the fossilized remains of Pliocene marine fossils at a fossil site in the Chino Hills and the Puente Hills (PEAI, 2007). This indicates that there is a high potential for additional, similar, scientifically highly important fossil remains being encountered by ground-disturbing activities where the Project area is underlain by the Fernando Formation (PEAI, 2007). These units are also crossed by the corresponding portions of Segments 7 and 8A; however, the small increase in ground disturbance for the excavation for new poles and for excavation for the underground re-routes would result in a slight increase in potential to encounter significant fossil remains for this alternative.

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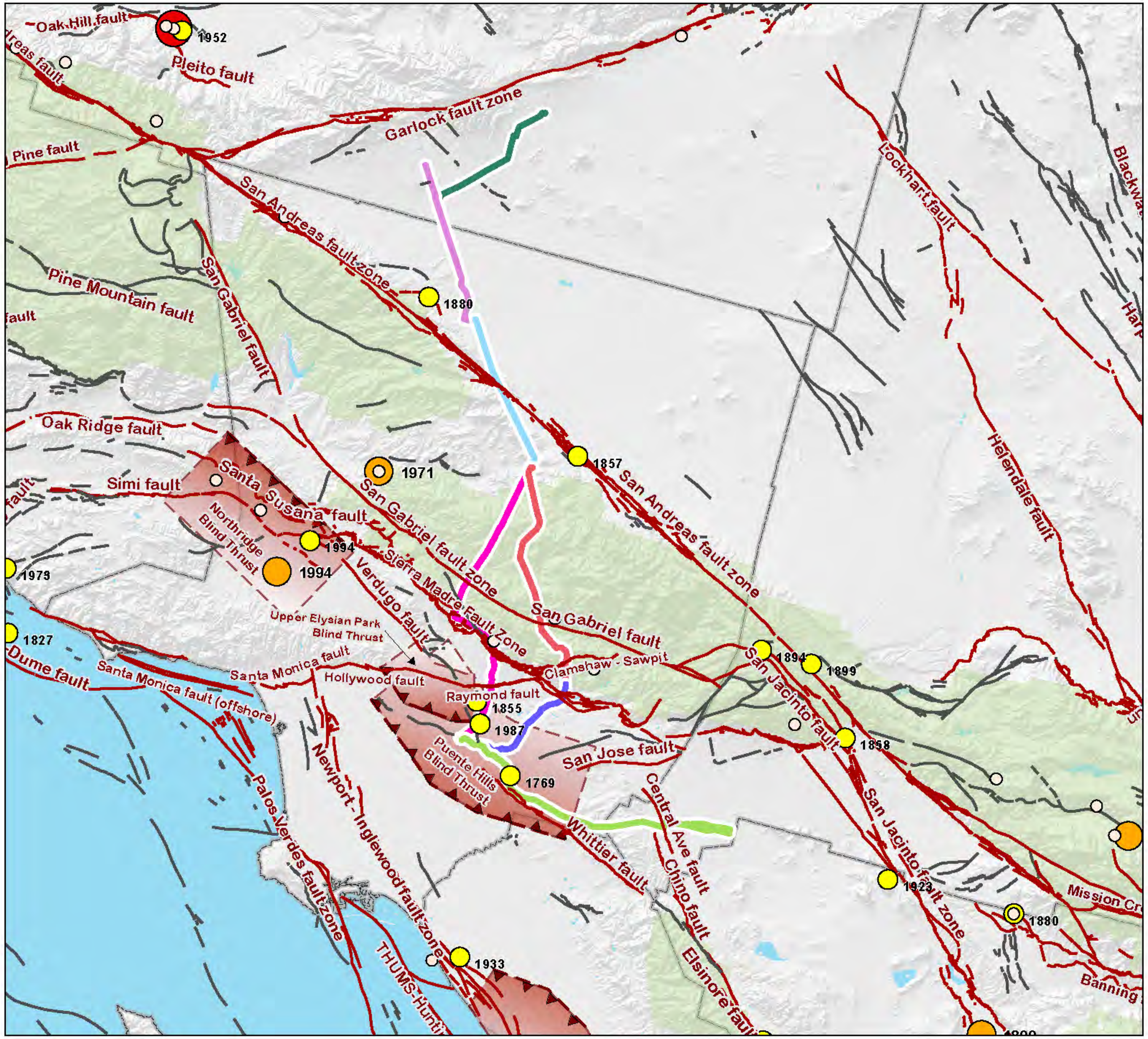


LEGEND

PROPOSED TRTP ROUTE SEGMENTS

- Segment 10
- Segment 4
- Segment 5
- Segment 6
- Segment 7
- Segment 11
- Segment 8: including Segments 8A, 8B, and 8C

FAULTS

- Significant Actve Fault
- Other Quaternary faults
- Blind Thrust Fault - (faults do not intersect the surface, mapped trace represents projection of upper edge of the fault to surface; rectangle represents projection of the fault plane to the surface)

REGIONAL EARTHQUAKES FROM 1800 TO 2005

MAGNITUDE

- 5.50 - 5.89
- 1933 5.90 - 6.49
- 1971 6.50 - 6.99
- 1952 7.00 - 7.80

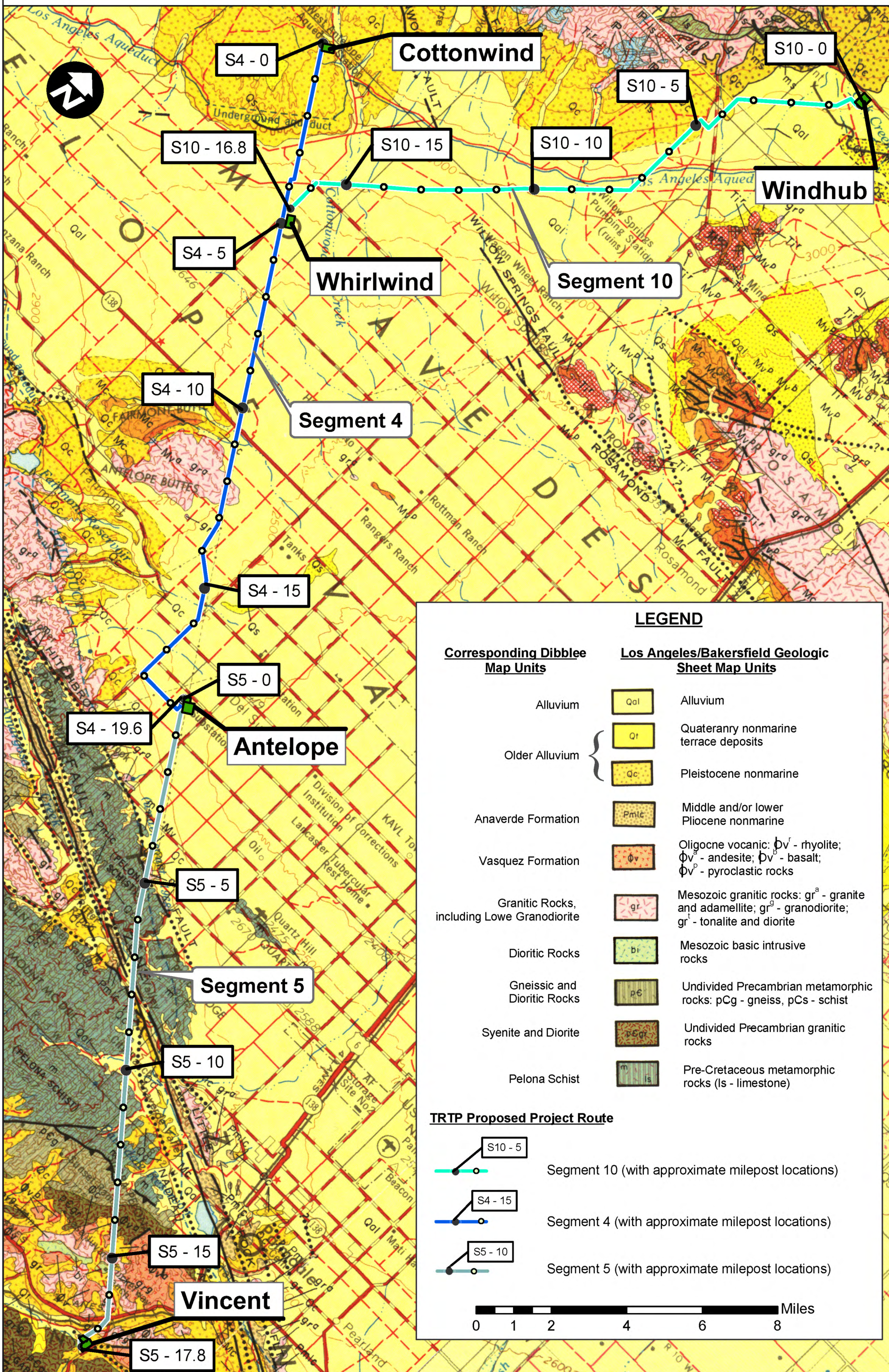
N W E S

0 2.5 5 10 15 20 25 30 Miles

Source: GTC, 2008.

Figure 2-2

Regional Active Faults and Historic Earthquakes



Source: GTC, 2008.

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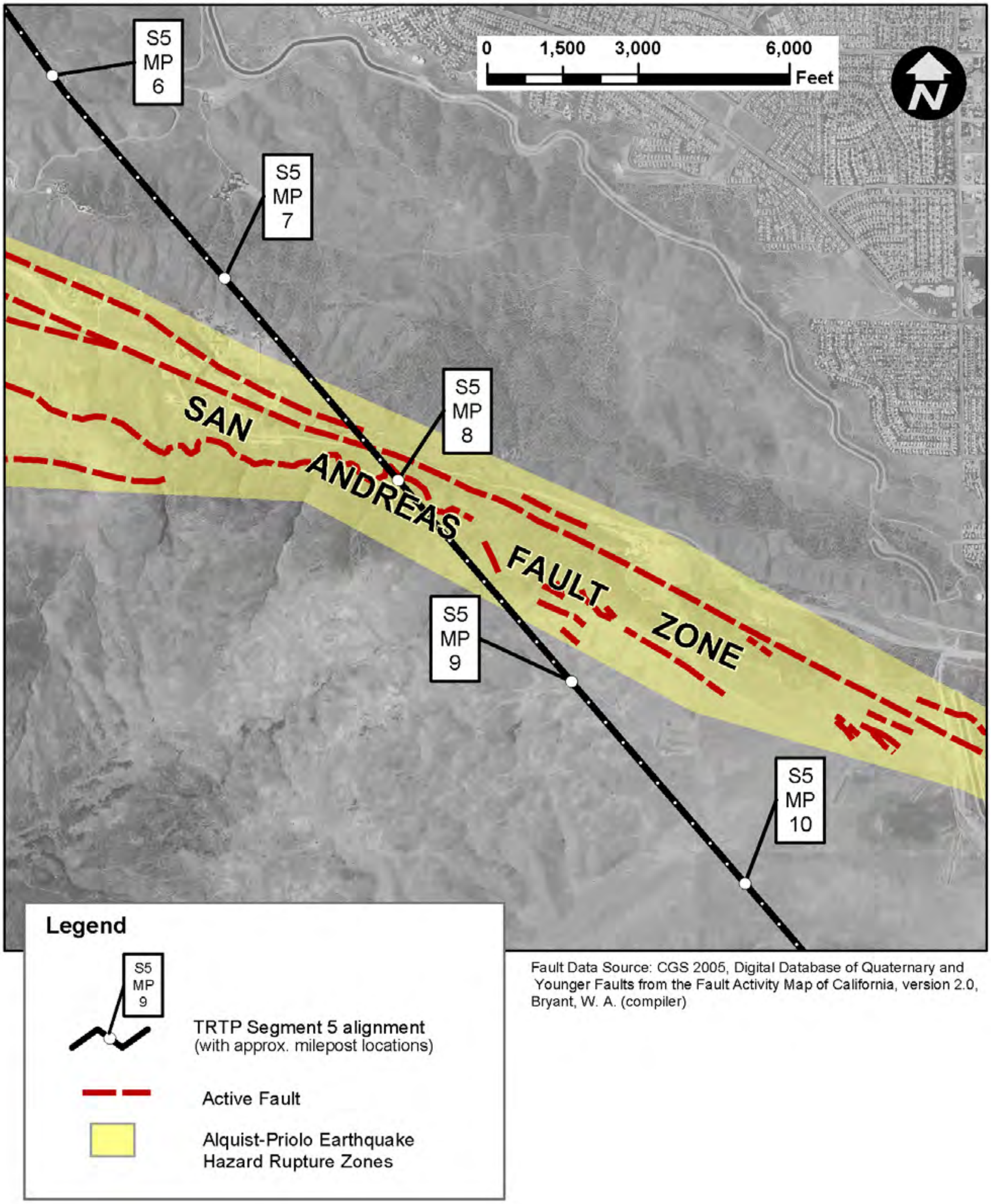
Figure 2-3
Regional Geology Map A



Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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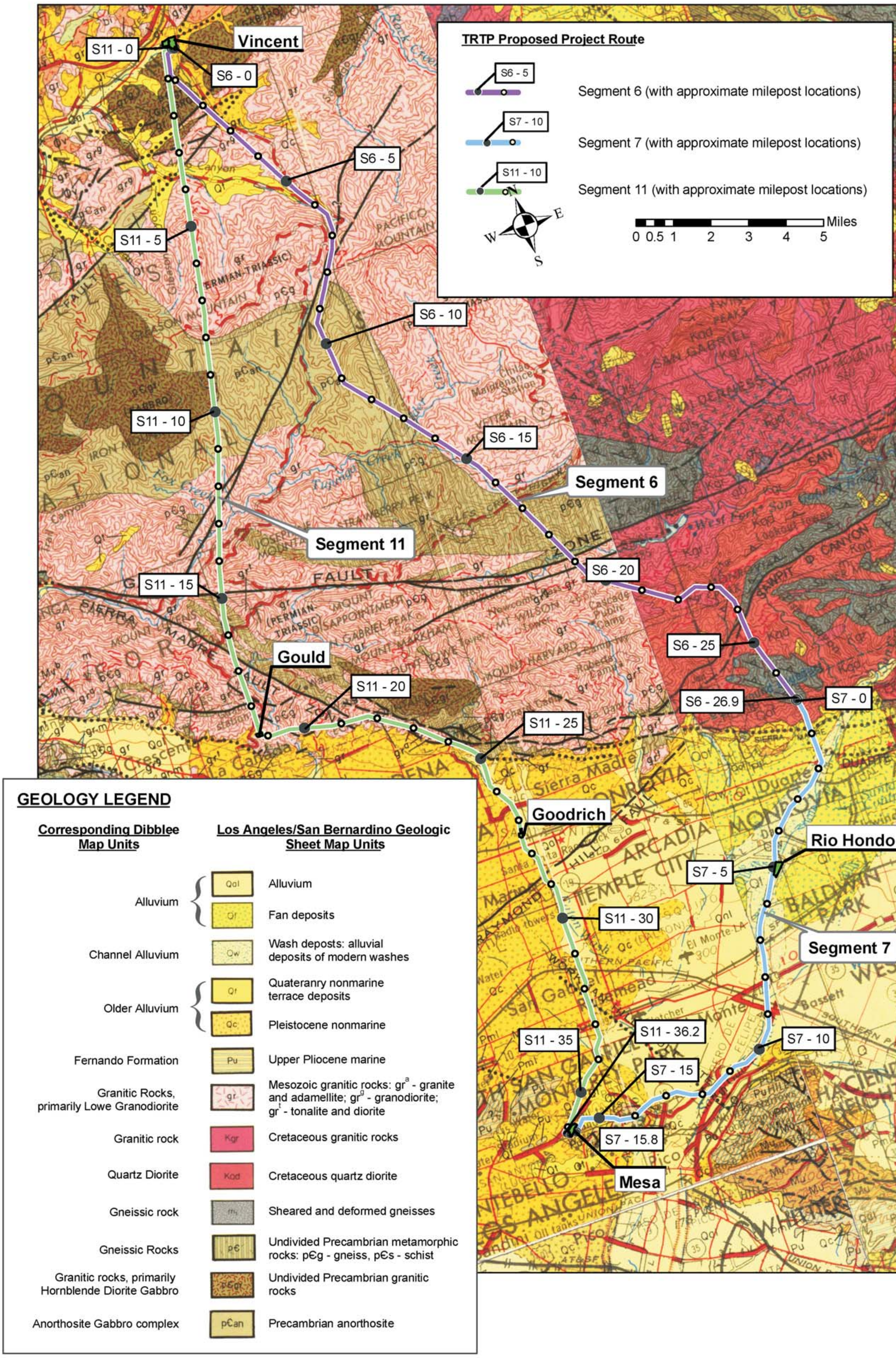
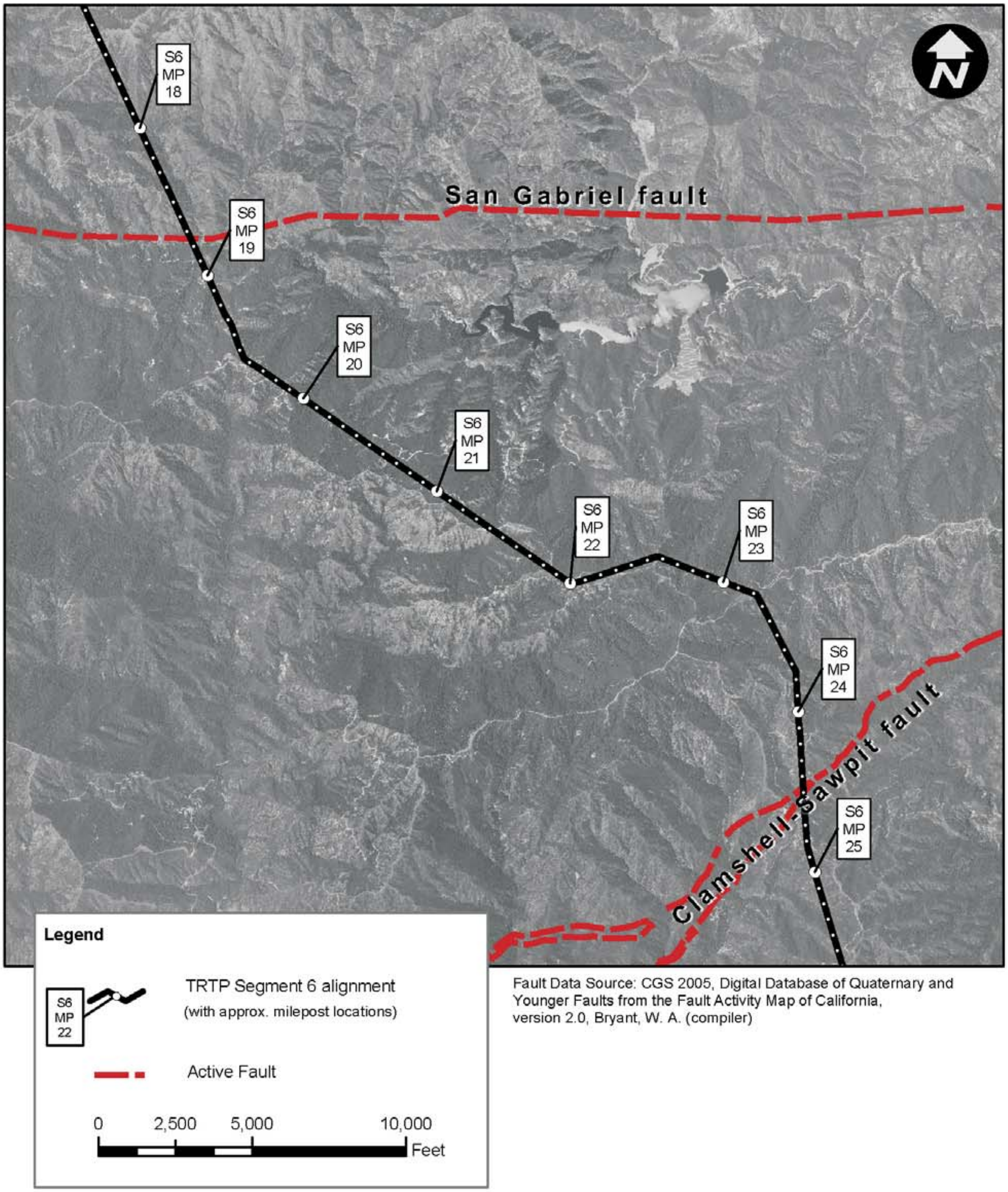
Figure 2-4

Segment 5
Active Fault Crossing



Source: GTC, 2008.

Figure 2-5
Regional Geology Map B



Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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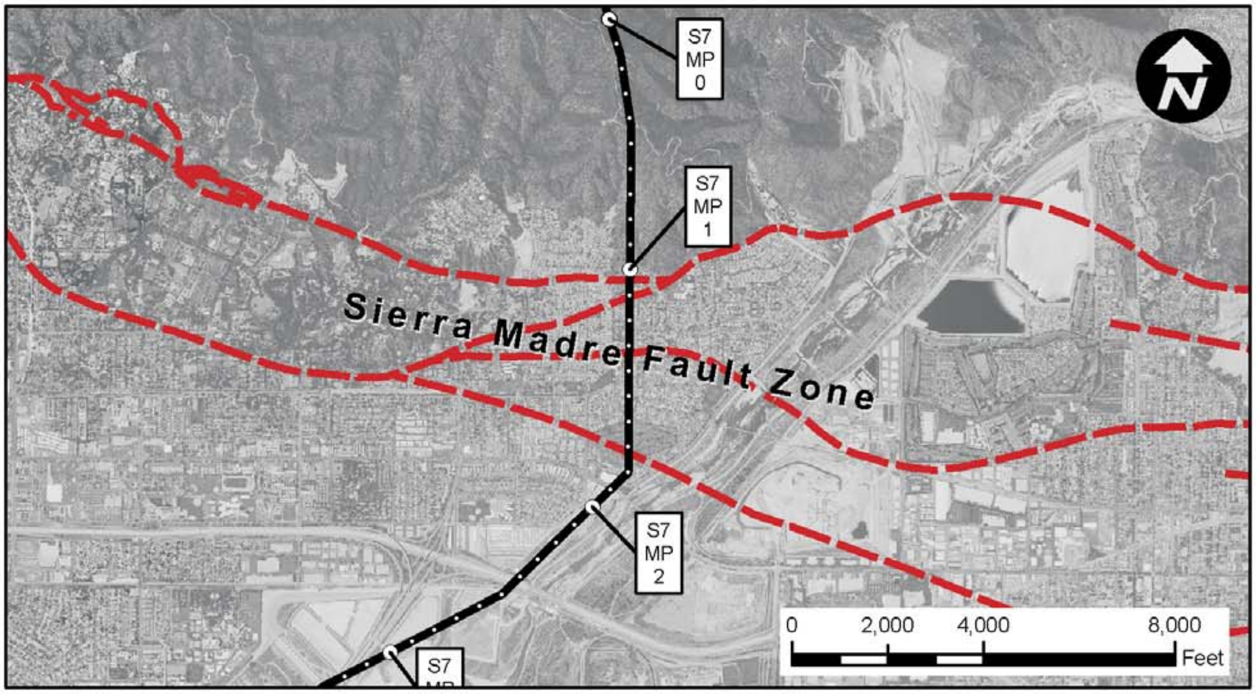
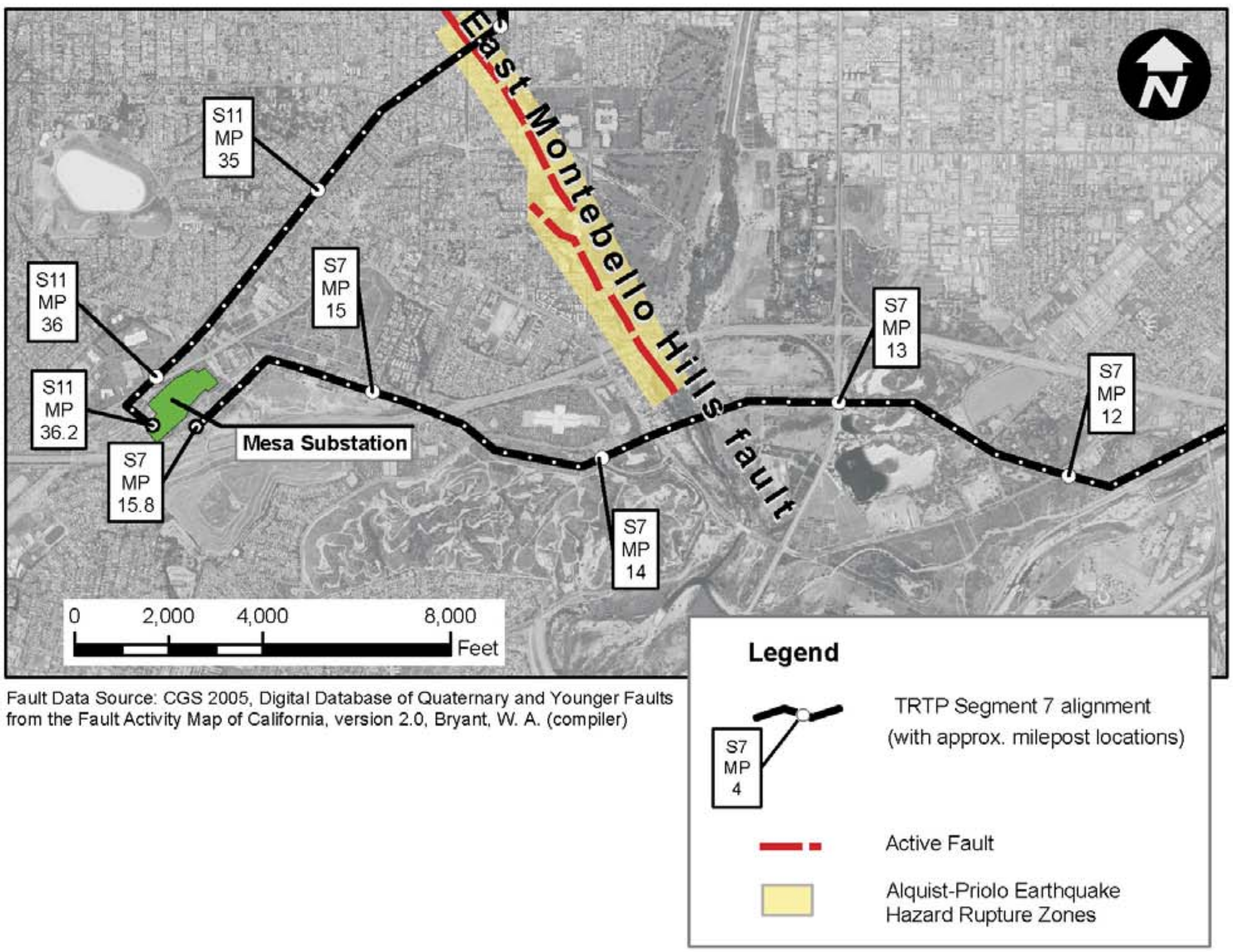
Figure 2-6
Segment 6
Active Fault Crossings





Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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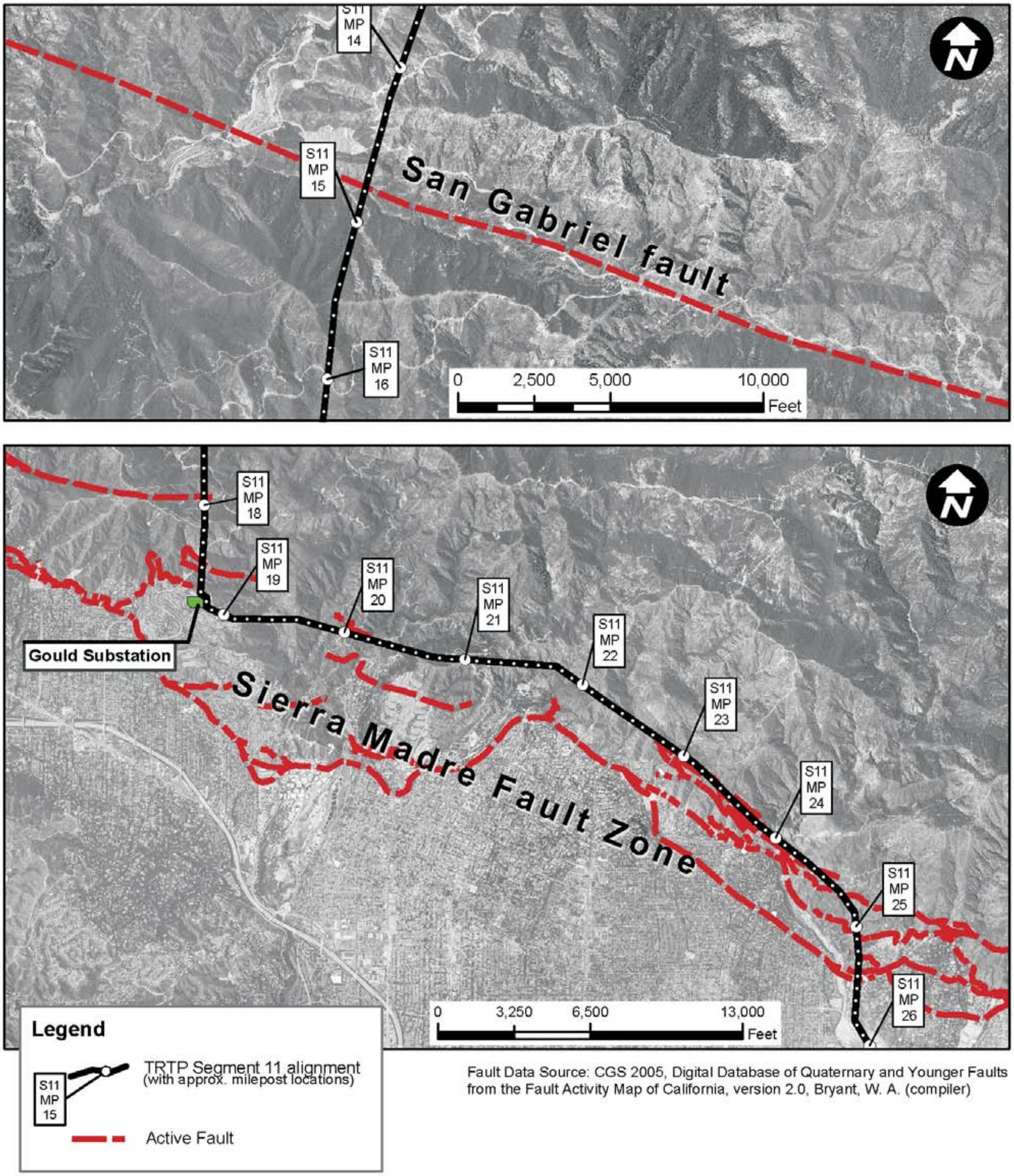
Figure 2-7

Segment 7 Active Fault Crossings



Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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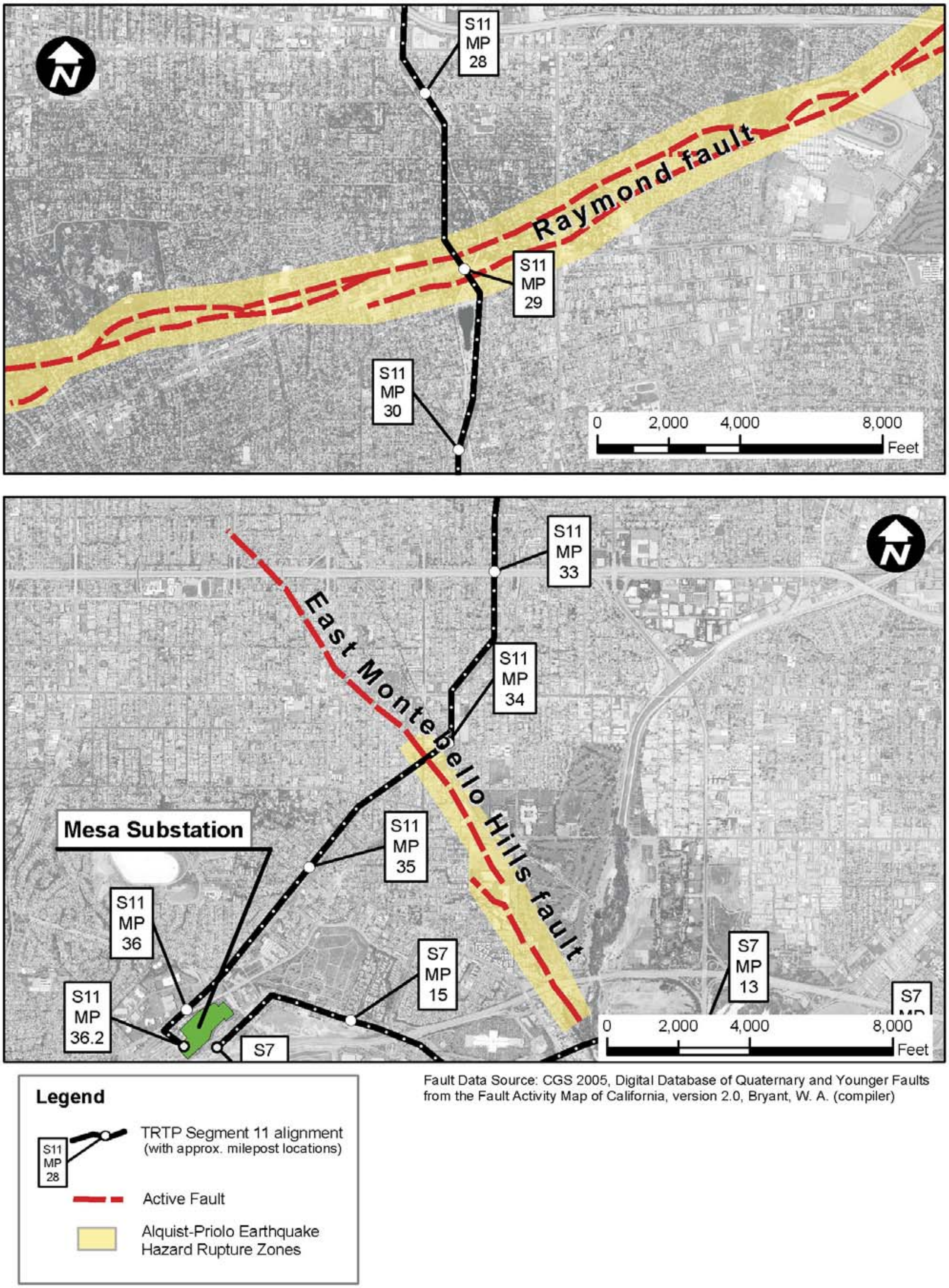
Figure 2-8a

Segment 11 Active Fault Crossings



Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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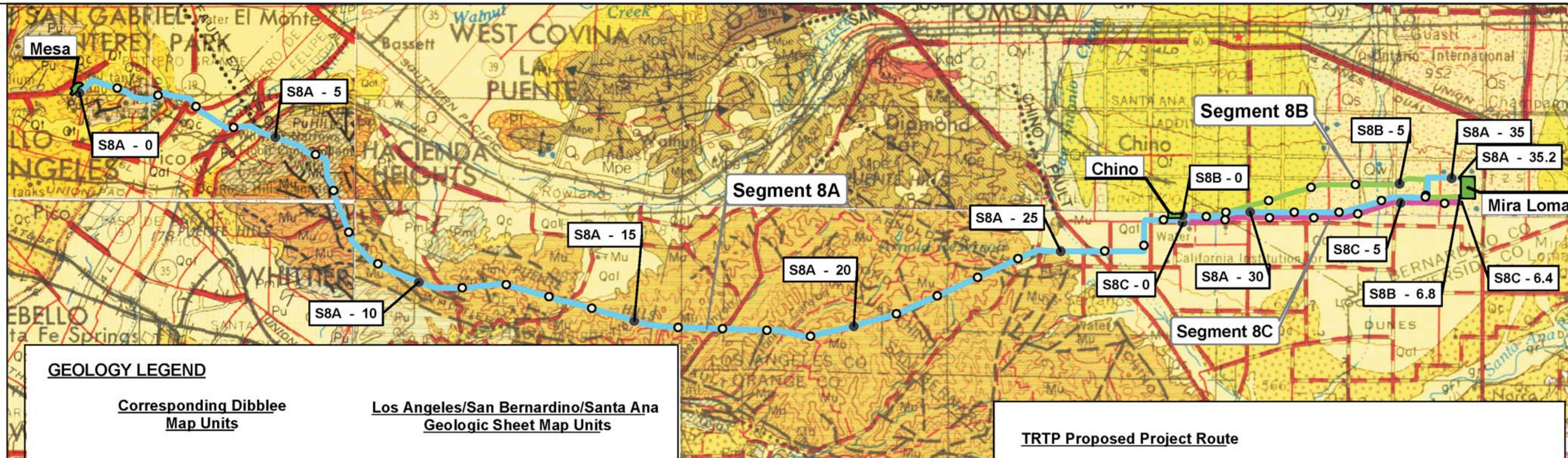
Figure 2-8b

**Segment 11
Active Fault Crossings**



GEOLOGY LEGEND

Corresponding Dibblee Map Units		Los Angeles/San Bernardino/Santa Ana Geologic Sheet Map Units
Alluvium	Qal	Alluvium
	Qf	Fan deposits
	Qs	Wind blown sand
Channel Alluvium	Qw	Wash deposts: alluvial deposits of modern washes
Older Alluvium	Qt	Quateranry nonmarine terrace deposits
	Qc	Pleistocene nonmarine
Fernando Formation	Pu	Upper Pliocene marine
	Pf	Fernando Formation: marine sitstone, sandstone, and conglomerate
	Pml	Middle and Lower Pliocene marine
Puente Formation: includes La Vida Shale, Soquel Sandstone, Sycamore Canyon, and Yorba Shale members	Mpe	Puente Formation: marine siltstone, sandstone, and shale
	Mu	Upper Miocene marine

TRTP Proposed Project Route

- S8A - 10: Segment 8A (with approximate milepost locations)
- S8B - 5: Segment 8B (with approximate milepost locations)
- S8C - 5: Segment 8C (with approximate milepost locations)

N W E S

0 0.5 1 2 3 4 5 Miles

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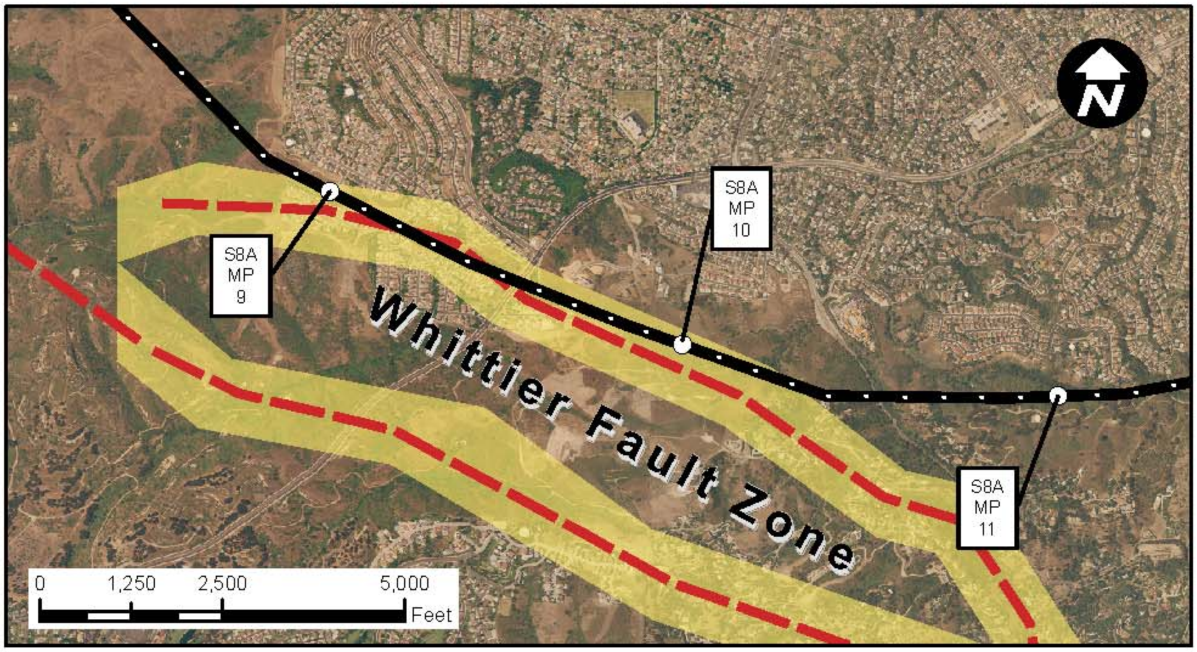
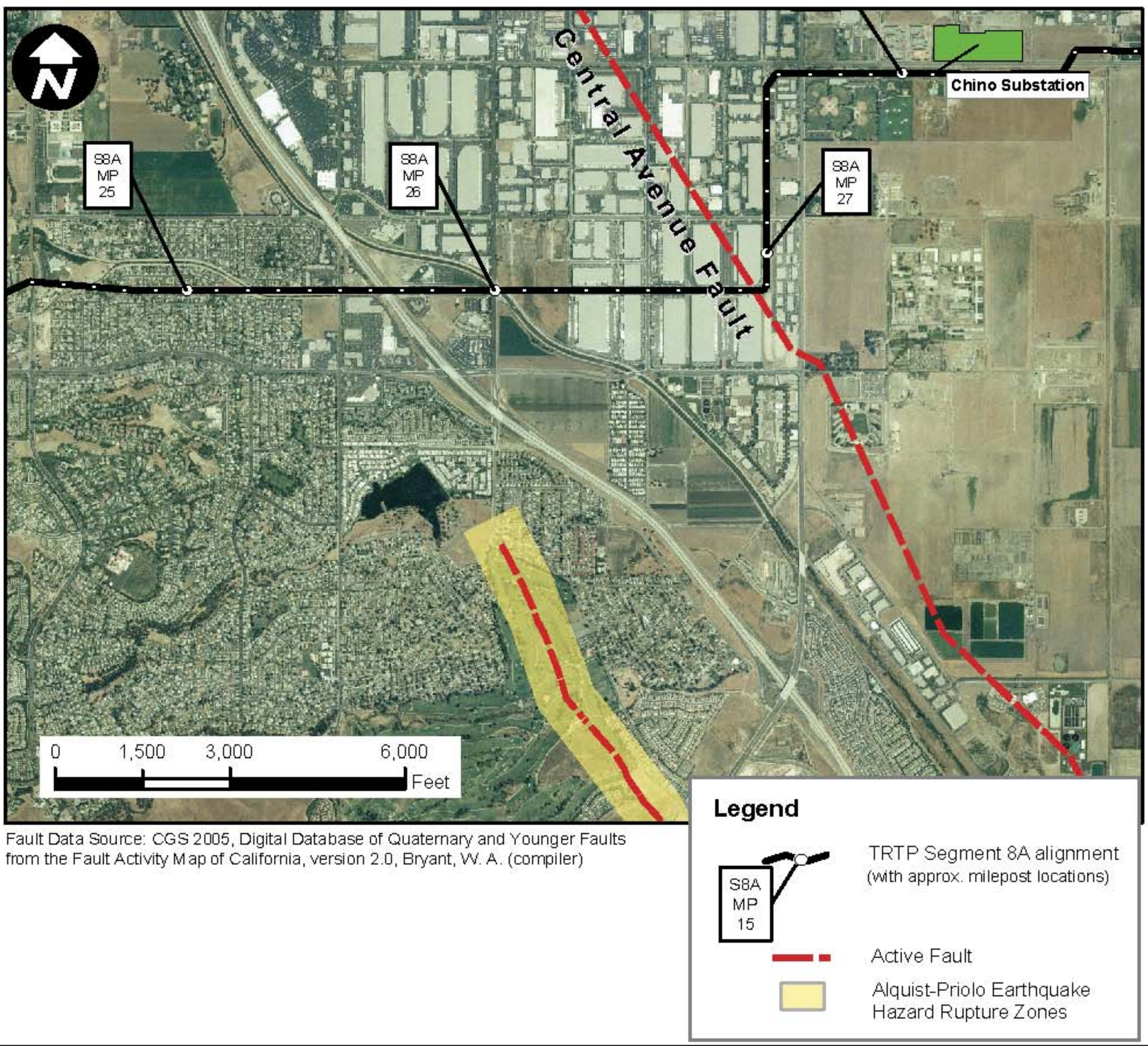
Source: GTC, 2008.

Figure 2-9
Regional Geology Map C

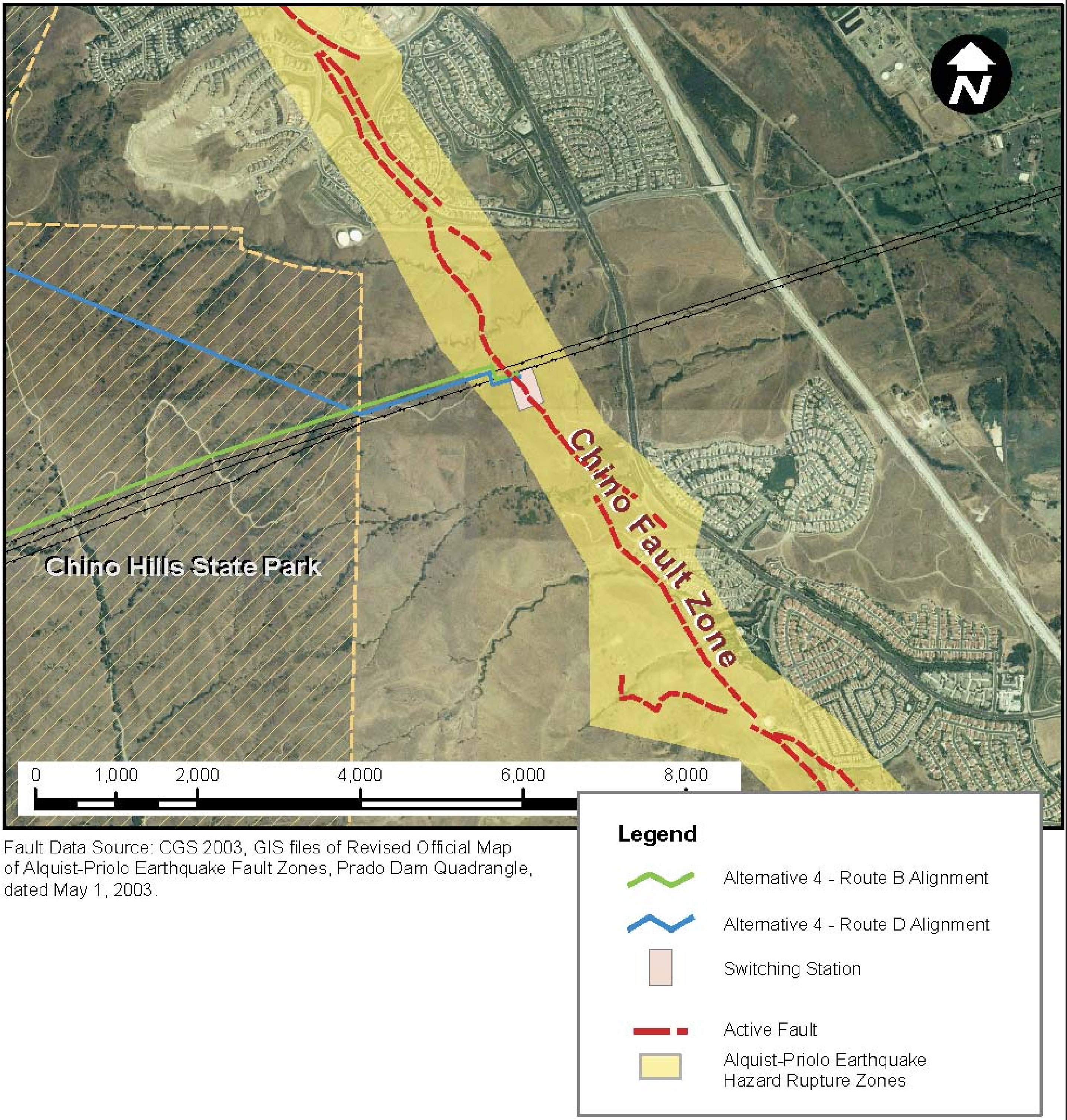




Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

Figure 2-10

Segment 8A Active Fault Crossings



Fault Data Source: CGS 2003, GIS files of Revised Official Map of Alquist-Priolo Earthquake Fault Zones, Prado Dam Quadrangle, dated May 1, 2003.

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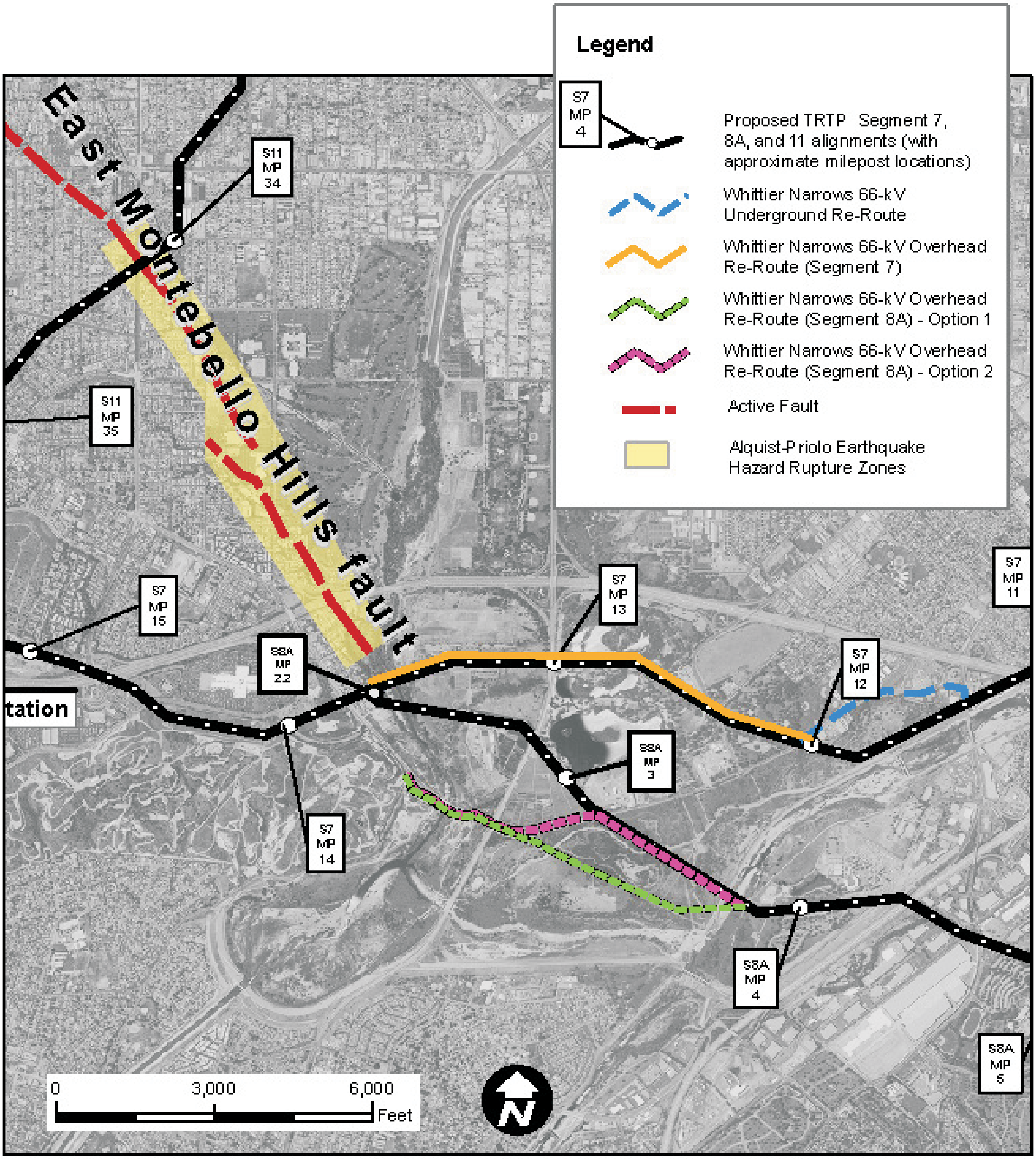
Figure 2-11
Alternative 4
Chino Fault Crossing



Fault Data Source: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler)

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Figure 2-12 (New)
Alternative 7 Fault Crossings