C.5 GEOLOGY, SOILS, AND PALEONTOLOGY

This section describes the geology, soils, paleontology, mineral resources, and geologic hazards of the Tri-Valley area. It then describes the potential impacts and mitigation measures for the Proposed Project and the alternatives.

C.5.1 ENVIRONMENTAL BASELINE AND REGULATORY SETTING

Baseline geologic information was collected from published and unpublished geologic, seismic and geotechnical literature covering the Proposed Project and the surrounding area. The literature review was supplemented by a field reconnaissance of the Proposed Project alignment and all Alternatives. The literature review and field reconnaissance focused on the identification of specific geologic hazards.

The Proposed Project is located in the eastern San Francisco Bay area. The Bay Area is known to be part of the seismically active tectonic boundary where the Pacific and North American plates interact. The most well known portion of this plate boundary is the San Andreas Fault, which has caused significant earthquake related damage within modern time.

C.5.1.1 Physiography and Topography

The project area is located in the Diablo Range, a northwest-trending group of hills and mountains extending southeast from Carquinez Straits along the west-side of the San Joaquin Valley to Coalinga. The Proposed Project is generally located in a topographic depression within the Diablo Range, locally referred to as the Tri-Valley area, and the surrounding foothills to the north, south and east. The Tri-Valley area consists of the lowlands of the San Ramon, Amador and Livermore Valleys. The Livermore and Amador valleys are adjacent valleys, aligned east-west across the Diablo Range with the smaller San Ramon Valley extending northwest from Amador Valley along the western edge of the Diablo Range.

The topography of the project area consists of valleys and their surrounding hills and ridges. The valley floors range in elevation from approximately 300 feet above sea level along Arroyo de la Laguna at the southern end of San Ramon Valley, to approximately 700 feet above sea level at the eastern margin of Livermore Valley. North and east of the Tri-Valley area, the Diablo Range rises to elevations between approximately 1,000 and 2,000 feet above sea level, with Mount Diablo reaching an elevation of 3,849 feet above sea level. A series of northwest-trending ridges, which range from approximately 1,000 feet near the valleys to over 3,000 feet, extend south of the Tri-Valley area. The hills and ridges of the Diablo Range typically have moderately steep to very steep slopes with numerous bedrock outcrops.

Several streams flow through the Tri-Valley area. Arroyo Las Positas, Arroyo Seco, and Arroyo Mocho drain the northeastern and southeastern hills, while Arroyo Valle drains the southern hills. These drainages converge and flow through the central Tri-Valley area, collecting the flow of Cayetano, Collier, Cottonwood, Tassajara, and Alamo Creeks from the northern hills. These streams join San Ramon Creek, which flows south through the San Ramon Valley and exits the basin along Arroyo de la Laguna.

Pleasanton Area

Between approximately Milepost M4.2 and M5.3 the proposed route lies in the level to moderately sloping terrain of the southern Amador Valley. The remainder of the route traverses the moderately to steeply sloping hills southeast of Pleasanton, with elevations ranging from approximately 350 to 1,150 feet. The overhead-underground transition structure is located at an approximate elevation of 800 feet in moderately to steeply sloping terrain.

Alternatives for the Pleasanton Area all involve minor modifications to the existing Vineyard Substation, with different transmission line routes. The S1 and S2 Alternative alignments begin in Sycamore Grove Regional Park, and then generally follow existing roadways. The topography along these alignments is nearly level. The S4 Alternative alignment traverses hilly terrain with moderate to steep slopes.

Dublin Area

The topography of the Dublin Area consists of moderate to steep hills west of the Livermore Valley, with elevations ranging from approximately 600 to 1,000 feet. The proposed transmission line alignment crosses Collier and Doolan Canyons, two narrow valleys trending in a southerly direction towards the Livermore Valley. The Proposed Dublin substation is located along the western side of an unnamed tributary to Tassajara Creek. Elevations at the substation site range from approximately 560 to 700 feet in terrain ranging from moderately to steeply sloping.

The topography of the D1 Alternative Substation site is nearly level, while the alternative transmission line alignment generally follows established roadways. The reconductoring component of the D2 alternative route follows an established powerline corridor from San Ramon to the Pittsburg-Antioch distribution center. This existing transmission line route traverses hilly terrain with moderate to very steep slopes.

North Livermore Area

The proposed North Livermore transmission line route traverses the Las Positas Valley at the northern end of the Livermore Valley. The route is characterized by flat to gently sloping topography with elevations that range from approximately 550 to 800 feet. The Proposed North Livermore Substation site is located on gently sloping terrain at an elevation of approximately 555 feet. The P1 and P2 underground alternatives follow the same route as the Proposed transmission line.

The L1 and L2 Alternatives follow established or planned roadways and are nearly level to moderately sloping. The alternative alignments all range in elevation from approximately 560 to 800 feet.

Tesla Connection

Slopes along the North Area Phase 2 route (between North Livermore and Tesla) are generally moderate to very steep, with elevations ranging from approximately 400 feet at the Tesla Substation to nearly 1,300 feet near Milepost B6.3. The proposed route intersects a number of ridges and narrow valleys in its path across the Altamont Hills.

Slopes across the Stanislaus Corridor route generally range from flat to moderate in the area near the Tesla Substation and the valley bottoms and low hills south of Livermore Valley, becoming moderate to very steep in the Altamont Hills. Elevations range from approximately 375 to 2,100 feet.

The topography of the Brushy Peak Alternative is hilly, ranging in elevation from approximately 600 to 1,000 feet over moderate to steep slopes.

C.5.1.2 Geology Overview

The project area lies within the Livermore Basin, a deep sedimentary trough, which formed as a result of extensional stresses between the Calaveras and Greenville faults, which form the western and eastern margins of the basin, respectively. These stresses resulted in faulting and subsidence within sedimentary and igneous rocks of the Great Valley Sequence. This trough was subsequently filled largely with Miocene to Pleistocene age sediments (Darrow, 1979). Following this period of extension, compressional forces acted on the basin, creating broad folds and faults throughout the region, and causing uplift and erosion of sediments in some areas.

To the north of the Livermore Basin the foothills of Mount Diablo, comprise a block of Cretaceous volcanic and sedimentary rocks, which is being pushed upward by the compressional stresses exerted along the Mount Diablo Thrust Fault. The Altamont Hills to the east of the Livermore Basin are being folded and pushed upward along the edge of the San Joaquin Basin, by the Coast Range Thrust Zone, also known as the Great Valley Fault System.

The geologic formations in the Tri-Valley area consist of a Cretaceous age basement complex, two Miocene marine formations, two Plio-Pleistocene non-marine formations, and overlying Quaternary sediments. The Quaternary sediments comprise alluvial terrace deposits, young and older alluvial fan and fluvial deposits, basin deposits, and floodplain deposits. The basement complex comprises the Great Valley Sequence, which is generally either in unconformable or fault contact with all younger units.

Great Valley Sequence

The Great Valley Sequence consists of graywacke, siltstone, shale, and sandstone metamorphosed to varying degrees. These rocks have been subdivided into several subunits mappable throughout the project area. These units are primarily of late Cretaceous age and generally comprise the majority of mapped bedrock in the Altamont Hills east of the Livermore Valley.

Miocene Series

Two major Upper Miocene marine formations are exposed in the Altamont Hills and the hills north of the Livermore Valley and west of the Greenville fault zone. The division between these two units is generally above or below a distinctive blue sandstone and conglomerate bed. Dibblee (1980a,b,g) describes the unit below this sandstone bed as the Cierbo Formation, and the overlying unit, including the blue sandstone, as the Neroly Formation. The Cierbo and Neroly formations form slopes that are rated as generally to mostly susceptible to slope failure through landsliding (Majmundar, 1991a).

Cierbo Formation. The Cierbo Formation consists of marine deposits of white, quartz-rich sandstone, tan to yellowish-brown feldspathic sandstone, sandy gravel, and brown and tan shale. The white sandstone is friable and massive to cross-bedded. The tan sandstone is generally friable, massive, and typically medium to coarse grained with abundant round, dark chert pebbles. The gravels contain pebble-sized clasts in a sandy matrix, with occasional cobble to boulder sized clasts of chert and quartzite.

Neroly Formation. The Neroly Formation consists of a blue, massive, arkosic to lithic sandstone interbedded with an andesitic pebble conglomerate at its base. The upper Neroly contains poorly exposed brown, arkosic sandstone, argillaceous shales, and some blue sandstone. The sandstone often weathers to a tan or yellow-brown color. The conglomerate contains rounded pebbles ranging from fine to coarse gravel, typically of andesite porphyry and commonly vesicular.

Miocene to Plio-Pleistocene Series

Miocene to Plio-Pleistocene non-marine sedimentary rocks unconformably overlie the units discussed above. These sedimentary rocks are generally exposed throughout the hills north of the Livermore and Amador Valleys. They units are poorly indurated non-marine deposits of pebble conglomerate, sandstone, and siltstone, with minor limestone, lignite, and tuff beds. These units are the undivided Green Valley and Tassajara Group of Miocene to Pliocene age and the Livermore Gravels of Plio-Pleistocene age. They generally erode into moderate to steep slopes that are rated as generally to mostly susceptible to slope failure through landsliding (Davenport, 1985; Majmundar, 1991a,b).

Green Valley/Tassajara Group. The Green Valley/Tassajara Group consists of poorly cemented silty sandstone, siltstone and poorly to moderately cemented conglomerate. The sandstone and siltstone are typically light gray, fine grained, and well-sorted, with occasional thin pebble lenses. The conglomerate consists of subrounded, fine gravel clasts with a poorly cemented, fine to coarse sand matrix. These deposits generally erode into moderate to steep slopes that are rated as generally to mostly susceptible to slope failure through earthflow (Davenport, 1985; Majmundar, 1991b). Expansive soils are common leading to creep-related movement on slopes as gentle as 7 degrees (13% slope) (Davenport, 1985).

Livermore Gravels. The Livermore Gravels are Pliocene to Pleistocene in age and consist of gray to yellow-brown pebble to cobble conglomerate, pebbly sandstone and coarse-grained sandstone with minor siltstone and claystone interbeds. These units are poorly to moderately consolidated, and are extensively mined for aggregate material within the Tri-Valley area. The gravel clasts are predominantly subrounded, hard, and strong chert and graywacke clasts derived from the Franciscan Formation. The clasts range in size from fine to coarse gravel. These deposits generally erode into low to steep slopes that are rated as marginally to mostly susceptible to slope failure through landslides (Majmundar, 1991a), with susceptibility increasing with slope. The high silt and clay content of some beds create moderate to high potential for expansive soils in areas underlain by this rock type.

Pleistocene to Holocene Deposits

The basins of the Tri-Valley area are covered with a complex of alluvial, fluvial and floodplain deposits of gravel, sand, silt and clay. These deposits have been subdivided by age and elevation above the valley floor. Helley and Graymer (1997) have divided the Quaternary alluvial deposits into Pleistocene age alluvial terrace deposits, alluvial fan and fluvial deposits, and Holocene age alluvial fan and fluvial deposits, floodplain deposits, and modern gravel pits. These units vary widely in thickness, composition, and areal extent as described below.

Pleistocene and Holocene deposits are generally found on gentle to moderate slopes, but may exhibit steep slopes along stream channels and fault scarp traces, or where slopes have been modified by human activities.

Alluvial Terrace Deposits. Pleistocene age terrace deposits occupy the margins of the Livermore and Vallecitos Valleys and consist of crudely bedded, poorly indurated, gravels, cobbles and boulders with a sandy matrix. Coarse sand lenses may also be present within the terrace deposits, the result of periodic variations in stream flow and sediment carrying capacity.

Older Alluvial Fan and Fluvial Deposits. Pleistocene-age alluvial fan and fluvial deposits are found primarily along the southern and northeastern margins of the Livermore Valley, and within the stream valleys of the surrounding hills. These deposits generally consist of brown gravelly to clayey sand, and clayey gravel, grading to sandy clay. Older alluvial deposits can be distinguished from younger deposits by higher topographic position, greater degree of stream dissection, and stronger soil profile development. The greater soil development makes these deposits less permeable than younger alluvial deposits. These deposits have low to marginal susceptibility to slope failure (Davenport, 1985; Majmundar, 1991a,b) due to low slopes.

Young Alluvial Fan and Fluvial Deposits. Large alluvial fan and fluvial deposits are located along the eastern and southeastern margins of the Livermore Valley, with deposits of smaller extent exposed along the eastern margin of San Ramon Valley, and in Dougherty Creek, and the larger drainages of the Altamont Hills. These deposits typically consist of brown or tan, medium dense to dense, gravelly sand and sandy gravel, which grades to sandy or silty clay. They are rated as least to marginally susceptible to slope failure (Davenport, 1985; Majmundar, 1991a,b) due to low slopes.

Floodplain Deposits. Basin and floodplain deposits are found within western Livermore, and central Amador and San Ramon Valleys. They consist of stream bank or natural levee deposits found along the courses of major drainages, and consist of medium to dark gray, soft to medium stiff, sandy to silty clay, with local lenses of coarser materials. These deposits are rated as least susceptible to slope failure through landsliding, but may be subject to slumping from undercut and oversteepened bank materials.

Gravel Pits. The western Livermore and central Amador Valleys are a rich source of sand and gravel aggregate. Gravel pits occupy the majority of the undeveloped land between Highway 580 and Vineyard Avenue. These gravel pits have been created for the excavation of sand and gravel from old and young fluvial deposits. These man-made depressions create a balance between increased slope angle and lowered water table resulting in only slightly increased potential for liquefaction by lateral spreading.

C.5.1.2.1 *Pleasanton Area Geology*

The most common unit in the Pleasanton Area is the Livermore Gravels. They underlie the Proposed Project between approximately Mileposts M0.3 and M4.2. Within the Vallecitos Valley, from approximately M0.0 to M0.3, the alignment generally overlies Pleistocene alluvial terrace, Pleistocene alluvial and fluvial, and Holocene floodplain deposits. The northern portion of the Pleasanton Area extending from Milepost M4.2 to Vineyard substation, generally overlies Pleistocene terraces deposits with local Pleistocene alluvial and fluvial sediments. The transition structure overlies the Livermore Gravel.

Areas classified as "mostly landslide" by the USGS (Wentworth et.al., 1997) are found near or underlying the Proposed route between approximately Mileposts M1.2 and M4.0. Some debris flow source areas have been mapped (Ellen, et. al., 1997) in the hills between approximately Mileposts M1.2 and M1.4. The largest mapped landslide along the Proposed route is found between approximately Mileposts M2.2 and M2.6 (Majmundar, 1991a). Mapped landslides near the underground portion of the route are found between approximately Mileposts M2.8 and M3.1. Other mapped landslides along the route are generally small and discontinuous. No landslides are mapped at the transition structure site, but some debris flow source areas (Ellen, et. al., 1997) are mapped in the area around the site. The transitions structure site is surrounded by areas designated as "mostly landslide" by the USGS (Wentworth et.al., 1997).

The S1 Alternative route overlies the alluvial and flood plain deposits of Arroyo Valle, Pleistocene and Holocene alluvial fan and flood plain deposits along Isabel Avenue, and floodplain deposits all along Stanley Boulevard. There are no mapped landslides or landslide prone deposits along this Alternative route.

The S2 Alternative route overlies the alluvial and flood plain deposits of Arroyo, Pleistocene alluvial fan and terrace deposits along Vineyard Avenue and Holocene floodplain deposits and gravel pits near the Vineyard substation (Helley and Graymer, 1997). There are no mapped landslides no landslide prone deposits along this Alternative route.

Nearly the entire length of the S4 Alternative transmission line route overlies the Livermore Gravels. The connection of this Alternative with S2 at Vineyard Avenue is within Pleistocene alluvial fan deposits. The route passes over two small and one moderately large, potential landslide areas. The larger landslide area underlies the underground portion of the route.

C.5.1.2.2 *Dublin Area Geology*

Portions of the Proposed transmission line route in Collier Canyon, Doolan Canyon and their tributaries generally overlie Pleistocene alluvial fan and fluvial deposits. From approximately Mileposts B13.2 to B17.2, the underlying bedrock consists of Green Valley and Tassajara Group rocks. The Dublin substation is underlain by both Pleistocene alluvial and fluvial deposits and Livermore Gravels.

The Proposed Dublin Area transmission line route generally traverses an area classified as “mostly landslide” by the USGS (Wentworth et. al., 1997) between approximately Mileposts B13.8 and B17.2. A large number of landslide complexes have been mapped along the route between Mileposts B15.0 and B16.1. In addition, a few debris flow source areas have also been mapped within the hilly terrain along this section of the route (Ellen, et. al., 1997). The Proposed Dublin Substation site is also located in an area classified as “mostly landslide” by the USGS. A portion of a landslide mapped by the CDMG (Davenport,1985) is found over the western side of the site and several other landslides are mapped nearby. Small debris flow source areas have been mapped in the hills south of the Proposed Dublin Substation site.

The site of the Alternative D1 substation lies within an area mapped as Holocene flood plain deposits. The Alternative route for the transmission line crosses areas mapped as Gravel Pits and as Holocene flood plain deposits of Arroyo Mocho (Helley and Graymer, 1997). There are no mapped landslides or landslide prone deposits along this Alternative route (Majmundar, 1991a).

The reconductoring component of the D2 alternative overlies Holocene alluvial and fluvial deposits in the valley adjacent to the San Ramon substation and along Dougherty Creek, the Green Valley and Tassajara formations in the Dougherty Hills, and the Livermore Gravel in the hills between Dougherty Creek and the Proposed Dublin substation site. The Alternative route crosses two moderate sized landslides (Majmundar, 1991).

C.5.1.2.3 *North Livermore Area Geology*

Portions of the Proposed Project in Las Positas Valley generally overlie Pleistocene alluvial fan and fluvial deposits. From approximately Mileposts B11.4 to B12.0, the Proposed Project is underlain by bedrock of the Green Valley and Tassajara Group sediments. Between approximately Mileposts B10.4 and B10.8, bedrock beneath the Proposed Project consists of Neroly and Cierbo sandstone. There are no mapped landslides along the North Livermore Proposed route, largely due to the gentle slope. The landslide susceptibility is described as very slight at the Proposed Substation site.

The geology for the P1 and P2 Underground Alternatives is the same as the portion of the Proposed Project they would replace. There are no mapped landslides or landslide prone deposits along these Alternative routes.

This L1 Alternative substation site and route overlies Pleistocene alluvial and fluvial deposits. There are no mapped landslides or landslide prone deposits along this Alternative route.

The L2 Alternative substation site overlies Pleistocene alluvial and fluvial deposits and Livermore Gravels. The L2 Alternative route overlies Holocene floodplain deposits south of Arroyo Las Positas, Pleistocene alluvial and fluvial deposits between the arroyo and the low hills, and Livermore Gravels within the low hills south of Las Positas College. There is one mapped landslide near this route on the slope south of Las Positas College.

C.5.1.2.4 *Tesla Connection Geology*

North Area (Proposed Phase 2)

The central segment of the Proposed Phase 2 transmission line route generally overlies bedrock of the Great Valley Sequence in the Altamont Hills. Both the eastern and western ends of the proposed route overlie sandstone of the Neroly and Cierbo formations. In addition, alluvial fan and fluvial deposits are found within the narrow valleys crossed by the route. On the western side of the Altamont Hills, these alluvial and fluvial deposits are generally Pleistocene in age, while on the eastern side some are of Holocene age, particularly those within the valleys west of the Tesla Substation.

The Proposed Phase 2 route either overlies or approaches areas classified as “mostly landslide” by the USGS (Wentworth et. al., 1997) from approximately Mileposts B1.8 to B2.1, B2.4 to B2.6, B3.0 to B5.2, B5.7 to B6.8, and B8.5 to W3.1. The largest mapped concentration of existing slides is found between approximately Mileposts B4.2 and B5.2. Some debris flow source areas have also been mapped along the route (Ellen, et. al., 1997).

The geology beneath the Brushy Peak Alternative route is almost entirely bedrock formations. The Alternative segment overlies the Cierbo Formation at the eastern end of the route and in the southern portion of the hill west of Laughlin Road. The remainder of the route overlies undivided Great Valley Sequence rocks and Pleistocene alluvial and fluvial deposits in the valley bottom along Laughlin Road. The route crosses two small and one moderate sized suspected landslides (Majmundar, 1991).

South Area (Stanislaus Corridor Alternative)

The Stanislaus Corridor route traverses the entire width of the southern project area, and includes all of the geologic units described in this study. The most common units beneath the route through the Altamont Hills are the Cierbo and Neroly Formations, with minor outcrops of Great Valley Sequence sediments. The Stanislaus Corridor route crosses over Pleistocene and Holocene alluvial terrace and alluvial and fluvial deposits near Arroyo Seco and Arroyo Mocho; Livermore Gravels on the ridge between Arroyo Mocho and Arroyo Valle; Pleistocene and Holocene alluvial terrace deposits in the lowland adjacent to Arroyo Valle; and Livermore Gravels in the hills south of Pleasanton. Minor amounts of floodplain deposits are found along the route near Arroyo Mocho and Arroyo Valle.

The Stanislaus Corridor Alternative route either overlies or closely approaches areas classified as “mostly landslide” by the USGS (Wentworth, et al, 1997) from approximately Mileposts V2.0 to V3.5

and V5.7 to V 6.4. The largest concentration of existing landslides is found between approximately Mileposts V5.7 and V6.1. Some debris flow source areas have also been mapped along the route.

C.5.1.3 Faults and Seismicity

The seismicity of the Tri-Valley area is generated by the San Andreas fault system. Major faults in the San Francisco Bay region include the San Gregorio, San Andreas, Hayward, Calaveras, and Greenville faults. The primary faults in the project area include the Hayward, Calaveras, and Greenville faults, and the blind thrust faults associated with the Mount Diablo Thrust and the Coast Range-Central Valley geomorphic boundary (CRCV) (WG99, 1999; Wakabayashi and Smith, 1994). Figure C.5-1 (Fault Map) depicts the location of the Proposed Project and alternatives in relation to known faults in the immediate Tri-Valley area. These faults have been classified as active, potentially active, or inactive by the CDMG based on the age of most recent activity (Jennings, 1994) as shown on Figure C.5-1 and defined below:

- Historic faults have experienced surface rupture during historic time (about the last 200 years) and are associated with either a recorded earthquake with surface rupture, aseismic creep or displaced fault survey lines,
- Holocene age faults have had surface displacement within the past 11,000 years, as demonstrated by young geomorphic evidence, offset young deposits, or radiometrically dated material,
- Late Quaternary age faults show evidence of surface rupture within approximately the last 700,000 years, as demonstrated using the same geomorphic evidence as for Holocene age faults, above,
- Quaternary age faults show evidence of surface rupture younger than about 1.6 million years ago, including faults which displace undifferentiated Plio-Pleistocene age deposits,
- Pre-Quaternary age faults show no evidence of movement within the Quaternary (about the past 1.6 million years) or lack evidence of displacement of younger deposits. Also included in this category are known faults for which detailed studies have not determined fault activity and those faults identified only in preliminary mapping.

The classification of "active" is applied to Historic and Holocene age faults, "potentially active" is applied to Quaternary and late Quaternary age faults, and "inactive" is applied to pre-Quaternary age faults. These classifications are used to define the extent of detailed study required prior to development of projects across known fault traces. This classification is not meant to imply that inactive fault traces will not rupture, only that they have not been shown to have ruptured for some time and the probability of fault rupture is low. This classification system also does not address subsurface or "blind" faults, which can rupture and cause significant earthquake damage without creating surface displacement.

The Tri-Valley area was shaken most recently by the 1989 Loma Prieta earthquake, which produced strong ground motions in the Livermore area of between 0.04 to 0.11g (gravity). The area was also subject to strong ground motion from the Livermore earthquake sequence of January 24-26, 1980. The two largest of these earthquakes had magnitudes of M5.7 and M5.2, respectively, and produced as much as 5 centimeters of surface offset over a discontinuous surface rupture of 6 kilometers.

Since the 1994 Northridge earthquake, the California Division of Mines and Geology (CDMG) and the United States Geological Survey (USGS) have taken renewed interest in investigating the potential for large earthquakes taking place on previously unknown “blind thrust faults” and poorly constrained potentially active faults with long recurrence intervals (Campbell, et al., 1995; WG99, 1999), one of which is the Mt. Diablo Blind Thrust fault. Based on these and other studies, the Working Group on California Earthquake Probabilities has calculated a cumulative probability of 70 percent for one or more M6.7 or greater earthquakes in the San Francisco Bay Area next 30 years and a cumulative probability of 80 percent for one or more events between M6.0 and M6.7 within the same period (WG99, 1999). The intensity of the strong ground motions generated in the project area by these events will be dependent upon the earthquake magnitude, epicentral distance, and the attenuation of seismic energy based on local soil and rock characteristics. Maps published by the CDMG (Petersen, et al, 1996) estimate that the peak ground acceleration in the project area, with a 10 percent probability of exceedance in 50 years, would be between 0.4 and >0.7 g, which is relatively strong ground shaking.

The characteristics of significant local faults that would contribute to the seismic shaking hazard within the Proposed Project area are listed in Table C.5-1, Fault Activity.

C.5.1.3.1 *Liquefaction Potential*

Liquefaction related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). Lateral spreading comprises the lateral displacement of surficial blocks of sediment and commonly occurs on gentle slopes between 0.3 and 3 degrees (Ziony, 1985). Lateral spreading is particularly likely near unlined stream and river channels or other sloping locations. In addition, densification of the soil resulting in vertical settlement of the ground can also occur. Damage induced by lateral spreading and liquefaction is generally most severe when liquefaction occurs within 15 to 20 feet of the ground surface. A form of lateral spreading was reported in the vicinity of the project area as a result of the shaking from the 1906 San Francisco earthquake (Youd and Hoose, 1978) where two hilltops north of Dublin were observed to have failed by circumferential landsliding.

Based on our review, portions of the Proposed Project overlie granular alluvial and fluvial deposits, including sands and silty sands. These deposits, accompanied by the high water table, may be moderately to highly susceptible to earthquake-induced liquefaction effects.

C.5.1.3.2 *Pleasanton Area Seismicity*

Portions of the Proposed route span the active Verona fault at approximately Milepost M0.2. The Proposed alignment is also within the Alquist-Priolo Earthquake Fault Zone for the Verona fault from approximately Mileposts M0.1 to M0.3 (CDMG, 1982e). This whole distance is spanned by one tower interval, and no towers are proposed within the Fault Zone. Additional traces of the Verona fault, mapped by Smith (1981), underlie the route between Mileposts M0.9 and M1.2. These traces are located outside of the Alquist-Priolo Earthquake Fault Zone. The Proposed transition structure site is

Placeholder: Figure C.5-1 **Tri-Valley Area Faults**

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Placeholder: Figure C.5-1 Tri-Valley Area Faults

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Table C.5-1 Fault Activity
Known Active and Potentially Active Faults Within 50-mile (80-kilometer) Radius

Fault	Minimum Distance From Project		Potential Rupture Length	Activity	Max. Earthquake Magnitude
	(mi)	(km)	(km)	(Geologic Period)	(M_W)
Calaveras—Northern Segment	3.4	6.0	52	Historical (1861)	6.8
Calaveras—Southern Segment	13.3	21.3	106	Historical (1989)	6.2
Calaveras—All Segments	3.4	6.0	48	Historical (1989)	7.0
Concord-Green Valley	12.0	16.3	66	Historical (Creep)	6.9
Corral Hollow	0	0	17	Holocene	6.5
Great Valley 4	39.0	32.7	42	Historical (1892)	6.6
Great Valley 5	22.0	35.4	28	Historical (1892)	6.5
Great Valley 6	4.8	7.7	45	Historical (1889)	6.7
Great Valley 7	4.9	7.9	45	Holocene	6.7
Great Valley 8	28.7	46.2	41	Holocene	6.6
Greenville	0	0	73	Historical (1980)	6.9
Hayward—Northern Segment	15.2	24.4	43	Historical (1836)	6.9
Hayward—Southern Segment	8.3	13.4	43	Historical (1868)	6.9
Hayward—All Segments	8.3	13.4	86	Historical	7.1
Hayward—Southeast Extension	12.2	19.6	26	Holocene	6.7
Las Positas	0	0.0	10	Historical (1980)	6.3
Livermore	4.0	6.4	8	Quaternary	6.2
Midway	0.2	0.3	11	Quaternary	6.3
Mission	7.5	12.0	15	Quaternary	6.2
Monte Vista-Shannon	27.0	43.5	41	Quaternary	6.8
Ortigalita	33.9	54.5	66	Holocene	6.9
San Andreas--Northern Segment	41.8	67.2	322	Historical (1906)	7.6
San Andreas--Peninsula Segment	27.3	44.0	88	Historical (1906)	7.1
San Andreas--Northern and Peninsula Segments	27.3	44.0	401	Historical (1906)	7.8
San Andreas--Santa Cruz Segment	33.0	53.1	37	Historical (1989)	7.0
San Andreas--All Segments	27.3	44.0	438	Historical (1906)	7.9
San Gregorio	36.5	58.8	80	Holocene	7.3

Notes: km = kilometer
M_W = Moment magnitude
mi = miles

Source: EQFAULT, v. 3.00; Petersen, et al., 1996; Wesnousky, 1986.

approximately 1 mile (1.6 km) northeast of the Verona fault and approximately 3 miles (4.8 km) northeast of the Calaveras fault.

Both the S1 and S2 Alternative routes pass within approximately one mile or less of the potentially active Livermore fault and West Branch Livermore fault, and cross a mapped trace of the potentially active Las Positas fault (Dibblee, 1980f). The western end of these alternative routes (at Vineyard

Substation) lies approximately 1.7 miles east of mapped traces of the active Pleasanton fault (Jennings, 1994; Graymer, et al, 1996).

The S4 Alternative would use the same route as the proposed project, crossing the Verona Fault. The remaining cross-country portion of the route does not cross any active or potentially active faults. The western end of this alternative route is the same as the S2 Alternative.

C.5.1.3.3 *Dublin Area Seismicity*

No mapped fault traces have been identified beneath the Proposed Dublin Area alignment or the Proposed Dublin substation site. The Proposed Dublin substation site is located approximately 3 miles from the Pleasanton Fault and approximately 5 miles from both the Greenville and Calaveras faults

This D1 Alternative substation site and the transmission line route do not overlie any mapped fault traces. The potentially active Parks fault is mapped 0.3 mile north of the substation site, while the potentially active Livermore fault is mapped approximately 2.5 miles west of the substation. The substation site is also located approximately 2.0 miles east of the active Pleasanton fault, 2.4 miles north of the active Verona fault, 4.8 miles east of the active Calaveras fault, and 7.7 miles west of the active Greenville fault.

The D2 Alternative would also use the Proposed Dublin Substation site. The transmission line route crosses a mapped trace of the Pleasanton fault (Dibblee, 1980c,d) approximately 0.4 mile east of the San Ramon Substation. This portion of the Pleasanton fault is classified as active, but is not sufficiently "well defined" to be included in the Alquist-Priolo Earthquake Fault Zone for the Pleasanton fault (CDMG, 1982d; Hart, 1981b,c). The San Ramon Substation is located 3.2 miles east of the active Pleasanton fault, 2.6 miles north of the potentially active Parks fault, 5.3 miles east of the active Calaveras fault, and 6.3 miles west of the active Greenville fault.

C.5.1.3.4 *North Livermore Area Seismicity*

No mapped fault traces have been identified along the North Livermore route, however, the easternmost portion of the Proposed route near Milepost B10.4 (the juncture with the Contra Costa-Newark Line) is located just within the Alquist-Priolo Earthquake Fault Zone established for the Greenville fault. The Greenville fault, at its closest approach of approximately 2.3 miles to the northeast, is the nearest known active fault to the Proposed North Livermore Substation. The P1 and P2 alternatives would use the same route as the Proposed Project.

The L1 Alternative route does not cross any known mapped faults. The substation for the L1 Alternative is located approximately 1.6 miles east of the mapped trace of the potentially active Parks fault, 2.8 miles southwest of the active Greenville fault, 7.2 miles west of the active Coast Ranges-Great Valley thrust fault (segment 6), 7.7 miles east of the active Pleasanton fault, and 10.4 miles east of the active Calaveras fault.

The L2 Alternative route crosses the potentially active Livermore and West Branch Livermore faults along Isabel Avenue in the vicinity of the sewage treatment plant (DWR, 1966; Jennings, 1994). These faults are poorly located.

The substation for the L2 alternative is located approximately 1.1 miles northeast of the potentially active Livermore fault, 4.8 miles southwest of the active Greenville fault, 5.5 miles east of the active Pleasanton fault, 8.0 miles east of the active Calaveras fault, and 8.8 miles west of the active Coast Ranges-Great Valley thrust fault (segment 6).

C.5.1.3.5 *Tesla Connection Seismicity*

North Area (PG&E's Phase 2)

The Proposed Phase 2 route crosses the active Greenville fault and its associated Alquist-Priolo Earthquake Fault Zone from approximately Mileposts B9.4 to B10.4 (CDMG, 1982a,b). Multiple fault traces have been mapped within the fault zone. Some traces of the Greenville fault mapped by Dibblee (1982a) are outside of the Alquist-Priolo earthquake fault zone and cross the Proposed route between approximately Mileposts B7.5 and B8.0.

The southeast corner of the North Area Brushy Peak Alternative route lies within the Alquist-Priolo Earthquake Fault Zone established for the Greenville fault zone. Active traces of the fault, which ruptured during the 1980 Livermore earthquake sequence, are mapped within 0.1 mile of the corner of the route.

South Area (Stanislaus Corridor)

The Stanislaus Corridor route crosses the active Greenville fault and its associated Alquist-Priolo Earthquake Fault Zone from approximately Mileposts V6.15 to V6.50 (CDMG, 1982a). An additional fault trace mapped by Dibblee (1980a) lies outside the Alquist-Priolo Earthquake Fault Zone at approximately Milepost V6.85.

The Stanislaus Corridor route also crosses the corner of the Alquist-Priolo Earthquake Fault Zone established for the Las Positas fault at approximately Milepost V9.9. This segment of the Las Positas fault zone was observed to have a small amount of creep displacement over a period of several months following the January 1980 Livermore earthquakes (Hart, 1981a). Additional traces of the Las Positas fault as mapped by Dibblee (1980a,e,f) extend the length of the Stanislaus Corridor route from Mocho Junction at Milepost V11.0, to its connection with the Proposed route at Milepost V17, These fault traces range from 0.1 to 0.5 kilometer (0.07 to 0.25 mile) distant and parallel to the route. They offset deposits of late Quaternary age and are classified as potentially active (Jennings, 1994). The Stanislaus corridor crosses a corner of the Alquist-Priolo Earthquake Fault Zone established for the Verona fault at approximately Milepost V17 (CDMG, 1982e), at its connection with the Proposed route south of Pleasanton (near Highway 84).

The Stanislaus Corridor Alternative route crosses several mapped faults within the Altamont Hills, one of which has been determined to be of early Quaternary age and is classified as potentially active

(Jennings, 1994). This fault, the Corral Hollow fault, crosses the Stanislaus Corridor route at approximately Milepost V4.7 (Dibblee, 1980a,g).

C.5.1.4 Soils

The United States Department of Agriculture, Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service, or SCS) has published soil survey reports for nearly all regions of California. The soil descriptions presented in this section were compiled from data published by the SCS for eastern Alameda (Welch, 1966) and Contra Costa Counties (Welch, 1977). Soils within the Tri-Valley area vary from well-drained soils present in the alluvial fans, to highly clayey soils, to gravelly soils of the basin floor, terraces, and uplands. Many of the soils in the project area are urbanized and have been disturbed, paved over, or replaced with artificial fill.

The soil characteristics, which may have the most significant impact on the design and operation of the Proposed Project, are the shrink-swell potential and corrosivity.

The shrink-swell potential is a reflection of the ability of some soils with high clay content to change in volume with a change in moisture content. Shrink-swell potential poses a less significant hazard where soil moisture is relatively constant, either always wet or always dry. This characteristic poses a significant hazard to sites, which undergo seasonal variation in soil moisture content, such as on hillsides or flatlands with a seasonally fluctuating water table. The corrosivity of a soil is an estimate of the potential for soil-induced chemical action that dissolves or weakens structural materials. Corrosion potential is based mainly on the polysulfide content, texture, and acidity of the soil. The corrosion potential in the native soils of the valley lowlands is high throughout much of the Project area and could impact the chemical stability of concrete and uncoated steel used in support structures and underground conduits.

Significant soil characteristics for the soil associations encountered within the entire Project area are summarized below.

Altamont-Diablo Association. These soils occur in the uplands north and east of Livermore Valley, and are characterized by smooth rounded hills, and rolling to steep topography, with some very steep slopes along streams. The Altamont, Diablo and Linne soils of this Association are found along most of the length of the Proposed Dublin route, the Proposed Phase 2 route through the Altamont Hills, the portion of the Stanislaus Corridor Alternative within the Altamont Hills southeast of Livermore, and along the D2 Alternative reconductoring of the Pittsburg transmission line in Contra Costa County.

These soils formed in weathered material from interbedded sedimentary rock producing typically fine and moderately fine textured, hard, clayey, and neutral to mildly alkaline soils. These soils are typically well drained to excessively drained, moderately deep to deep and have moderate to high fertility and water holding capacity. Many of the soils in this Association are moderately eroded, primarily due to previous cultivation and replacement of native vegetation through overgrazing. The erosion hazard is considered moderate for cultivated slopes between 15 and 30 percent, and severe to very severe for slopes greater than 30 percent. Altamont clay soils have high shrink-swell potential and corrosivity.

Along small valleys of the Association are minor amounts of Pescadero, Cropley, Conejo and Los Osos soils, which are typically poorly drained, saline-alkali, and shallow to moderately deep. Los Osos soils are slightly acid. Pescadero soils have moderate to high shrink-swell potential with very high corrosivity. Cropley and Los Osos soils have high shrink-swell potential and corrosivity. Conejo soils have moderate shrink-swell potential and corrosivity.

Yolo-Pleasanton Association. The Yolo-Pleasanton Association is found in the valley bottomlands in the vicinity of Livermore and Pleasanton. These soils underlie most of the S1 and S2 Alternatives along Vineyard Avenue and Stanley Boulevard, the L2 Alternative route south of Arroyo Las Positas, portions of the D2 Alternative near Vineyard Substation, and the portions of the Stanislaus Corridor Alternative on the terraces and in the arroyos south of Livermore.

Yolo-Pleasanton Association soils are characterized by nearly level topography, with a few steeply sloping escarpments on the low terraces. Soils in this association within the project area include the Livermore, Pleasanton and Yolo series. These soils are typically very deep, well-drained, and neutral to mildly alkaline. These soils typically contain abundant gravel and are extensively planted with vineyards along the southern margin of the Tri-Valley area. Livermore and Yolo series soils have low shrink-swell potential, and Pleasanton soils have low to moderate shrink-swell potential. These soils are typically non-corrosive.

Positas-Perkins Association. The Positas-Perkins Association is found on the upper terraces and low hills to the south of the Livermore and Amador Valleys. These soils underlie most of the length of the Proposed South Area route through the hills south of Pleasanton, the S4 Alternative within the hills south of Pleasanton, and portions of the Stanislaus Corridor Alternative southwest of the S1/S2 Alternative’s connection to the Contra Costa-Newark transmission line and the terrace upland between Arroyo Valle and Arroyo Mocho.

The topography of the Positas-Perkins Association is gently sloping to very steep with elevations ranging from 300 to 900 feet within the project area. The Positas series soils make up the majority of this association with small amounts of Perkins and Diablo clay, very deep soil. The Positas soils occur mainly on the gravelly high terraces and uplands, and typically consist of medium acid, shallow soils above a claypan, and with low fertility and water holding capacity. Perkins soils occur on lower terraces and are generally similar to the Positas soils, but lacking the claypan, are moderately deep, with low water holding capacity. The claypan of Positas series soils is typically 1.5 feet thick and has high shrink-swell potential and high corrosivity, with gravelly soils above and below the claypan having low to moderate shrink-swell potential and low corrosivity.

Clear Lake-Sunnyvale Association. The Clear Lake-Sunnyvale Association is found in the valley bottoms and low terraces of the northern Livermore and Amador Valleys and much of San Ramon Valley. These soils are characterized by nearly level topography, and formed under poorly drained conditions, though they are now imperfectly to moderately well drained soils. The Clear Lake soils are clayey, neutral to mildly alkaline, and very hard. These soils grade to a very hard, calcareous, clayey subsoil. These soils have high fertility and water holding capacity. Clear Lake soils have high shrink-swell potential and have very high corrosivity.

Other soils of minor extent in this association are the Danville and Pescadero series. Danville soils formed on low terraces and alluvial fan deposits. These soils are generally very deep, slightly acid silty clay loam and silty clay, with high water holding capacity. Danville soils have moderate shrink-swell potential.

Rincon-San Ysidro Association. The Rincon-San Ysidro Association soils are crossed by the Phase 2 segment of the Proposed Project in the valleys west of Tesla Substation and by the Stanislaus Corridor Alternative south of Tesla Substation. The topography of these soils is nearly level to gently sloping on alluvial fans and flood plains. This association consists primarily of Rincon and San Ysidro series soils, which formed from alluvial parent materials weathered from sedimentary rocks.

Rincon series soils are typically neutral clay loam that grades to mildly alkaline clay subsoils. Rincon soils have a high water holding capacity and a moderate to high shrink-swell potential, with moderate to high corrosivity. San Ysidro series soils are characterized as medium acid loam which lies abruptly on a neutral claypan, with the clay becoming increasingly calcareous with depth. San Ysidro soils have low water holding capacity, a low to high shrink-swell potential and are highly corrosive.

C.5.1.4.1 *Pleasanton Area Soils*

Soil associations along the Proposed Pleasanton Area route include the Positas-Perkins, Yolo-Pleasanton, Altamont-Diablo, Clear Lake-Sunnyvale, and Rincon-San Ysidro associations. Soils of the Positas series are generally located from Mileposts M0.0 to M0.3 and approximately M1.5 to M4.2. The Yolo, Livermore, and Pleasanton soil series, members of the Yolo-Pleasanton association, are generally found over gravely deposits in Vallecitos Valley (Mileposts M4.2 to M5.3). The Diablo soil series is common from Mileposts M0.6 to approximately M1.5 in the hills southeast of Pleasanton. Soils at the Transition structure site are of Positas gravelly loam, a sandy gravelly clay soil found on moderate to steep slopes. It has a moderate to high shrink-swell potential, its pH varies from medium acid to mildly alkali, and the erosion potential at the site is considered severe due to moderate to steep slopes.

Both the S1 and S2 Alternatives generally overlie Livermore and Danville series soils south of Highway 84. The S1 Alternative overlies Livermore gravelly and very gravelly soils as well as riverbed deposits and a minor amount of Zamora series soils along Isabel Avenue and Yolo series soils along Stanley Boulevard. The S2 Alternative overlies Livermore and Yolo series soils along Vineyard Avenue to S4, and Yolo, Positas and Pleasanton series soils from S4 to the Vineyard substation.

The S4 Alternative alignment segment overlies Positas series soils over most of its length, with minor areas of Diablo clay at the southern end and Linne clay soils at the northern end where it connects with the S2 Alternative.

The area proposed for the construction of a local power generation plant alternative lies within an area mapped predominantly as Yolo series soil with areas of gravel pit mapped where the soils have been removed.

C.5.1.4.2 *Dublin Area Soils*

Soil associations along the Proposed Dublin Area route include the Altamont-Diablo and Clear Lake-Sunnyvale associations. The Diablo soil series is most common between Mileposts B14.2 and B17.2 in the hills northwest of Livermore, while small amounts of both Pescadero and Clear Lake soils are found in the valley bottoms of Collier, Doolan, and Tassajara Canyons. Soils of the Linne, Diablo, and Altamont series are found in the hills at the north end of the Las Positas Valley, between Mileposts B13.2 and B14.2. Clay soils of both the Diablo and Pescadero series underlie the Proposed Dublin substation site. Diablo clay, on 30 to 50 percent slopes, is considered to be moderately to highly redouble, while the Pescadero soils, in the valley bottom, present only a minor erosion hazard. Both Diablo and Pescadero soils have a high shrink-swell potential.

The soils at the D1 Substation alternative site are mapped as Pescadero clay series soils. From the substation to Arroyo Las Positas, the alternative route overlies Clear Lake soils. Between Arroyo Las Positas and Arroyo Mocho, the route overlies Sycamore series soils. South of Arroyo Mocho, the route overlies Yolo and Gravel Pit series soils.

Along the reconductored portion of D2 alternative, soils were analyzed only for their erosion potential due to construction activities during reconductoring. Soils near the Pittsburg substation include Cape and Altamont soil series, with minor areas of Clear Lake, Omni, Sycamore, Rincon Soils series and Joyce muck. South of Pittsburg, the route overlies predominantly Altamont-Fontana Complex soils with minor amounts of Diablo, Pescadero, Los Gatos, Briones, and Lodo Rock Outcrop series soils. East of Clayton, the route overlies predominantly Altamont-Fontana Complex, Los Osos, and Rock Outcrop series soils with minor amounts of Gaviota series soils. East of Mount Diablo State Park, the predominant soils are Rock outcrop-Xerorthents, with minor amounts of Los Gatos, Los Osos, Millsholm, and Valecitos series soils. North and south of Tassajara Road, the route overlies predominantly Diablo series clay with small areas of Clear Lake clay soils along Alamo Creek.

All of these soils are moderately to severely prone to erosion, especially where found on moderate to steep slopes and where disturbed by construction activities and removal of vegetation.

The D2 Alternative route from the San Ramon substation to the Proposed Dublin substation overlies predominantly Diablo series soils with minor amounts of Pescadero, Clear Lake and Cropley series soils in valley bottoms.

C.5.1.4.3 *North Livermore Area Soils*

Soil associations along the Proposed North Livermore route include the Altamont-Diablo and Clear Lake-Sunnyvale Associations. Soils of the Linne, Diablo, and Altamont series are found in the hills at the north end of the Las Positas Valley, between Mileposts B10.4 and B13.2. Clear Lake soils have been identified over a large area of the bottom of the Las Positas Valley, from approximately Mileposts B12.0 to B13.2 and U0.0 to U1.0. The Proposed North Livermore Substation site overlies clays of the Clear Lake series, a high plasticity soil found on very gently sloping or flat lying plains (0 to 3 percent slopes). The soil formed in fine-textured alluvium from sedimentary rock and has a high shrink-swell potential, its pH varies from slightly acid to moderately alkali, and, because of shallow slopes, erosion potential at the site is considered to be low.

The soils along the P1 and P2 Underground Alternatives are the same as soils along the portion of the Proposed Project these Alternatives would replace.

The L1 Alternative substation site overlies Clear Lake series soils. The L1 Alternative route overlies Solano, San Ysidro, Pescadero and Clear Lake series soils. The Solano and San Ysidro series soils are typical of the alkali flat.

The L2 Alternative substation site is underlain by Linne series clay soils. The L2 Alternative route is mapped as Linne, Diablo and Rincon series soils north of Interstate 580. Between the highway and the sewage treatment plant, soils along the route are mapped as predominantly Rincon series soils with minor amounts of Pleasanton gravelly soils and Riverwash along Arroyo Las Positas. Between the Sewage treatment plant and Stanley Boulevard, the route overlies predominantly Yolo and Livermore soils with a small amount of Riverwash along Arroyo Mocho.

C.5.1.4.4 *Tesla Connection*

North Area (PG&E's Phase 2)

Soils. Soils of the Altamont-Diablo Association are by far the most common soils along the Proposed Phase 2 route. A minor amount of Rincon-San Ysidro Association soil is found within the valleys west of Midway, near the Tesla Substation. These soils have been identified over a small portion of the route between Mileposts B0.0 and B0.2. From Mileposts B0.2 to B2.6, the route generally overlies soils of the Linne, Altamont, and Diablo series. The remainder of the route, from Milepost B2.6 to B10.2, primarily overlies soils of the Altamont series, with limited areas of Pescadero series soils within some of the narrow valley bottoms.

The North Area Brushy Peak Alternative route crosses predominantly Altamont clay series soils, with a minor amount of Gaviota sandy series soils along the ridgetops.

South Area (Stanislaus Corridor)

Soils. The Altamont-Diablo soil association is by far the most common along the Stanislaus Corridor Alternative route within the Altamont Hills. A small amount of Rincon-San Ysidro Association soils are found within the valley south of the Tesla Substation. Soils of the Rincon series have been identified over a portion of the route between Mileposts V0.0 and V1.5. From Mileposts V1.5 to V7.3, the route generally overlies soils of the Altamont, Linne, and Diablo series. From Mileposts V7.3 to V10.9, the route generally overlies soils of the Pleasanton, Linne, and Clear Lake series. From Mileposts V10.9 to V13.0, the route overlies soils of the Positas series. The route overlies

Pleasanton and Linne series soils from Mileposts V13.0 to V13.4, Riverwash from Mileposts V13.4 to V13.6, and Livermore and Danville series soils from Mileposts V13.6 to V13.8. From Mileposts V13.8 to V15.0, the route generally overlies soils of the Positas and San Ysidro series. From Mileposts V15.0 to V17.0, the route generally overlies Positas and Diablo series soils.

C.5.1.5 Mineral Resources

Aggregate Resources

The most significant mineral resources identified in the project area are the sand and gravel deposits in the western Livermore Valley and Central Amador Valley. These deposits are a major source of construction-grade aggregate for the San Francisco Bay Area. Major quarry operators in the area include Kaiser Sand and Gravel, Rhodes-Jamieson Company, and RMC Lonestar, Inc. Transportation costs are a major factor in the marketing of bulky, low cost commodities like sand and gravel. The extent and proximity of these deposits to the consumers throughout the Bay Area makes these a significant local and regional resource.

The CDMG (Stinson and others, 1987) has mapped portions of the project area as Mineral Resource Zones (MRZs) using the following definitions:

- MRZ-1: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- MRZ-2: Areas where adequate information indicates that significant aggregate deposits are present, or where it is judged that a high likelihood for their presence exists.
- MRZ-3: Areas containing aggregate deposits, the significance of which cannot be evaluated from available data.
- MRZ-4: Areas where available information is inadequate for assignment to any other MRZ.

Areas classified as MRZ-2 that also have existing land uses compatible with mining have been further delineated as Mineral Resource Sectors. Segments of the Proposed Project do not cross existing aggregate operations. Project Alternatives which would impact existing aggregate operations or reserves are the transmission lines of the D1 route, the S1 and S2 routes, the L2 route, the S4 route (where it coincides with S1), and a portion of the Stanislaus Corridor route.

Oil and Mineral Resources

The Livermore Oil Field, located east of Livermore, produced approximately 1.6 million barrels of oil between 1967 and 1987 (Darrow, 1988). As of 1987, the reserves within the Livermore Field were estimated at only 132,000 barrels remaining. Other dry exploratory wells are scattered elsewhere in the project area, but the complex subsurface geology needs to be better understood before it would be economical for further exploration. Remaining petroleum resources are considered to be deeply buried and very limited. Other potentially valuable mineral resources identified within the region include manganese, chromium, gemstones, pyrite, dimension stone, and natural gas (Bailey and Harden, 1975).

Coal and glass sand have been exploited from several mines within the Project area, but these mineral commodities are no longer economical to produce.

C.5.1.5.1 *Pleasanton Area Mineral Resources*

Mineral Resource Zones 2 and 3 have been mapped by the CDMG along the Proposed Route in the Pleasanton Area. MRZ-2 classification is found from approximately M5.2 to the Vineyard substation. Areas classified as MRZ-3 are found from approximately Mileposts M4.1 to M4.8. While the Proposed route overlies some MRZ-2 areas, the route does not cross existing gravel pits or areas designated as Mineral Resource Sectors. No significant mineral resources have been mapped at the Proposed transition structure site

The entire length of the S1 Alternative is mapped within either MRZ-2 or MRZ-3. The route is mapped as MRZ-3, south of Highway 84, and as MRZ-2 from Highway 84 to Vineyard substation. The route lies along the boundary of existing gravel pits west of Isabel Avenue, however, current residential construction to the east of this roadway.

The entire length of the S2 Alternative is mapped within either MRZ-1, MRZ-2 or MRZ-3. The route is mapped as MRZ-3, south of Highway 84 and along most of the remaining route from the northeast corner of the Ruby Hill Vineyard to Vineyard substation. The route is mapped as MRZ-2 from Highway 84 to the Ruby Hill Vineyard. Small portions of the route in Pleasanton are mapped as MRZ-1, near the Shadow Cliffs Park.

This S4 Alternative route connects with the S2 Alternative within an area mapped as MRZ-3, however, none of the remainder of the route has been mapped within a mineral resource zone.

C.5.1.5.2 *Dublin/San Ramon Area Mineral Resources*

No significant mineral resources have been mapped along the Proposed Dublin Area route or at the Proposed substation site.

The D1 Alternative substation site is located in an area mapped as MRZ-1, and the D1 Alternative route overlies areas mapped as MRZ-1, north of the Santa Rita Rehabilitation Center Annex, and MRZ-2, along private roads maintained by the gravel pit operators for transportation of their products.

The D2 Reconductoring route alternative overlies areas mapped as MRZ-1, in the San Ramon and Dougherty Creek valleys, and MRZ-4, in the Dougherty Hills and hills east of Dougherty Creek. The area near the D2 substation alternative has not been mapped for mineral resources.

C.5.1.5.3 *North Livermore Area Mineral Resources*

No significant mineral resources have been mapped along the Proposed North Livermore route and the Proposed Substation site, or along the P1, P2, or L1 alternatives.

The L2 Alternative substation site is located in an area mapped as MRZ-4. The L2 Alternative route is within an area mapped as MRZ-2 between Stanley Boulevard and the sewage treatment plant and an area mapped as MRZ-3 from the sewage treatment plant to Arroyo Las Positas.

C.5.1.5.4 *Tesla Connection Mineral Resources*

North Area (PG&E's Phase 2)

Although manganese, gemstone, and limestone deposits have been identified in the Altamont Hills east of Livermore, no mapped deposits are crossed by the Proposed Phase 2 route.

No significant mineral resources have been mapped along the North Area Brushy Peak alternative.

South Area (Stanislaus Corridor)

Mineral Resource Zones 2 and 3 have been mapped by the CDMG along the Stanislaus Corridor route. The MRZ-2 classification is found from approximately Mileposts V10.2 to V10.8, and V13.3 to V13.6. Areas classified as MRZ-3 are found from approximately Mileposts V9.0 to V10.2, V10.8 to V10.9, V11.9 to V13.3, and V13.6 to V13.9. The Stanislaus Corridor Alternative route does not cross existing gravel pits or areas designated as Mineral Resource Sectors. Although manganese, gemstone, and limestone deposits have been identified in the Altamont Hills east of Livermore, no mapped deposits are crossed by the Stanislaus Corridor Alternative route.

C.5.1.6 Paleontologic Resources

Known paleontologic resources occur as localized sites in specific geologic formations, which are widely distributed throughout the Tri-Valley area, however, no paleontological sites of significance are known to exist within the project area.

C.5.1.7 Applicable Regulations, Plans, and Standards

Geologic resources and geotechnical hazards are governed primarily by local jurisdictions. The conservation and seismic safety elements of General Plans for the cities of Dublin, Livermore, Pleasanton, and San Ramon, and for Alameda and Contra Costa counties, contain policies for the protection of unique geologic features and avoidance of geologic hazards. The General Plans specifically address construction requiring that they be placed underground wherever feasible. The City of Livermore Community General Plan (1998) specifically calls for major utility lines to cross faults at right angles, or nearly so, and be equipped with safety features to accommodate fault offset with minimal disruption of service, providing access for rapid repair. Local grading ordinances establish detailed procedures for excavation and earthwork required during trenching. In addition, building codes in each jurisdiction establish standards for construction of above ground structures and foundations, generally in accordance with the UBC.

In California, the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupation to avoid the hazard of surface fault rupture. This Act and supplemental amendments groups faults into the categories of active, potentially active, and inactive. Historic and Holocene age faults are considered active, Late Quaternary and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geotechnical explorations in order to determine that building setbacks might be established.

The impact assessments were developed based on a geologic, soils, and geotechnical engineering evaluation of the Proposed Project and each Alternative. The assumptions and justification for site-specific assessments are explained in the following sections.

C.5.2 ENVIRONMENTAL IMPACT ANALYSIS AND APPLICANT PROPOSED MEASURES

C.5.2.1 Definition and Use of Significance Criteria

Geologic and soil conditions were evaluated with respect to the impacts the project may have on the local geology, as well as the impact specific geologic hazards may have upon the proposed substations and their related facilities. The standards of significance for these impacts were derived from Appendix G of the CEQA Guidelines and Appendices, thresholds of significance developed by local agencies, government codes and ordinances, and requirements stipulated by California Alquist-Priolo statutes. Significance criteria and methods of analysis were also based on standards set or expected by governing agencies for the evaluation of geologic hazards as outlined by the CDMG in Special Publication 117 (1997).

Impacts of the Proposed Project on the geologic environment would be considered significant if:

- Unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by the substations and alignments and consequent construction activities
- Known mineral and/or energy resources would be rendered inaccessible by substation and construction
- Agricultural soils would be converted to non-agricultural uses
- Geologic processes, such as landslides or erosion, could be triggered or accelerated by construction or disturbance of landforms
- Substantial alteration of topography would be required or could occur beyond that which would result from natural erosion and deposition.

Impacts of the following geologic hazards on the Proposed Project would also be considered significant if:

- High potential for ground rupture due to presence of an active earthquake fault crossing substations or transmission line routes with attendant potential for damage to the substations, transmission lines, or other project structures
- High potential from earthquake-induced ground shaking to cause liquefaction, settlement, lateral spreading and/or surface cracking within substations or along the transmission line routes, resulting in probable attendant damage to one of the Proposed substations, transmission lines, or other project structures

- Potential for failure of construction excavations or underground borings due to the presence of loose saturated sand or soft clay
- Presence of corrosive soils which would damage substations, underground portions of transmission lines or their support structures.

C.5.2.2 Applicant Proposed Measures

The PEA describes geotechnical and seismic hazards and their impacts. PG&E Co.'s proposed measures to reduce each impact are presented in Table C.5-2. These impacts have been divided into the project phases: construction, and operation and maintenance.

Table C.5-2 Applicant Proposed Measures

Impact	Measure
Impacts during Construction	
Soft or Loose Soils	**13.1** PG&E Co. will perform design-level geotechnical studies to evaluate the potential for and effects of soft or loose soils, which will be over-excavated during construction and replaced with engineered backfill or other ground treatment. Where necessary, construction activities will be limited to the dry season. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Erosion	**13.2** PG&E Co. will develop an Erosion Control Plan which will be implemented throughout the construction period. Erosion control measures will include avoiding disturbance of steep slopes, using drainage control, controlling vehicular traffic, implementing dust control, and revegetating disturbed areas following construction.
Slope Instability and Unstable Soil Conditions	**13.3** PG&E Co. will use appropriate design features and construction procedures to maintain stable slope configurations during construction. Construction activities will be suspended during and immediately following periods of heavy precipitation. Development of grading plans and construction procedures will address access roads, substations, transmission towers, and the stability of temporary and permanent cut, fill, and otherwise impacted slopes. A design-level geotechnical investigation will be performed to evaluate subsurface conditions, identify potential hazards, and provide information for development of excavation plans and procedures to limit ground deformation, and protect the public and workers' safety during trenching and excavating operations. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Paleontologic Resources	**13.4** PG&E Co. will contact a qualified paleontologist to examine and determine the significance of any fossils encountered during construction. If the find is deemed to have scientific value, the paleontologist and PG&E Co. will devise a plan to either avoid impacts or continue construction without disturbing the integrity of the find.
Mineral Resources	**13.5** PG&E Co. has developed their Proposed Project to avoid areas within specially designated mineral resource sectors. Aggregate and other mineral resources are known to exist beneath existing facilities of the Pleasanton Area and the Tesla-Newark transmission corridor, however these facilities lie outside specially designated mineral resource sectors and mitigation is not required.
Impacts during Operation and Maintenance	
Ground Subsidence	**13.6** PG&E Co. will evaluate the potential for subsidence due to compaction from groundwater withdrawal, strong ground motions, and the presence of soft, loose compressible soils during design-level geotechnical investigations. The need to place additional fill or construct berms to reduce potential flooding from past subsidence will be evaluated and incorporated into design and construction plans. PG&E Co. will remove or rework near surface deposits likely to experience settlement prior to placing new fill. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Settlement	**13.7** PG&E Co. will conduct a design-level geotechnical investigation to evaluate the potential for settlement of approved project facilities. The results of the investigation will be used to develop appropriate foundation and structural designs to accommodate expected settlements. Soils found to be potentially susceptible during the investigation may be excavated, removed and replaced with engineered fill. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Expansive, Soft, or Loose Soils	**13.8** PG&E Co. will conduct design-level geotechnical studies to develop appropriate design features for locations where potential problems are known to exist. Appropriate design features may include excavation of problematic soils and replacement with engineered backfill, ground treatment processes for densification of soft or loose soils, direction of surface water and drainage away from foundation soils, and the use of deep foundations such as piers or piles. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Slope Instability, Landslides,	**13.9** PG&E Co. will perform a design-level geotechnical survey to evaluate the potential for unstable slopes, landslides, mudflows, and debris flows along the approved routes. Facilities will be located away from steep hillsides, debris flow

Table C.5-2 Applicant Proposed Measures

Impact	Measure
Mudflows, or Debris Flows	source areas, the mouths of steep sidehill drainages, and the mouths of canyons that drain steep terrain. Specially designed deep foundations may be used in areas of shallow sliding where unstable slopes cannot be avoided. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Surface Fault Rupture	**13.10** PG&E Co. addressed the overhead crossings of four mapped faults with mitigation measures as follows: **Elk Ravine Fault:** Pre-Quaternary inactive fault; avoidance of mapped fault traces beneath transmission tower locations will avoid the hazard. **Greenville Fault:** Historically active fault; performance of geotechnical investigations at tower foundation sites to locate and avoid potential for surface fault rupture, design transmission lines to accommodate potential fault displacement. **Pleasanton Fault:** Holocene active fault; Proposed Project not located across or adjacent to fault. **Verona Fault:** Holocene active fault; performance of geotechnical investigations at tower foundation sites to locate and avoid potential for surface fault rupture, design transmission lines to accommodate potential fault displacement. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.
Strong Ground Motions	**13.11** Some types of substation equipment are very susceptible to damage from earthquakes. To address this problem, PG&E Co. in conjunction with other utilities throughout the United States and Canada, and equipment vendors and consultants, have revised IEEE 693, "Recommended Practices for Seismic Design of Substations." Within this document are equipment and voltage-specific seismic qualification requirements. These requirements are much more stringent than those in the Uniform Building Code. Qualification includes shake table testing and dynamic analysis. PG&E Co. will purchase equipment for the substation using the seismic qualification requirements in IEEE 693. When these requirements are followed, very little structural damage from levels approaching 1.0 g peak ground acceleration are anticipated. PG&E Co. will design all substation control buildings in accordance with the Uniform Building Code.
Liquefaction and Seismic Ground Failure	**13.12** PG&E Co. will perform design-level geotechnical investigations to evaluate the liquefaction potential of soils underlying all substation, transition station, Transmission tower, and underground sites. Analysis of existing data will examine the possibility of liquefaction, and develop appropriate engineering design and construction measures including pile foundations, ground improvement of liquefiable zones by densification, flexible bus connections, and slack in underground cables to allow ground deformations without damage to structures. Incorporation of standard engineering practices as part of the project shall ensure that people or structures are not exposed to geological hazards.

C.5.3 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Geotechnical hazards and conditions that exist within the project area or could result from construction related excavation, trenching, backfilling, and grading activities during construction of the Proposed Project include the following:

- Ground subsidence
- Settlement
- Expansive, soft, or loose soils
- High groundwater levels
- Erosion potential
- Topography changes or unstable soil conditions from excavation, grading, or fill
- Slope instability, landslides, mudflows, or debris flows
- Corrosive soils
- Unique geological or physical features
- Paleontologic resources
- Mineral resources

These conditions or hazards may affect the long-term performance of building and equipment foundations and pavements due to settlements or ground cracking during the life of the project. Some of these hazards also constitute a hazard to workers during construction of the project facilities. Most of these geologic and geotechnical hazards are found to differing extent in all of the Proposed Project areas, therefore, hazards are addressed as generally applicable impacts below. Where a potential hazard is primarily applicable to a particular location, that location is described in the applicable section.

C.5.3.1 Construction Impacts for All Alternatives

Impact 5-1: Expansive, Soft, or Loose Soils. Expansive clay-rich soils may shrink or swell with changes in water content. Some soils present beneath the Proposed route alignments have high clay contents, and are described as having a moderate to high shrink-swell potential. In particular, soils of the Altamont, Pescadero, Cropley, Los Osos, Positas, Diablo, Clear Lake, and Rincon soil series developed on a wide range of deposits, all have high shrink-swell potential. In addition, saturated loose sands and soft clays may pose difficulties in access for construction and in excavating for foundations for poles or piers. Unconsolidated sands and gravelly sands may also pose a problem for foundations, especially where the water table is shallow.

If the project design does not adequately anticipate soil conditions, there is potential for tilting or misalignment of towers and/or substation equipment, particularly at the Proposed North Livermore substation site. Implementation of design-level investigation, engineering, and appropriate construction practices identified in PG&E Co.'s Measures 13.1 and 13.8 should ensure that the impact of expansive, soft, and loose soils is less than significant (**Class III**).

Impact 5-2: Erosion. The potential for erosion significantly increases as slopes become steeper and less vegetated. Fine-grained soils can rapidly develop rilling once vegetation is removed, and this effect can be exacerbated by the application of water for dust control. PG&E Co.'s development and implementation of an Erosion Control Plan, as identified in Applicant Proposed Measure 13.2, to be maintained throughout the project construction period should ensure that this impact is less than significant (**Class III**).

Impact 5-3: Slope Instability and Unstable Soil Conditions. Destabilization of natural or constructed slopes could occur as a result of construction activities, and from loading of unstable slopes with heavy construction equipment and project facilities. Excavation, grading, and fill operations could alter existing slope profiles and could result in the excavation of slope-supporting material, steepening of the slope, or increased loading, particularly at the Proposed transition structure site in the hills south of Pleasanton.

Implementation of PG&E Co.'s Measure 13.3, which includes design-level geotechnical investigations, appropriate engineering, and construction practices as controls for areas with high landslide potential and suspension of construction activities during and immediately following periods of heavy precipitation should ensure these impacts are less than significant (**Class III**).

C.5.3.1.1 *Operation and Maintenance Impacts for All Alternatives*

Geotechnical Hazards and Soils

Impact 5-4: Ground Subsidence and Settlement. Subsidence is the settling of the ground surface caused by compaction of underlying unconsolidated sediments, often because of groundwater withdrawal. Ground subsidence can also cause relative elevation changes within an area, increasing the potential for inadequate drainage or flooding. Subsidence can also be caused by strong ground motions, and the presence of soft, loose, or compressible soils. With implementation of site-specific geotechnical investigations and incorporation of standard engineering practices as part of the project, as proposed in PG&E Co.'s Measure 13.6 and 13.7, impacts from subsidence and settlement should be less than significant (**Class III**).

Impact 5-5: Corrosive Soils. The corrosion potential in the native soils of the Altamont, Clear Lake, Cropley, Diablo, Los Osos, Pescadero, Rincon, and San Ysidro soil series is high throughout much of the project area and could impact the chemical stability of concrete and uncoated steel used in support structures and underground conduit. The corrosivity of a soil is an estimate of the potential for soil-induced chemical action that dissolves or weakens the structural materials. Corrosion potential is based mainly on the texture and acidity of the soil.

Mitigation Measure for Corrosive Soils Impact

G-1. PG&E Co. should perform corrosivity testing on a site-specific basis for each support structure to be located within areas mapped as having high potential for corrosive soils by the USDA. Remediation measures or soil treatment procedures shall be implemented on a site-specific basis dependent upon the soil test results.

Implementation of this mitigation measure should ensure that the impact of this hazard remains a less than significant (**Class III**).

Seismic Hazards

Seismic hazards include potential surface fault rupture, strong vibratory ground motions from local and regional seismic sources, and liquefaction-related ground deformation.

Impact 5-6: Surface Fault Rupture. Large, abrupt differential fault displacements comprise a minor earthquake hazard for the Proposed Project at fault crossings of the Greenville, Las Positas, Pleasanton, Verona, Corral Hollow, Patterson Pass, and Elk Ravine faults. In general, the hazard posed by earthquake surface rupture to overhead transmission lines is only imposed on the support structures, because of the ability of the lines to accommodate the offset. Implementation of the mitigation measures identified in PG&E Co.'s Measure 13.10, which includes site-specific studies at tower locations potentially exposed to surface rupture hazard and relocation of towers, as necessary, will reduce these hazards to a less than significant level (**Class III**). The hazards imposed by each of these faults is discussed separately below.

The Proposed Project's Phase 2 route crosses the active Greenville fault zone between Mileposts B9.4 to B10.4. The Stanislaus Corridor Alternative route crosses the Greenville fault zone between Mileposts V6.1 to V6.5. PG&E Co.'s Measure 13.10 proposes geotechnical investigations for tower locations along the Proposed Project route to evaluate the potential for surface rupture. Where significant potential for surface rupture exists, tower locations will be adjusted. Application of this measure to the Stanislaus Corridor Alternative crossing of this fault should reduce the hazard of surface fault rupture to a less than significant (**Class III**) level.

The Stanislaus Corridor Alternative route crosses the active Las Positas fault zone at approximately Milepost V9.9. The mapped traces outside the fault zone extend parallel to the route between approximately Mileposts V10.9 and V17. PG&E Co.'s Measure 13.10 proposing geotechnical investigations at tower locations to evaluate the potential for surface rupture should be applied in these areas. Where significant potential for surface rupture exists, tower locations should be adjusted. Application of this measure to the Stanislaus Corridor Alternative crossings of this fault zone should reduce the hazard of surface fault rupture to a less than significant (**Class III**) level.

The Proposed Project's South Area connection with the Stanislaus Corridor (Phase 2) crosses the trace of the Verona fault and its Alquist-Priolo Earthquake Fault Zone between approximately Mileposts M0.0 and M0.4 (CDMG, 1982e). Application of PG&E Co.'s Measure 13.10 and resultant avoidance of areas with evidence of fault rupture should reduce the hazard of surface fault rupture to a less than significant (**Class III**) level.

The Corral Hollow fault is an early-Quaternary fault located in the Altamont Hills west of the Tesla Substation at Midway. The Stanislaus Corridor Alternative connection to the Tesla Substation crosses the trace of this fault mapped by Dibblee (1980a,g) near Milepost V4.8. Application of PG&E Co.'s Measure 13.10 proposing the use of standard engineering practices and avoidance of areas with evidence of fault rupture to this Alternative's fault crossing should reduce the hazard of surface fault rupture to a less than significant (**Class III**) level.

The Patterson Pass fault is a pre-Quaternary fault located in the Altamont Hills west of the Tesla Substation at Midway. The Stanislaus Corridor Alternative connection to the Tesla Substation crosses the trace of this fault mapped by Dibblee (1980g) near Milepost V3.8. The absence of evidence for Quaternary displacement makes it likely that the fault is inactive. As a result, the potential impact of surface rupture is considered to be less than significant and mitigation is not required.

The Elk Ravine fault is a pre-Quaternary fault located in the Altamont Hills west of the Tesla substation at Midway. The Proposed North Area and South Area connections to the Tesla substation cross traces of this fault mapped by Dibblee (1980g) near Milepost B2.8 along the North Area and near Mileposts V1.5 and V2 along the South Area connections. The lack of evidence for Quaternary displacement makes it likely that the fault is inactive. As a result, the potential impact of surface rupture is considered to be less than significant and mitigation is not required.

None of the Proposed Project routes crosses the Pleasanton fault within its Alquist Priolo Fault Hazard Zone, however, a segment of the Pleasanton fault outside of the Fault Hazard Zone is crossed by the D2 Alternative's underground segment. This is a **Class II** impact, with implementation of Mitigation Measure G-2 below.

The potentially active Livermore and West Branch Livermore faults (DWR, 1966; Jennings, 1994) pass beneath the L2 Alternative underground alignment along Isabel Avenue near the airport and sewage treatment plant. The Seismic Safety Element of the City of Livermore's General Plan requires a comprehensive geologic and engineering study of critical structures, including "utility centers and substations", regardless of location. This element includes a requirement that active faults be crossed at right angles and that vaults be incorporated into fault crossing design to accommodate potential displacements and allow access for rapid repair. This fault crossing is a potentially significant impact, mitigable to less than significant levels (**Class II**), with implementation of Mitigation Measure G-2.

Mitigation Measure for Surface Fault Rupture (Impact 5-6). For the D2 and L2 Alternatives, there would be crossings of the active Pleasanton fault and potentially active Livermore and West Livermore faults, respectively. These fault crossings could result in damage to the underground transmission line during an earthquake on these faults. Incorporation of Mitigation Measure G-2in the project design will reduce the impact of the underground fault crossings to less than significant (**Class II**).

G-2 For underground transmission line crossings of the Livermore, West Livermore, and Pleasanton faults, PG&E Co. shall comply with the City of Livermore's General Plan by designing the fault crossings to be at right angles to the fault and by constructing vaults at these crossings to accommodate potential displacements and allow access for rapid repair. If PG&E Co. considers these design measures to be infeasible or otherwise inappropriate, a geotechnical report documenting the fault crossing design shall be submitted for review and approval to the CPUC and the local jurisdiction. This report shall be submitted at least 30 days prior to the start of construction.

Impact 5-7: Strong Ground Shaking. Strong earthquake-induced ground shaking can result in significant damage to above ground structures. However, transmission lines and support structures can withstand strong ground shaking and moderate ground deformations; therefore, the potential impact from seismic ground shaking on transmission lines would be less than significant, and mitigation is not required. Implementation of PG&E's commitment to conform with IEEE 693 standards for seismic safety of substation sites (Measure 13.11) would reduce the risk of damage from strong ground shaking to a significant but mitigable (**Class II**) level.

Impact 5-8: Liquefaction Potential. Liquefaction-related hazards to the project include lateral spreading and differential ground settlement. Liquefaction can cause ground deformation at the surface including lateral spreading, differential compaction or settlement, and sand boils. Possible impacts to the project include liquefaction-induced failure of stream banks. Loss of bearing strength and ground movements associated with liquefaction may result in damage to project structures.

Deposits potentially susceptible to liquefaction are present throughout the valley bottom area; however, the greatest liquefaction hazard is within alluvial and fluvial deposits along Arroyo Las Positas and Arroyo Valle. These deposits have a moderate to high likelihood of undergoing liquefaction during long-duration, strong ground motion exceeding 0.2 g peak ground acceleration. Liquefaction hazards are greatest along the Proposed route where it closely approaches creek beds

Generally, substation facilities can tolerate ground deformations on the order of a few inches without damage to equipment or structures. Implementation of the design level geotechnical investigations and appropriate engineering and construction measures described in PG&E Co.'s Measure 13.12 should reduce potential impacts to a less than significant level (**Class III**).

Impact 5-9: Seismic Dam Failure. The hazard of seismic failure of Del Valle Dam, however improbable, could affect the Proposed Project facilities and the surrounding area. In the event of the seismic failure of Del Valle Dam, leading to the catastrophic draining of the reservoir, the project facilities most affected would be the Stanislaus Corridor Alternative's crossing of Arroyo Valle, the S1 and S2 Alternative alignments along East Vineyard and Vineyard Avenue adjacent to Arroyo Valle, the S1 and L2 Alternatives' crossing of Arroyo Valle along Isabel Avenue, the Proposed Project's crossing of Arroyo Valle south of Vineyard Substation, and Vineyard Substation itself, situated adjacent to Arroyo Valle.

In a worst-case scenario, the flood waters would inundate the Stanley Boulevard portion of Alternative S1, the L2 Alternative along Isabel Avenue, the D1 Alternative substation site (Dublin), and the San Ramon Substation. All these project facilities are within the catastrophic failure flood zone. The extent of damage to project facilities would be dependent upon the rate of discharge of the reservoir capacity, as well as the reservoir level prior to failure, with the level of damage increasing to nearby facilities as the extent of the damage increased. The impact of seismic dam failure is a significant, unmitigable **(Class I**) impact on the Proposed Project and its alternatives.

C.5.4 MITIGATION MONITORING PROGRAM

Table C.5-4 presents the mitigation monitoring program for geology, soils, and paleontologic resources.

Table C.5-4 Mitigation Monitoring Program for Geology and Soils

Impact	Mitigation Measure	Location	Monitoring/Reporting Action	Effectiveness Criteria	Responsible Agency	Timing
Proposed Project and All Alternatives						
Corrosive soils (Class III)	**G-1** Conduct design-level geotechnical testing in areas classified as having moderately to highly corrosive soils. Amend soils found to be corrosive to concrete.	Areas with moderately to highly corrosive soils	Approve geotechnical report and foundation designs	Plan/design prevents corrosion of facilities/foundations to extent feasible	CPUC, local planning agencies	Prior to construction
Crossings of active or potentially active faults by underground transmission line (Class II)	**G-2** For underground transmission line crossings of the Livermore, West Livermore, and Pleasanton faults, PG&E Co. shall comply with the City of Livermore's General Plan by designing the fault crossings to be at right angles to the fault and by constructing vaults at these crossings to accommodate potential displacements and allow access for rapid repair. If PG&E Co. considers these design measures to be infeasible or otherwise inappropriate, a geotechnical report documenting the fault crossing design shall be submitted for review and approval to the CPUC and the local jurisdiction. This report shall be submitted at least 30 days prior to the start of construction.	Crossings of Livermore, West Livermore, and Pleasanton faults	Review and approve geotechnical report	Report documents appropriate fault crossing engineering	CPUC, local planning agencies	At least 30 days prior to construction

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