5.6 Geology and Soils

GEOLOGY AND SOILS Would the project:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
a. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic groundshaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
iv) Landslides?	☐	☐	☐	☒
b. Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c. Be located on geologic units or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d. Be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2010), creating substantial risks to life or property?	☐	☐	☐	☒
e. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

Significance criteria established by CEQA Guidelines, Appendix G. Question (d) reflects the current 2010 California Building Code (CBC), effective January 1, 2011, which is based on the International Building Code (2009).

5.6.1 Setting

This section describes geology, soils, seismic, and mineral resource conditions and analyzes environmental impacts related to geologic and seismic hazards that are expected to result from the implementation of the Proposed Project. The following discussion addresses existing environmental conditions in the affected area, identifies and analyzes environmental impacts, and recommends measures to reduce or avoid adverse impacts anticipated from Project construction and operation. In addition, existing laws and regulations relevant to geologic and seismic hazards are described. In some cases, compliance with these existing laws and regulations would serve to reduce or avoid certain impacts that might otherwise occur with the implementation of the Project.

Baseline geologic, seismic, and soils information were collected from published and unpublished literature, GIS data, and online sources for the Proposed Project and the surrounding area. Data sources included the following: the Proponent's Environmental Assessment (PG&E, 2012a), geologic literature from the U.S. Geological Survey (USGS) and California Geological Survey, geologic and soils GIS data, and online reference materials. The study area was defined as the locations of project components and the areas of San Francisco and the bay immediately adjacent to the Proposed Project for most geologic and soils issue areas with the following exception: the study area related to seismically induced ground shaking includes significant regional active and potentially active faults within 50 miles of the Proposed Project.

Regional Geologic Setting

The Embarcadero-Potrero project area is located in the western portion of the Coast Ranges Geomorphic Province of California. Past episodes of tectonism have folded and faulted the rock of the Coast Ranges creating the regional topography of northwest-trending ridges and valleys that is characteristic of this province. The San Francisco Bay and other local topographic depressions have been subsequently filled with various marine, estuarine, alluvial, and wind-blown sediments. Basement rock in the region is comprised of Franciscan Complex rocks of Jurassic and Cretaceous age that form the bedrock both east and west of the San Andreas fault on the San Francisco Peninsula. The Franciscan Complex consists of an intermixed assemblage of volcanic, sedimentary and low grade metamorphic rocks that accumulated along and were subsequently highly deformed in the boundary between two converging tectonic plates.

Local Geology

The onshore segments of the Proposed Project are located within the former Mission Bay area of eastern San Francisco. The Mission Bay area historically was a small embayment of the San Francisco Bay consisting of shallow water, tidal flats, and marshland. Placement of artificial fill with the Mission Bay area began in the late 1800's and continued into the early 20th century. Some of the central portions of Mission Bay reportedly were filled with debris from the City following the 1906 earthquake and fire. As part of PG&E's Feasibility Study for the Proposed Project, AMEC prepared a geotechnical evaluation report for the onshore segments of the Project which included review of existing borings and conducting field exploration (AMEC, 2012). Review of the local geologic maps (USGS, 2000a and 2000b) and AMEC's report indicate that the subsurface geologic units beneath the onshore project components include three primary geologic units, as shown in Figure 5.6-1, Geologic Map. The offshore portion of the Proposed Project is entirely underlain by Bay Mud. The HDD transitional portion of the alignments would pass through Bay Mud, older alluvial sediments beneath the Bay Mud, and artificial fill as they transition onto land. The geologic units are described below, in general order of youngest to oldest.

Artificial Fill. Artificial fill is found along both the northern and southern segments of the onshore alignment. Thickness of the fill is expected to range from 10 to about 25 feet (AMEC, 2012). Due to the age and undocumented nature of much of the artificial fill in the Mission Bay area, the characteristics and distribution of it is likely to vary along the segment alignments. Generally the artificial fill is comprised varying amounts of sand, clay, and gravel, with local areas of man-made debris such as lumber, concrete and brick fragments, and industrial slag materials. Consistency of the clays range from soft to very stiff, and density of the sands range from very loose to medium dense (AMEC, 2012). Serpentinite gravel in the fill is likely sourced from the nearby and underlying Franciscan Complex bedrock.

Dune Sand. A small portion of the northern onshore segment is underlain by Quaternary aeolian deposits, Dune Sands, with thickness ranging from 0 to 20 feet near the alignment (AMEC, 2012). The Dune Sand deposits generally comprised of light gray to light brown, fine to medium grained, loose to medium dense sand.

Young Bay Mud. Holocene (Young) Bay Mud deposits may be encountered during trenching for the transmission line in areas of thin artificial fill and will be encountered by the HDD transitional borings. Young Bay Mud ranges in thickness from 0 to about 110 feet and typically consists of organic-rich, compressible silts and clays deposited within the bay basin and along the margins of the basin and along its margins as mud or tidal flats. The silts and clays of the Young Bay Mud are high plasticity, very soft to soft clay and silt, with local lenses of sand, shells, and peat. It is typically dark gray to dark greenish gray, and commonly has layers with abundant organic debris such as leafs, wood fragments, rootlets, and shell fragments.

Young Bay Mud within 10 to 20 feet below the San Francisco Bay floor in the vicinity of the offshore segment of the Proposed Project generally shows horizontal sediment layers characteristic of inter-bedded silt and clay deposits with some sand and is expected to be soft to very soft (B&V, 2012).

Older Alluvial Sediments. Older alluvial deposits are found beneath the Young Bay Mud and vary in thickness. The older alluvial sediments are typically composed of interbedded layers of sand and clay with varying amounts of sand, silt, and clay. The sand layers are generally dense to very dense and the clays are very stiff. Colors are typically olive and olive brown, but also include brown, dark gray, and greenish gray (B&V, 2012).

Franciscan Complex Bedrock. Serpentinite is mapped along southern onshore segment of the Proposed Project and near to the northern onshore segment. Serpentinite is expected to be encountered at the surface along the southern onshore segment; serpentinite at and near the surface is commonly. Serpentinite is encountered within a foot of the ground surface in the northeastern portion of project area near Embarcadero Substation (B&V, 2012), and is expected to be encountered fairly shallowly beneath the artificial fill along portions of the northern onshore segment. The degree of weathering ranges from severe to locally fresh and resistant. The severely weathered rock is generally soft and weathered to clay, and the fresh and resistant rock is generally hard with little clay development. The serpentinite is usually light olive gray, olive gray, and grayish green (B&V, 2012).

Soils

Soils within the Proposed Project area reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of human modification. Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variations in soil moisture content. Changes in soil moisture can result from rainfall, landscape irrigation, utility leakage, roof drainage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay.

Based on the NRCS Web Soil Survey the soil units underlying proposed onshore project components are mapped as Urban land and Urban land-Orthents, reclaimed complex (NRCS, 2013). These areas are almost completely covered by concrete, asphalt and other urban structures or are primarily made up of fill of varying compositions. These areas have very little to no data associated with them in the NRCS databases.

An evaluation of borings logs and CPT soundings prepared for this and previous investigations conducted by AMEC (2012) indicates that the fill sediments underlying the onshore portion of the project are primarily comprised of granular sediments ranging from sand to sandy silt. These granular soils are not expected to exhibit any shrink swell behavior.

Slope Stability

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

The project alignment traverses flat to relatively flat topography and no known landslides occur in the immediate project vicinity, therefore landslides and other slope failures would not occur.

Seismicity

The San Francisco Bay Area is in a seismically active region near the boundary between two major tectonic plates, the Pacific Plate to the southwest and the North American Plate to the northeast. The relative movement between the Pacific Plate and the North American Plate generally occurs across a 50-mile zone extending from the San Gregorio fault in the southwest to the Great Valley Thrust Belt to the northeast. Strain produced by the relative motions of these plates is relieved by right lateral strike slip faulting on the San Andreas Fault Zone and related faults (San Gregorio, Calaveras, Hayward), and by vertical reverse slip displacement on the Great Valley and other thrust faults in the central California area.

Strong ground shaking at the project sites could occur as a result of an earthquake on any one of the active regional faults shown in Figure 5.6-2, Regional Active Fault Map. The San Andreas fault, the dominant tectonic feature of the San Francisco Peninsula, is the primary structure within the broad transform boundary that accommodates right lateral motion between the North American and Pacific tectonic plates. Movement of these plates is primarily translated in the Bay Area as right lateral slip along the San Andreas Fault Zone. The USGS Working Group on California Earthquake Probabilities concluded that there is a 62 percent probability of a strong earthquake (Magnitude $M \geq 6.7$) occurring in the San Francisco Bay Region in a thirty year period between 2003 and 2032 (WGCEP, 2003). Additionally the 2007 Working Group on California Earthquake Probabilities (WGCEP, 2008) has concluded that within the next 30 years the probability of a strong earthquake ($M \geq 6.7$) occurring on regional faults is as follows: 21 percent for the Northern San Andreas Fault Zone, 31 percent for the Hayward-Rodgers Creek Fault Zone, and 6 percent for the San Gregorio Fault.

The San Francisco Bay Area is characterized by numerous geologically young right-lateral strike slip and normal-right oblique slip faults due to this combination of translational and extensional stress. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999):

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

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area through the lifetime of the Proposed Project, the effects of strong groundshaking and fault rupture are of primary concern to safe operation of the project components.

The nearest fault to the project site is the northern segment of the San Andreas Fault, passing about 7.5 miles to the west of the Proposed Project. Active and potentially active faults within 50 miles of the Project alignments that are significant potential seismic sources relative to the Proposed Project are presented in Table 5.6-1.

Table 5.6-1. Significant Active and Potentially Active Faults within 50 miles of the Proposed Project

Fault Name	Closest Distance[a] (miles)	Closest Project Component(s)	Estimated Maximum Magnitude[b]
San Andreas (Peninsula)	7.5	Southern Onshore Segment & Potrero Switchyard	7.2 to 7.8
Hayward-Rodgers Creek	9.6	Offshore Segment	6.6 to 7.3
San Gregorio	11.6	Southern Onshore Segment & Potrero Switchyard	7.5
Mount Diablo Thrust	19.9	Offshore Segment	6.7
Calaveras	20.3	Offshore Segment	6.3 to 7.0
Concord	22.7	Offshore Segment	6.2
Green Valley	23.0	Northern Onshore Segment and Offshore Segment	6.8
Monte-Vista Shannon	23.2	Southern Onshore Segment & Potrero Switchyard	6.5
West Napa	27.0	Northern Onshore Segment	6.7
Greenville	30.8	Offshore Segment	7.0
Great Valley 5	33.6	Northern Onshore Segment	6.7
Great Valley 4	41.9	Northern Onshore Segment	6.8
Great Valley 7	47.1	Southern Onshore Segment	6.9

[a] Fault distances obtained from USGS GIS Quaternary fault data (USGS and CGS, 2006) and 2008 National Seismic Hazard Maps – Fault Parameters website (USGS, 2013).

[b] Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF08-1128 (Documentation for the 2008 Update of the U.S. National Seismic Hazard Maps) unless otherwise noted. Magnitude varies by rupture strategy, one or several segments of the fault rupturing in the same event.

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

Fault Rupture

Fault rupture is the surface displacement that occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture and displacement almost always follows preexisting faults, which are zones of weakness, however not all earthquakes result in surface rupture (i.e., earthquakes that occur on blind thrusts do not result in surface fault rupture). Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. In addition to damage caused by ground shaking from an earthquake, fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset leading to damage or collapse of structures across this zone.

While the closest fault to the project site is the active San Andreas fault, no known active or potentially active faults are mapped crossing or immediately adjacent to any project components. Therefore there is no potential for primary fault rupture to impact the project site.

Ground Shaking

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

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the Project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the Project area. Earthquakes occurring on faults closest to the Project area would most likely generate the largest ground motion. The intensity of earthquake induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). The USGS National Seismic Hazard (NSH) Maps were used to estimate approximate peak ground accelerations (PGAs) in the Proposed Project area. The NSH Maps depict peak ground accelerations with a 2 percent probability of exceedance in 50 years which corresponds to a return interval of 2,475 years and for a maximum considered earthquake. The estimated approximate peak ground acceleration from large earthquakes for the project area is 0.70 g, which corresponds to strong ground shaking.

A review of historic earthquake activity from 1800 to 2012 indicates that many earthquakes of M 6.0 or greater have occurred within 50 miles of the project route (NEIC, 2012). A summary of significant damaging earthquake events in the San Francisco Bay Area is presented in Table 5.6-2.

Table 5.6-2. Significant Historic Earthquakes

Date	Magnitude	Name, Location, or Region Affected	Associated Fault	Comments[a]
June 1838	Assumed between 6.8 and 7.4	San Francisco area	San Andreas	This earthquake is associated with probable rupture of the San Andreas fault from Santa Clara to San Francisco (approximately 37 miles). Walls were cracked at Mission Dolores and in Monterey.
October 8, 1865	6.5	Santa Cruz Mountains	San Andreas	Caused severe damage in New Almaden, Petaluma, San Francisco, San Jose, Santa Clara, and Santa Cruz resulting in $500,000 in property damage. Ground cracks, heaving, and subsidence were noted in several areas.
October 21, 1868	7.0	Hayward	Hayward	Felt throughout northern California and Nevada. Resulted in 30 deaths and $300,000 in property damage. Occurred on the Hayward fault with rupture from Berkeley to Fremont. Caused severe damage in the East Bay and San Francisco.
June 20, 1897	6.2	Gilroy	Calaveras	Felt from Woodland to San Luis Obispo. Resulted in building collapse in the Santa Clara Valley. Fissures were noted on the Calaveras fault southeast of Gilroy.
April 18, 1906	7.8	San Francisco Earthquake, San Francisco	San Andreas	This earthquake and the resulting fires caused approximately 3,000 deaths and $524 million in damage ($24 million from the earthquake alone). Destruction from this earthquake occurred at distances of up to 350 miles from the epicenter.
July 1, 1911	6.4	Morgan Hill	Calaveras	Located on the Calaveras fault, caused substantial damage in Gilroy and the Santa Clara Valley. Felt as far away as Reno, Nevada.

Table 5.6-2. Significant Historic Earthquakes

Date	Magnitude	Name, Location, or Region Affected	Associated Fault	Comments[a]
January 24, 1980	5.8	North of Livermore Valley	Greenville	Occurred on the Greenville fault with surface rupture of approximately nine miles. Resulted in numerous injuries and $11.5 million in property damage (primarily at Lawrence Livermore Laboratory).
April 24, 1984	6.2	Morgan Hill Earthquake, Morgan Hill	Calaveras	Earthquake was felt from San Francisco to Bakersfield and was located near the epicenter of the 1911 earthquake in Morgan Hill. Resulted in injuries and approximately $8 million in property damage.
October 17, 1989	6.9	Loma Prieta Earthquake, Santa Cruz Mountains	San Andreas	Largest earthquake to occur on the San Andreas fault since 1906. Resulted in 63 deaths, over 3,000 injuries, and an estimated $6 billion in property damage. Severe damage occurred from San Francisco to Monterey and in the East Bay, and included damage and destruction of buildings, roads, bridges, and freeways.

[a] Earthquake damage information primarily compiled from the National Earthquake Information Center and the Berkeley Seismological Laboratory websites. Estimates of property damage values are in dollars valued to the year of damage.

Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong ground shaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur. In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of ground shaking; and (c) the depth to groundwater.

According to the California Geological Survey (CGS) Seismic Hazard map for the City and County of San Francisco (CGS, 2001), a large portion of the onshore project area is located within a mapped area of potential liquefaction hazard zone as shown in Figure 5.6-3, Seismic Hazard Map. Along the onshore project alignments, groundwater levels are expected to be shallow; varying from 5 to 15 feet in depth with some seasonal variation (AMEC, 2012) and granular layers in the artificial fill underlying large portions of the project would be subject to earthquake induced liquefaction. The undocumented artificial fill placed on the bay margins are highly prone to liquefaction. Saturated granular layers with the artificial fills consisting of sands or silty sands would be highly susceptible to liquefaction. In addition, sand lenses within the Young Bay Mud deposits may also be susceptible to liquefaction. AMEC conducted a liquefaction analyses that indicated that in the Mission Bay area, liquefaction-induced settlement is likely to be in the range 6 to 12 inches, with an upper bound on the order of 18 inches.

The offshore segment of the route is not liquefaction prone due to the fine grained nature of the Young Bay Mud sediments. Liquefaction analysis conducted for PG&E's Feasibility Study indicated up to an inch or two of settlement associated with liquefaction induced volumetric compaction and up to several tens of inches of lateral seismic deformation may be possible (B&V, 2012).

Based on the history of liquefaction induced lateral spreading that occurred in the general project area in past earthquakes and the available subsurface data, AMEC estimated that in the near-shore areas where fill overlies Young Bay Mud the likely lateral spreading would be in the range of 0.5 to 3 feet, with an upper bound on the order of 6 feet (AMEC, 2012).

Applicable Standards and Regulations

Federal. The Clean Water Act establishes the basic structure for regulating discharges of pollutants into the Waters of the U.S. The Act authorized the Public Health Service to prepare comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries and improving the sanitary condition of surface and underground waters with the goal of improvements to and conservation of waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural and industrial uses. The Proposed Project construction would disturb a surface area greater than one acre; therefore, SCE would be required to obtain under Clean Water Act regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity. Compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP).

The International Building Code (IBC) is published by the International Code Council (ICC), the scope of this code covers major aspects of construction and design of structures and buildings, except for three-story one- and two-family dwellings and town homes. The International Building Code has replaced the Uniform Building Code as the basis for the California Building Code and contains provisions for structural engineering design. The 2009 IBC addresses the design and installation of structures and building systems through requirements that emphasize performance. The IBC includes codes governing structural as well as fire- and life-safety provisions covering seismic, wind, accessibility, egress, occupancy, and roofs.

The Institute of Electrical and Electronics Engineers (IEEE) 693 “Recommended Practices for Seismic Design of Substations” was developed by the Substations Committee of the IEEE Power Engineering Society, and approved by the American National Standards Institute and the IEEE-SA Standards Board. This document provides seismic design recommendations for substations and equipment consisting of seismic criteria, qualification methods and levels, structural capacities, performance requirements for equipment operation, installation methods, and documentation. This recommended practice emphasizes the qualification of electrical equipment. IEEE 693 is intended to establish standard methods of providing and validating the seismic withstand capability of electrical substation equipment. It provides detailed test and analysis methods for each type of major equipment or component found in electrical substations. This recommended practice is intended to assist the substation user or operator in providing substation equipment that will have a high probability of withstanding seismic events to predefined ground acceleration levels. It establishes standard methods of verifying seismic withstand capability, which gives the substation designer the ability to select equipment from various manufacturers, knowing that the seismic withstand rating of each manufacturer's equipment is an equivalent measure. Although most damaging seismic activity occurs in limited areas, many additional areas could experience an earthquake with forces capable of causing great damage. This recommended practice should be used in all areas that may experience earthquakes.

State. The California Building Code, Title 24, Part 2 (CBC, 2010) provides building codes and standards for design and construction of structures in California. The 2010 CBC is based on the 2009 International Building Code with the addition of more extensive structural seismic provisions. As the Proposed Project lies within ~~Seismic Zone 4~~a high seismic hazard area, provisions for design should follow the requirements of Chapter 16 of the CBC, which contains definitions of seismic sources and the procedure used to calculate seismic forces on structures.

The Alquist-Priolo Earthquake Fault Zoning Act of 1972, Public Resources Code (PRC), sections 2621–2630 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. While this act does not specifically regulate transmission and telecommunication lines; it does help define areas where fault rupture is most likely to occur. This Act groups faults into 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 geologic explorations in order to determine whether building setbacks should be established.

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter7.8, Division 2, sections 2690–2699.) directs the California Department of Conservation, Division of Mines and Geology [now called California Geological Survey (CGS)] to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and State agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones.

CPUC General Order 128 (Rules for Construction of Underground Electric Supply and Communication Systems) contains State of California rules formulated to provide uniform requirements for underground electrical supply and communication systems, to insure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of underground electrical supply and communication systems and to the public. General Order 128 is not intended as complete construction specification, but to embody requirements which are most important from the standpoint of safety and service. Construction shall be according to accepted good practice for the given local conditions in all particulars not specified in the rules. General Order 128 applies to (a) all underground electrical supply systems used in connection with public utility service; when located in buildings, the vaults, conduit, pull boxes or other enclosures for such systems shall also meet the requirements of any statutes, regulations or local ordinances applicable to such enclosures in buildings; and (b) all underground communication systems used in connection with public utility service located outside of buildings. General Order 128 applies to the following activities related to underground electrical supply and communication systems: Construction and Reconstruction of Lines, and Maintenance.

Local. The San Francisco General Plan Community Safety Element contains policies that require new structures built in areas where site conditions could pose hazards, such as liquefaction or landslide, to be constructed in ways that reduce those hazards. Policy 2-3 is to "consider site soils conditions when reviewing projects in areas subject to liquefaction or slope instability." Policy 2-9 is to "consider information about geologic hazards whenever City decisions that will influence land use, building density, building configuration or infrastructure are made" (City of San Francisco, 1997).

Applicant Proposed Measures

PG&E proposes to implement measures during the design, construction, and operation of the Proposed Project to ensure it would occur with minimal environmental impacts in a manner consistent with applicable rules and regulations. Applicant Proposed Measures (APMs) are considered part of the Proposed Project in the evaluation of environmental impacts. CPUC approval would be based upon PG&E adhering to the Proposed Project as described in this document, including this project description and the APMs, as well as any adopted mitigation measures identified by this Initial Study (see Table 5.6-3).

Table 5.6-3. Applicant Proposed Measures (APMs) Related Geology and Soils

APM Number	Issue Area
Geology and Soils	
APM GS-1	**Appropriate soil stability design measures implementation.** Based on available references, artificial fills, fine sands, silts, and bay mud are the primary soil types expected to be encountered in the excavated areas as project construction proceeds. Potentially problematic subsurface conditions may include soft or loose soils. Where soft, loose, or liquefiable soils are encountered during design studies or construction of the onshore portion of the route, appropriate measures will be implemented to avoid, accommodate, replace, or improve soft or loose soils and liquefaction hazards encountered during construction. Such measures may include the following: ▪ Locating construction staging and operations away from areas of soft and loose soil. ▪ Over-excavating soft or loose soils and replacing them with suitable non-expansive engineered fill. ▪ Increasing the density and strength of soft or loose soils through mechanical vibration and/or compaction. ▪ Treating soft or loose soils in place with binding or cementing agents. ▪ Construction activities in areas where soft or loose soils are encountered may be scheduled for the dry season, as necessary, to allow safe and reliable equipment access. ▪ Physical ground improvement such as in-situ soil mixing, drain piles, or sheet piles. ▪ Deepening of trench and/or the HDD to place the transmission line beneath liquefiable fills and/or potential for lateral spreading, where feasible.
APM GS-2	**Appropriate seismic safety design measures implementation.** As part of conceptual design investigation, site-specific seismic analyses were performed to evaluate PGAs for design of project components. Because the proposed transmission cables will be lifeline utilities, the 84th percentile motions (i.e., one standard deviation above the median; see Table 3.6-2), were used (B&V, 2012). The project will be designed based on current seismic design practices and guidelines. Potential seismic safety design practices for onshore segments may include geotextile wrap, an oversized trench with a compressible zone, flexible joints, duct banks with heavier/ high strength reinforcement, flexible conduits in place of concrete duct banks, soil improvement, or use of deep foundations; offshore segments may include flexible joints at the transition to land cables, sinusoidal installation or other methods to provide slack in the submarine cable.
APM GS-3	**Appropriate erosion-control measures implementation.** Best Management Practices (BMPs) will be implemented to minimize and avoid surface runoff, erosion, and pollution (see APM WQ-1 and WQ-2).

Table 5.6-3. Applicant Proposed Measures (APMs) Related Geology and Soils

APM WQ-1	**Development and Implementation of a Stormwater Pollution Prevention Plan (SWPPP).** Stormwater discharges associated with project construction activities are regulated under the General Construction Permit. Cases in which construction will disturb more than one acre of soil require submittal of a Notice of Intent, development of a SWPPP (both certified by the Legally Responsible Person (LRP)), periodic monitoring and inspections, retention of monitoring records, reporting of incidences of noncompliance, and submittal of annual compliance reports. PG&E will comply with all General Construction Permit requirements. Following project approval, PG&E will prepare and implement a SWPPP, which will address erosion and sediment control to minimize construction impacts on surface water quality. The SWPPP will be designed specifically for the hydrologic setting of the Proposed Project in proximity to the San Francisco Bay. Implementation of the SWPPP will help stabilize graded areas and reduce erosion and sedimentation. The SWPPP will designate BMPs that will be adhered to during construction activities. Erosion and sediment control BMPs, such as straw wattles, erosion control blankets, and/or silt fences, will be installed in compliance with the SWPPP and the General Construction Permit. Suitable soil stabilization BMPs will be used to protect exposed areas during construction activities, as specified in the SWPPP. During construction activities, BMPs will be in place to address construction materials and wastes. BMPs, where applicable, will be designed by using specific criteria from recognized BMP design guidance manuals. Erosion and sediment-minimizing efforts will include measures such as the following: ▪ Defining ingress and egress within the project site to control track-out ▪ Implementing a dust control program during construction ▪ Properly containing stockpiled soil Identified erosion and sediment control measures will be installed in an area before construction begins and inspected and improved as needed before any anticipated storm events. Temporary sediment control measures intended to minimize sediment transport from temporarily disturbed areas, such as silt fences or wattles, will remain in place until disturbed areas are stabilized. In areas where soil is to be temporarily stockpiled, soil will be placed in a controlled area and managed with similar erosion-control techniques. Where construction activities occur near a surface water body or drainage channel, the staging of construction materials and equipment and excavation spoil stockpiles will be placed at least 50 feet from the water body and properly contained, such as with berms and/or covers, to minimize risk of sediment transport to the drainage. Any surplus soil will be transported from the site and appropriately disposed of. A copy of the SWPPP will be provided to the CPUC for recordkeeping. The plan will be maintained and updated during construction as required by the SWRCB.
APM WQ-2	**Implementation of a Worker Environmental Awareness Program.** The project's worker environmental awareness program will communicate environmental issues and appropriate work practices specific to this project to all field personnel. These will include spill prevention and response measures and proper BMP implementation. The training program will emphasize site-specific physical conditions to improve hazard prevention (such as identification of flow paths to nearest water bodies) and will include a review of all site-specific water quality requirements, applicable portions of erosion control and sediment transport BMPs contained in the SWPPP (APM WQ-1) and the health and safety plan (see APM HM-2 in PEA Section 3.8.4.2). A copy of the project's worker environmental awareness training record will be provided to the CPUC for recordkeeping. An environmental monitoring program will also be implemented to ensure that the plans are followed throughout the construction period.

5.6.2 Environmental Impacts and Mitigation Measures

a. *Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:*

i) *Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.*

NO IMPACT. No known faults are located in a manner that would cross the proposed transmission line or other facilities or would be immediately adjacent to it. Therefore, there is no potential for primary fault rupture to impact the project.

ii) Strong seismic ground shaking?

LESS THAN SIGNIFICANT. The Proposed Project would be located in an area mapped as likely to experience strong ground shaking in the event of a large earthquake with PGA's of 0.70 or a 2 percent probability of exceedance in 50 years. The area has historically experienced moderate to severe groundshaking due to the numerous earthquakes that have occurred in the San Francisco Bay Area, as shown in Table 5.6-2. These earthquakes have resulted in severe damage to structures, millions of dollars in property damage, and deaths. Although the Proposed Project would be located in an area that may experience strong groundshaking due to large local or regional earthquakes, the new Potrero 230 kV Switchyard would be designed as required by CPUC General Order 131-D (Planning and construction of facilities for the generation of electricity and certain electric transmission facilities), and the 230 kV transmission line and associated structures would be designed as required by CPUC General Order 128 (Rules for Construction of Underground Electric Supply and Communication Systems). Current standard design practices for substation and similar facilities also would include design recommendations in the Institute of Electrical and Electronic Engineers guidelines IEEE 693 (Recommended Practices for Seismic Design of Substations). Design of these new facilities and structures to the above referenced guidelines and standards would reduce the impact of any potential damage from groundshaking to these features. Additionally APM GS-2, which requires site specific seismic analysis and design based on current seismic design practices and guidelines, would be implemented. Application of the above mentioned requirements and implementation of APM GS-2 would reduce the impact from earthquake induced ground shaking to a less than significant level.

iii) Seismic-related ground failure, including liquefaction?

LESS THAN SIGNIFICANT. Strong groundshaking could result in liquefaction-related phenomena along sections of the proposed underlain by artificial fill and Young Bay Mud with potentially liquefiable granular layers. Portions of the proposed onshore transmission line would be within a CGS mapped liquefaction hazard zone as shown in Figure 5.6-3. Based on analyses and evaluation conducted by AMEC for the project, liquefaction induced settlement in the range of 6 to 12 inches and liquefaction induced lateral spreading of 0.5 to 3 feet could be triggered by a large regional earthquake. The proposed offshore segment of the route would be underlain by fine grained Young Bay Mud and not likely to liquefy. However, analysis conducted for PG&E's Feasibility Study indicated that up to an inch or two of settlement associated with liquefaction induced volumetric compaction and up to several tens of inches of lateral seismic deformation may be possible (B&V, 2012). Implementation of APM GS-1 (Appropriate soil stability design measures implementation) and APM GS-2 (Appropriate seismic safety design measures implementation) would reduce the potential for liquefaction related phenomena to damage project components, and with these measures, the impact related to seismic related ground failure, including liquefaction, would be less than significant.

iv) Landslides?

NO IMPACT. The Proposed Project would be built in an area that is flat to gently sloping and offshore. As a result, there would be no potential for landslides to impact project components.

b. Would the project result in substantial soil erosion or the loss of topsoil?

LESS THAN SIGNIFICANT. Significant ground disturbing activities which could result in erosion would occur during construction of the onshore sections of the proposed transmission line and switchyard. Ground disturbance would occur for: trenching and excavation for the underground sections connecting to Potrero Switchyard and Embarcadero Substation, horizontal directional drilling (HDD) at the two transitions from land to the submarine alignment, excavation for the HDD entry pits and splice vaults, and grading and excavation for construction of the new Potrero 230 kV Switchyard near the existing Potrero 115 kV Switchyard. Implementation of appropriate erosion control BMPs would occur as required by APM GS-3 (Appropriate erosion-control measures implementation), and this measure would reduce the potential impact related to soil erosion to a less than significant level.

c. Would the project be located on geologic units or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

LESS THAN SIGNIFICANT. As discussed above for Item (a)[iii – Seismic related ground failure], portions of the Proposed Project would introduce new project facilities and structures in areas with potentially liquefiable artificial fill and Young Bay Mud sediments (Figure 5.6-3), and these project components could potentially suffer liquefaction related damage. As discussed under Item (a), implementation of APM GS-1 and APM GS-2 would reduce this potential impact to a less than significant level.

d. Would the project be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2010), creating substantial risks to life or property?

NO IMPACT. Based on the geologic and soils units underlying the proposed onshore project components, expansive soils are not expected to occur. Therefore, there would be no impact.

e. Would the project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

NO IMPACT. The project would not include any components requiring septic tanks or alternative wastewater systems. Therefore, there would be no impact.

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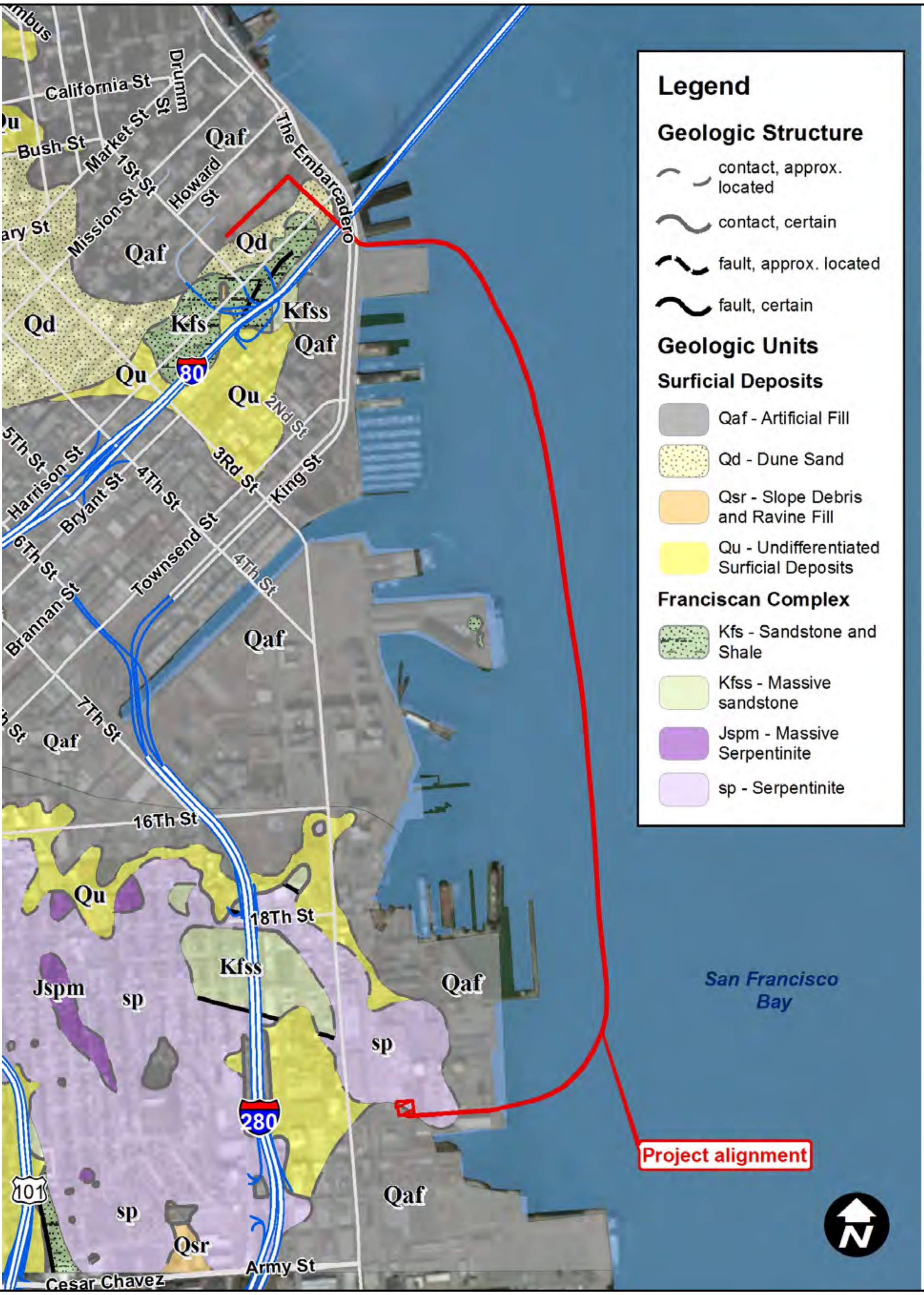

Aspen Environmental Group

Source: Aspen, 2013.

Figure 5.6-1
Geologic Map

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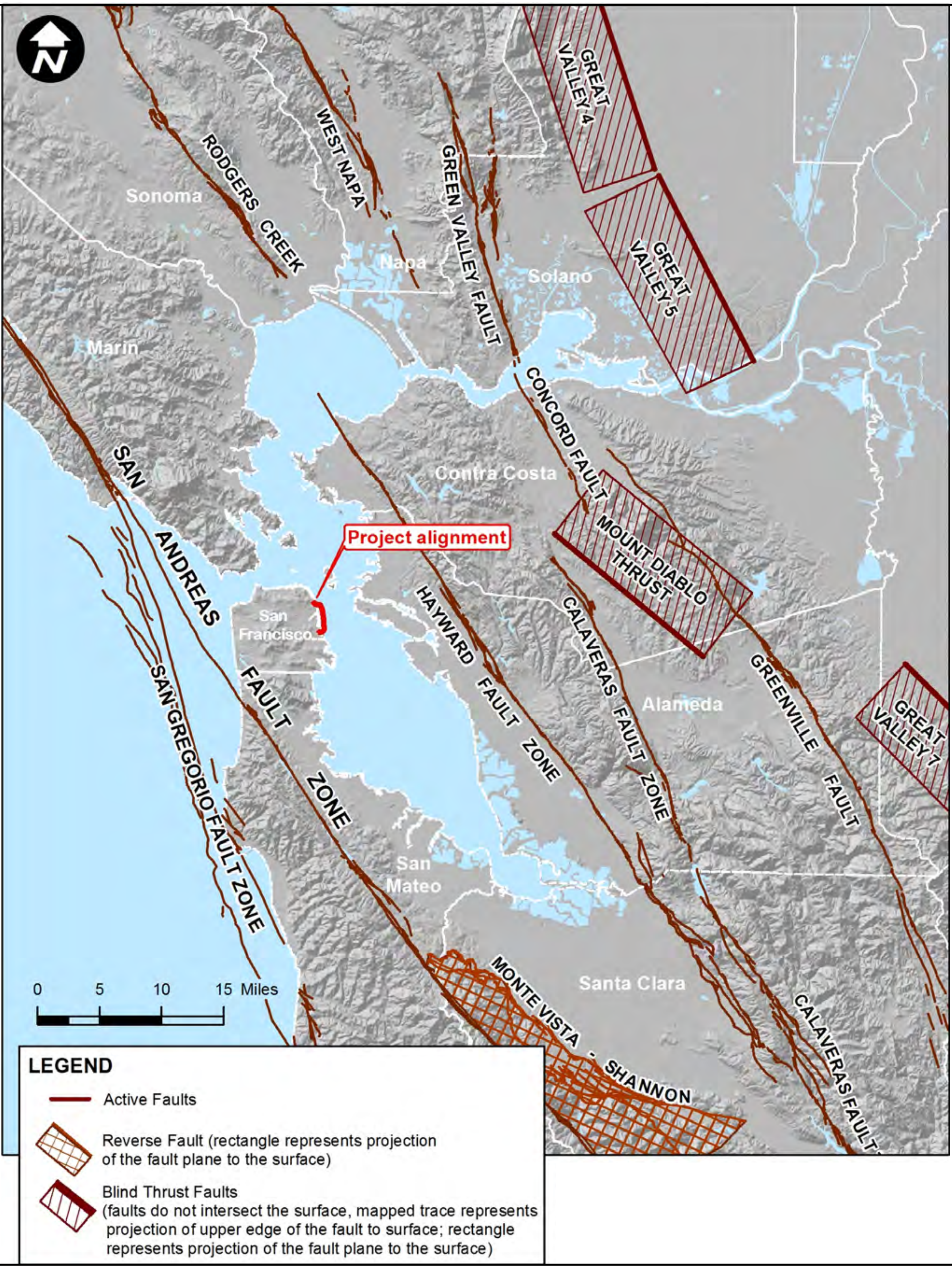

Aspen
Environmental Group

Source: Aspen, 2013.

Figure 5.6-2

Regional Active Fault Map

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Figure 5.6-3
Seismic Hazard Map

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