6. 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 a geologic unit 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 soils, as defined in Table 18-1-13 of the Uniform Building Code (1994), 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?	☐	☐	☐	■

Existing Conditions

The project is on the east side of the San Francisco Peninsula. Topography in the east part of the project area varies from the nearly level bay margins along San Francisco Bay to rolling foothills crossed by small streams. Shoreline features consist of tidal marshlands subject to periodic inundation and exposure during high and low tides. In the northwest part of the project area, the rugged, densely forested ridges of San Mateo County reach elevations in excess of 1,300 feet. The 1,310-foot-high San Bruno Mountain, near the north end of the project area, is crossed by the project route.

Geology

The bedrock of the San Francisco Peninsula, in the vicinity of the project area, is composed primarily of Mesozoic and Cenozoic sandstone and shale deposited as long ago as 208 million years. These rocks make up the bulk of the Coast Ranges in San Mateo County. Weathering, erosion, deposition, and natural or artificial filling have created the present shape of the ground surface and composition of the surface soils. The northern portion of the project area is underlain by the Franciscan sandstone and sheared rock of San Bruno Mountain. Bedrock in the central portion of the project area is buried by as much as 200 feet of Colma sand. The southern portion of the project area is underlain at depth by Santa Clara conglomerate, sandstone, and mudstone.

Most of the existing power line alignment crosses ground surface and near-surface deposits of Quaternary Bay mud. The Bay mud is recently deposited sediment along the margins of San Francisco Bay. Deposited during the current geologic epoch (the Holocene Epoch encompassing the last 11 thousand years) in estuarine environments, the Bay mud consists primarily of clays and silty clays and is water-saturated. The sediments generally are less than 5 thousand years old and may be as thick as 40 feet in the vicinity of San Francisco International Airport. These soft sediments can be highly plastic and compressible when structures are placed on their surface. They provide extremely poor foundation support. The Bay mud is buried by as much as 100 feet of artificial fill.

East of the Burlingame Substation, fine-grained younger alluvial fan deposits are adjacent to the inland side of the alignment and underlie U.S. Highway 101. These deposits of mixed sand, silt, and clay also are Holocene in age, but probably are not more that 5 to 7 thousand years old, and provide good to fair foundation support. Near the project alignment they are buried by Bay mud and artificial fill.

From the Millbrae Substation north to the vicinity of the Shaw Road (BART) Substation, the inland side of the alignment is underlain by Colma formation sandy clay, sand, and gravel of mid-Pleistocene age (500 thousand to 1 million years old), which provides good foundation support. Colma formation is buried by Bay mud, stream deposits, and artificial fill throughout much of this portion of the project alignment.

Soils. The soils of San Mateo County belong to three major groups which are related to the substrate on which the soils have developed: coastal dunes, terraces, and hills; uplands; and bottom lands. The major soil groups are subdivided into fourteen associations. Three associations are represented along the project alignment: Urban Land-Orthents, Reclaimed; Urban Land-Orthents, Cut and Fill; and Barnabe-Candlestick-Buriburi. These soil associations are subdivided into eight soil types based on a variety of distinguishing characteristics, such as texture, slope, drainage, etc.

The Urban Land-Orthents, Reclaimed soil association underlies about 70 percent of the project alignment, from the San Mateo Substation to the crossing of Highway 101 north of the East Grand Substation. With the exception of about one quarter of a mile of Novato clay east of the Burlingame Substation, the land surface along this portion of the alignment has been cut, filled, covered with asphalt or concrete or buildings. The fill materials include Bay mud, clay, sand, gravel, demolition debris and other solid wastes. The properties and characteristics of the constituents of this soil unit (such as drainage, texture, compaction) are highly variable because of the differences in the kind and amount of material used for fill. Slopes are less than 2 percent. The Novato clay is the only natural soil in this association. It is a deep, very poorly drained soil that developed in salt marshes along the margin of San Francisco Bay. Slopes are less than 1 percent, permeability is slow, runoff is very slow. The clay is strongly acidic, expansive, and low in strength.

Expansive soils have relatively high clay content and are subject to changes in volume with changing moisture conditions. The poorly drained Novato clay is subject to change in volume (shrink-swell), typical of expansive soils. Expansion can cause damage to building foundations, concrete slabs, pavement, underground utility lines, and other surface or near-surface improvements. The other soils in the project area have little or no clay content.

The Urban Land-Orthents, Cut and Fill soil association underlies about 13 percent of the project alignment: north of the US 101 crossing near the East Grand Substation; in the vicinity of central Brisbane, west of the north end of the Lagoon; and about one quarter of a mile south of the Martin Substation. As its name implies, this association is also composed mostly of artificially created land surfaces. In the vicinity of central Brisbane, more than 85 percent of the area in this map unit is urbanized - covered by asphalt, concrete, buildings, and other structures. Slopes range from less than 5 percent to near 25 percent. Near the East Grand Substation and the Martin Substation, this association contains upland areas that are also about 85 percent urbanized, but the slopes are steeper – from less than 10 percent to more than 30 percent. The fill is similar to that described in the previous paragraph, although in recent years more control has been exerted over the type of fill materials used in order to provide better foundation support in the urban areas.

The Barnabe-Candlestick-Buriburi soil association underlies about 17 percent of the project alignment: a little more than half the area between the crossing of Highway 101 near the East Grand Substation and the Martin Substation. Four soil types are represented in this upland soil association: Barnabe very gravelly loam, Candlestick fine sandy loam, Buriburi gravelly loam, and Kron sandy loam. The soil types in this association range from shallow (exposed bedrock on San Bruno Mountain forms part of the Barnabe soil complexes) to moderately deep. Slopes range from 15 percent to 75 percent and are underlain by hard, fractured sandstone. The Barnabe soil is relatively coarse-grained, well drained, and usually less than 20 inches thick over the bedrock. The Candlestick soil is as thick as 40 inches over bedrock, well drained, and more finely textured with a subsoil of sandy clay loam. The Buriburi soil also is as thick as 40 inches over bedrock and well drained. The Kron soil is no more than 20 inches thick over bedrock. Topography in all these soil types is steep, runoff is rapid, and erosion hazard is high to very high. None of the soils contains expansive clay and none is corrosive to untreated steel or concrete.

Geologic Hazards. Geologic hazards are caused by natural, episodic events interacting with the specific rocks, soils, and other natural features of an area. Hazards from seismic activity include strong vibratory ground motion from local and regional earthquakes, potential surface fault rupture, and liquefaction.

Regional and Local Seismicity. No active faults are known to cross the project area; however, one of the longest and most studied fault zones in the world, the San Andreas, is approximately 2 to 5.5 miles southwest of the project area. The estimated slip rate of the Peninsula segment of the San Andreas fault (closest to the project area) is reported to be 0.669 +/- 0.12 inches (17.0 +/– 3.0 millimeters) per year. The fault has generated at least five major earthquakes since 1838. Major earthquakes are those with a magnitude greater than 7.0 on the Moment Magnitude (M_W) Scale (greater than 7.5 on the Richter scale). The Loma Prieta earthquake, measuring M_W 6.9 (M7.1 Richter), occurred on 17 October 1989. Its epicenter was between Santa Cruz and San Jose, approximately 45 miles southeast of the project area. Table B.6-1 summarizes the known major active faults in the project area.

Table B.6-1
Estimated Maximum Parameters for Major Known Faults
Affecting the PG&E San Mateo-Martin #4 Project Area

Fault	San Gregorio	San Andreas	Hayward	Calaveras
Moment Magnitude[1]	7.1	7.9	7.1	6.8
Duration of Strong Shaking (seconds)[2]	18 - 30	30 - 60	30 - 60	18 - 30
Maximum Intensity (MMI)[3]	VI - IX	VIII - X	VI - VIII	V - VII
Peak Horizontal Accelerations in Rock and Stiff Soil (Gravity)[4]	0.07 - 0.60	0.09 - 0.85	0.07 – 0.25	0.30 – 0.95
Approximate Distance and Direction from Site to Fault (Miles)	9 to 12 SW	2 to 5.5 SW	15 to 17 NE	24 to 25 NE

Source: EIP Associates, 2003.

Notes:

1 For the purposes of describing the size of the design (or scenario) earthquake of a particular fault segment, **moment magnitude** (M_W) of the characteristic earthquake for that segment has replaced the concept of a maximum credible earthquake of a particular Richter magnitude. This has become necessary because the Richter Scale "saturates" at the higher magnitudes; that is, the Richter scale has difficulty differentiating the size of earthquakes above magnitude 7.5. The M_W scale is proportional to the area of the fault surface that has slipped, and thus, is directly related to the length of the fault segment. Although the numbers appear lower than the traditional Richter magnitudes, they convey more precise (and more useable) information to geologic and structural engineers.

2 Duration of ground motion at 0.5 g within 10 miles of the fault. Estimates based on relationships developed by Bolt, 1973.

3 Estimated Modified Mercalli Intensity damage level based on relationships developed by Perkins and Boatwright, 1995, or Richter, 1958 (San Andreas fault only).

4 Estimates based on relationships developed by Seed and Idriss, 1972, Joyner and Boore, 1981, Campbell and Sadigh, 1983.

The Hayward fault is between 15 and 17 miles northeast of the project site. At least two major earthquakes have occurred along this fault within the last 150 years. The fault has an estimated slip rate of 0.354 +/- 0.04 inches (9.0 +/– 1.0 millimeters) per year, however, the actual segmentation and recurrence history of the Hayward fault remains highly uncertain.

The Northern Calaveras fault (between 24 and 25 miles northeast of the project site) has a slip rate of 0.276 +/- 0.04 inches (7.0 +/– 1.0 millimeters) per year. The Calaveras fault has generated at least two major earthquakes within the last 150 years. The Northern Calaveras fault extends north from Calaveras Reservoir in Santa Clara County, eventually connecting to the Concord fault in Contra Costa County.

The Seal Cove–San Gregorio fault is between 9 and 12 miles southwest of the project site. It is the principal active fault west of the San Andreas fault, yet its potential to generate major earthquakes remains unknown. Recent studies indicate that the Seal Cove–San Gregorio fault is an active seismic source that should be considered a hazard when conducting assessments in the San Francisco Bay area.

Liquefaction. Liquefaction of soils may occur when the ground shakes strongly during earthquakes. Liquefiable soils are uniformly fine-grained granular soils that contain less than 15 percent clay, are less than 50 feet below the ground surface, and are saturated with water. As the shaking continues, the soil loses its capacity to support its own weight or the weight of structures built on it, essentially turning into quicksand at least for the duration of the groundshaking. Small areas of soil and wetlands with the potential for liquefaction occur within the project area. Specifically, the tower sites in Burlingame Lagoon and San Francisco Bay occur on soils with liquefaction potential. In addition, most of the West of Bayshore parcel in Millbrae and unincorporated San Mateo County is susceptible to liquefaction. The United States Geological Survey indicates the potential for seismically induced liquefaction along the alignment between the San Mateo Substation and the crossing of Highway 101 north of the East Grand Substation is generally low, but locally can be high near active, abandoned, or buried stream channels, or where pockets of liquefiable soils are in or adjacent to Bay mud. Crossing San Bruno Mountain there is no potential for liquefaction because the mountain is bedrock.

Landslides. San Bruno Mountain is the only portion of the project area with potential landslide hazards. The native soil structure commonly holds slopes of 30 degrees or more if undisturbed. If disturbed, the area has the potential to become unstable. Areas with high susceptibility for seismically induced slope failure have been mapped along the southern slope of San Bruno Mountain crossing the project site. These areas cover less than 0.3 mile of the alignment and would not be disrupted during the construction of the project.

Significance Criteria

The significance criteria for this analysis is based on Appendix G of the CEQA Guidelines. The project is considered to have a significance impact on geology and soils if it would:

- 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. Landslide;

- Result in substantial soil erosion, or the loss of topsoil;
- Be located on a geologic unit 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;
- Be located on expansive soils, as defined in Table 18-1-13 of the Uniform Building Code (1994), creating substantial risks to life or property; or
- 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.

Explanation of Geology and Soils Checklist

a.i. Fault Rupture — No Impact

Although the proposed project is less than two miles of the San Andreas fault, no portion of the proposed project is in an active fault zone. Consequently, it is anticipated that implementation of the proposed project would not expose people or structures to substantial adverse effects, including the risk of loss, injury or death caused by fault rupture.

a.ii. Strong Groundshaking — Less-than-Significant Impact

The project site is in a Zone 4 seismic area. All proposed foundations, structures, and electrical equipment, including circuit breakers, circuit switchers, switches, reactors, and transformers, etc. to be installed at the each substation would be designed and installed to withstand the characteristic earthquakes anticipated in Seismic Zone 4 areas. A previous earthquake had reduced facility reliability at the San Mateo Substation (see San Francisco Peninsula Long-Term Electric Transmission Planning Technical Study: 2004-2009 (October 2000)). The following measures have been or would be implemented at each substation to avoid seismic-related reliability reductions of the proposed modifications:

- Failed 230 kV circuit breakers were replaced with new ones that would withstand characteristic earthquakes anticipated in Seismic Zone 4 areas.
- The San Mateo Substation lattice steel structures have been analyzed for their ability to withstand the characteristic earthquakes anticipated in Seismic Zone 4 areas. Necessary repairs consistent with that analysis have been performed.
- Existing San Mateo Substation transformer banks and circuit breakers were also analyzed for their ability to withstand the characteristic earthquakes anticipated in Seismic Zone 4 areas. Necessary repairs consistent with that analysis have been performed.
- Because of the proximity of active faults to the project site, strong seismic groundshaking could create a potentially significant impact. The new standard substation and power line design specifications take into account groundshaking and other seismic activity, which would reduce the impact to less than significant.

a.iii. Ground Failure, Including Liquefaction **No Impact**

Small areas that contain soil with the potential for liquefaction occur along the project route. Temporary guard structures in the West of Bayshore parcel potentially could be affected by liquefaction and lateral spreading in the event of an earthquake. These structures would be removed at the end of the construction period and would not expose people or structures to a substantial risk of loss, injury, or death. Therefore, no impacts are anticipated from ground failure.

a.iv. Landslides **Less-than-Significant Impact**

Because no ground disturbance would occur on San Bruno Mountain, the only portion of the project area susceptible to landslides, the potential for landslides would not increase as a result of project construction or operation.

b. Erosion or Loss of Topsoil **Less-Than-Significant with Mitigation Incorporated**

The project would involve limited ground disturbance. No new ROWs or other access routes would be needed, and none of the existing roads would need widening or grading. Additionally, no new structure foundation work would be necessary in high erosion hazard areas, such as steep hillsides or on exposed soils. The only proposed excavation outside of the substation properties would involve auguring ten 6- to 8 foot-deep holes (removing approximately 5 cubic yards of soil) and eight 14-foot-deep holes (removing approximately 7 cubic yards of soil) for the temporary guard structures northeast of the Millbrae Substation and near the BART tracks on mostly level ground. The soil removed from the holes would be stockpiled adjacent to the poles and used to refill the holes after the poles were removed. The stockpiles would be watered regularly or covered, as provided by the APMs. Approximately 12 cubic yards of native material would be used to fill the holes left by pole removal. This disturbance would be minimal and temporary, so impacts on topsoil would be less than significant.

The project would require 16 pull or tension sites, varying in size from 40 by 120 feet to 200 by 200 feet. Helicopters used in construction activities would be based at two or three undetermined staging areas. Pull or tension and helicopter landing sites have potential to temporarily disturb limited areas along the route. The potential for erosion significantly increases as slopes increase. The pull or tension sites or helicopter landing sites could be located in areas with erosion potential and could result in a potentially significant impact unless mitigated. Mitigation measures are provided in this Initial Study, as well as APMs (see Table B-5) to reduce the potential erosion impact to a less-than-significant level (see below).

The only areas along the power line that pose a high potential for erosion occur along steep slopes in San Bruno Mountain State and County Park. Construction-related activities would not expose soils in these areas because access to and from the towers would be primarily by helicopter or on foot. A single pull or tension site in the Guadalupe Hills area adjacent to Tower 10/80 would be located on a disturbed area (a site similar to that used for the San Mateo–Martin #3 115 kV Reconductoring Project in 2000) with low erosion potential. Because of the APMs, the potential impacts would be less-than-significant (see below).

In the substation properties, grading would be conducted at the San Mateo Substation to accommodate the new 115 kV breaker and bus structure, at the Burlingame Substation for site preparation, and at the Millbrae Substation to accommodate the transformers and the bus extension and to level a perimeter road within the fenceline. At the San Mateo Substation, grading would involve less than 10 cubic yards of material. At the Burlingame Substation, approximately 50 cubic yards of material would be moved. At the Millbrae Substation, approximately 20 cubic yards would be moved. All potential ground-disturbing activity at the substations would occur on level ground and within existing property lines. The excavations would be necessary for the installation of drilled pier foundations (two new tubular steel poles inside the existing graded area at the Millbrae Substation). Surface soils would be removed and stockpiled as previously described. Any expansive soil encountered during the grading would be removed and replaced with engineered fill. Materials excavated from the sites would be tested for toxicity, and disposed in compliance with applicable federal, state and local regulations and guidelines.

APM-17 (see Table B-5) states that Best Management Practices (BMPs) to reduce sedimentation and minimize erosion would be employed on all work sites. PG&E has prepared a BMP Plan for the proposed project (PG&E 2003a). The BMP Plan would implement measures, such as applying soil stabilizers to inactive construction areas and covering or stabilizing exposed stockpiles of soil to reduce erosion. It is noted that many of these BMPs for erosion and sediment control also appear in Table B-5 as APMs for the control of fugitive particles to preserve air quality. APM-2 through -8 provide for the stabilization and protection of exposed or loose soil during and following construction (PG&E 2003a). Although the likelihood of erosion from the proposed project would be low, because there are no areas along the project alignment where soil on steep hillsides would be exposed, PG&E would reduce further any potential for such erosion through implementation of the APMs and BMP Plan.

c. Geological Unit or Soil that is Unstable **No Impact**

Portions of PG&E's right-of-way contain soil susceptible to landslides, lateral spreading, and liquefaction or collapse. However, the project would not increase any of these risks, because it does not include any excavation in high susceptibility areas, because no permanent new structures would be built on unstable soils, and because PG&E would use pier or pile foundations (which would be supported by the stronger materials below the ground-surface and near-surface soils) for permanent structures. Consequently, there would be no impact caused by unstable soils.

d. Expansive Soil **No Impact**

The proposed project would not construct any new structures in areas with expansive soils, except for the substations. Construction of the substations would include removal of expansive soils during the grading process. Consequently, the proposed project would not be affected expansive soils.

e. Soils for Septic Tank Use **No Impact**

The construction and operation of the project would not include modifications or additions to current wastewater disposal systems. The project is in areas with existing sewer systems. Therefore, there would be no impact related to or from soils incapable of supporting septic systems.