

3.6 GEOLOGY AND SOILS

3.6.1 INTRODUCTION

This section describes the existing geological and soil conditions, and potential geologic and geotechnical hazards at the project site and surrounding areas, and concludes that any impacts will be less than significant. Potential geologic hazards along the project route include fault-surface rupture, ground shaking, landsliding, liquefaction, and other ground-failure mechanisms. The implementation of the Applicant-Proposed Measure described in Section 3.6.4.2 will further reduce these less-than-significant impacts. The project's potential effects on geology and soils were evaluated using the significance criteria set forth in Appendix G of the California Environmental Quality Act (CEQA) Guidelines. The conclusions are summarized in Table 3.6-1 and discussed in more detail in Section 3.6.4.

Table 3.6-1: CEQA Checklist for Geology and Soils

Would the project:	Potentially Significant Impact	Less-than-Significant Impact 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.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
ii) Strong seismic ground shaking?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
iii) Seismic-related ground failure, including liquefaction?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
iv) Landslides?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
b) Result in substantial soil erosion or the loss of topsoil?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Would the project:	Potentially Significant Impact	Less-than-Significant Impact with Mitigation Incorporated	Less-than-Significant Impact	No Impact
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste-water disposal systems where sewers are not available for the disposal of waste water?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

3.6.2 REGULATORY BACKGROUND AND METHODOLOGY

3.6.2.1 Regulatory Background

Federal

No federal regulations related to geology, soils, and seismicity are applicable to the project.

State

Alquist-Priolo Earthquake Fault Zoning Act

California enacted the Alquist-Priolo Special Studies Zones Act in 1972, which was renamed the Alquist-Priolo Earthquake Fault Zoning Act in 1994. Also known as the Alquist-Priolo Act, it requires the establishment of “earthquake fault zones” along known active faults in California. Regulations on development within these zones are enforced to reduce the potential for damage resulting from fault displacement. Information on earthquake fault zones is provided for public information purposes (see Section 3.6.3.4, Seismicity, for further discussion).

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) of 1990 addresses earthquake hazards other than fault rupture, including liquefaction and seismically induced landslides. Seismic hazard zones are to be mapped by the State Geologist to assist local governments in land use planning. The SHMA states that “it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety.”

California Building Standards Code

The California Building Standards Commission is responsible for coordinating, managing, adopting, and approving building codes in California. The State of California provides minimum standards for building design through the 2010 California Building Standards Code (CBC) (CCR, Title 24). The state earthquake protection law (California Health and Safety Code Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes and is contained in Chapter 16 of the CBC. Chapter 18 of the CBC regulates the excavation of foundations and retaining walls and specifies required geological reports. Appendix J of the 2010 CBC regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

Local

Because the CPUC has exclusive jurisdiction over the siting, design, and construction of the project, the project is not subject to local discretionary regulations. If necessary, PG&E will obtain a building permit or other required ministerial permits.

3.6.2.2 Methodology

Information on the geology and soils was compiled from published literature, maps, and examination of aerial photographs. Geologic units and structural features were obtained from maps published by the California Geological Survey (CGS) and United States Geological Survey (USGS).

Soil descriptions were obtained from mapping by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). Information on mineral resources was obtained from the USGS, CGS, and the Sonoma County Year 2020 General Plan. Seismic information was developed from several sources, including the USGS, CGS, and the Safety Element of the Sonoma County General Plan.

3.6.3 ENVIRONMENTAL SETTING

3.6.3.1 Regional Setting

The project site is located near the geographic center of Sonoma County, California, which is in the northern portion of the San Francisco Bay region. The topography in Sonoma County is varied, and includes several mountain ranges, distinctive valleys, and coastal terraces. The geology is quite complex, and is continually evolving because of its location at an active plate margin. The County is bounded on the south by the San Pablo Bay and associated wetlands. The Cotati and Petaluma valleys create the wide basin stretching from Santa Rosa to the San Francisco Bay. Rolling hills and grasslands predominate here, as well as in Marin County to the south. The rugged Mayacamas and Sonoma mountains geographically form the eastern boundary and physically separate Sonoma County from Lake and Napa counties. The Sonoma Valley runs north-south between the Sonoma Mountains on the west and the taller Mayacamas Mountains to the east. The Geysers geothermal field, located in the northeastern section of the County, extends into both Sonoma and Lake counties. The Mendocino Highlands form a common geographic unit with Mendocino County to the north. The Alexander Valley runs from northwest to southeast, bounded on the east by the Mayacamas Mountains and on the west by the Coast Range. The Pacific Ocean forms the western County boundary, including an interesting assemblage of steep hills, marine terraces, beaches, and offshore sea stacks.

The geology of Sonoma County is a result of the past tectonic, volcanic, erosion, and sedimentation processes of the California Coast Range geomorphic province. Ongoing tectonic forces resulting from the collision of the North American Plate with the Pacific Plate, combined with more geologically recent volcanic activity, has resulted in mountain building and down warping of parallel valleys. The margin of the two tectonic plates is defined by the San Andreas Fault system—a broad zone of active, dormant, and inactive faults dominated by the San Andreas Fault, which trends along the western margin of the County. This fault system results in the northwestern structural alignment that controls the overall orientation of the County's ridges

and valleys. The land has been modified by more recent volcanic activity, evidenced by Mount St. Helena, which dominates the northeastern part of the County. Erosion, sedimentation, and active faulting occurring in recent times have further modified Sonoma County's landscape to its current form.

3.6.3.2 Stratigraphic Units

The bedrock units in the San Francisco Bay region are made up of two components—amalgamated, highly deformed tectonostratigraphic terranes that are displaced, at least in part, hundreds to thousands of kilometers from their position of origin, and generally younger, less-deformed rocks that overlie the terranes and are roughly in their original location. In most of the region, the older set of rocks is Mesozoic and the younger is Tertiary, but in the Sonoma County area, the terranes include some rocks as young as Miocene. The young age of rocks within these displaced terranes reflects additional complexity in the geologic and structural history of the Sonoma County area that is not found in any other part of the region.

The Great Valley complex is the oldest rock assemblage assigned to the Healdsburg terrane. It is composed of steeply dipping sandstone, fault bounded, siltstone and shale (KJgvs) and conglomerate (KJgvc). The type area is near the City of Healdsburg, where as much as 3,000 meters of Lower Cretaceous conglomerate depositionally overlie Upper Jurassic serpentine (sp) of the Coast Range ophiolite. The Healdsburg terrane is distinguished from coeval Great Valley sequence rocks by its abundant conglomerate-containing clasts, mostly of light-colored (often pink) rhyolite porphyry and rhyolitic welded ashflow tuff, plus minor quartzite (quartz arenite) pebbles (Blake et al. 1984; Jayko and Blake 1993).

The Great Valley complex is overlain by Miocene-Pliocene Sonoma Volcanics such as andesite (Tsa) and the Pliocene/Pleistocene Sonoma/Clear Lake Volcanics composed of the Glen Ellen Formation (QTge) and a tuffaceous member (QTget) (See Figure 3.6-1: Geologic Map).

Quaternary surficial deposits in Sonoma County area are mostly undivided. The exceptions are river terraces along the Russian River and other major drainages, and older alluvial fan deposits in Santa Rosa Valley (Healdsburg and Sebastapol quadrangles) (Blake et al. 2000). The surficial deposit on the project track are the Pleistocene older alluvial fan deposits (Qpoaf) and Historic artificial fill.

3.6.3.3 Soils

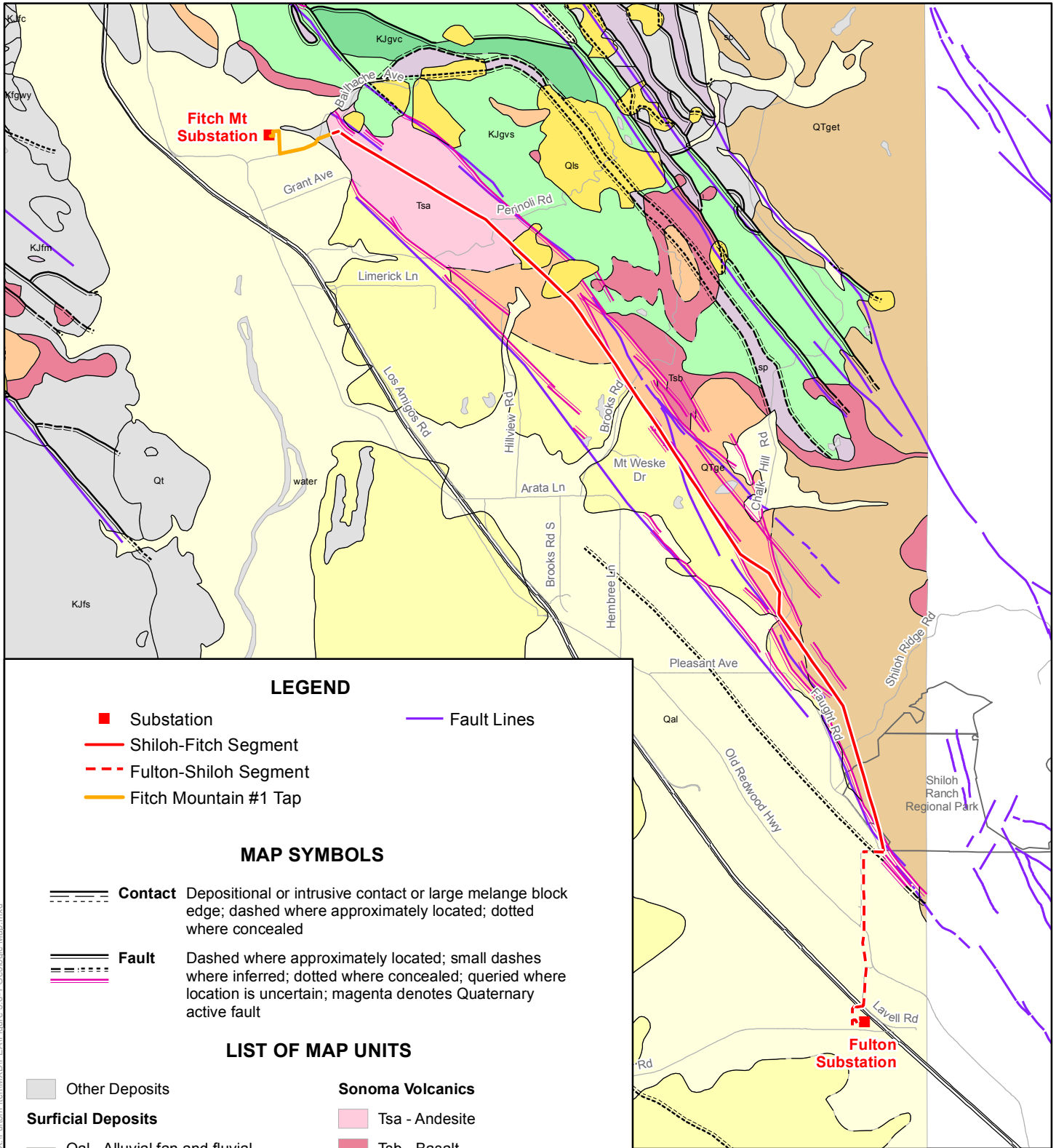
The following 14 soil series comprise 29 individual soil types located within the project area (see Figure 3.6-2: Soil Series Map) (NRCS 2011):

- Arbuckle gravelly loam (AkB, 0 to 5 percent slopes)
- Clear Lake clay (CeA, 0 to 2 percent slopes)
- Dibble clay loam (DcC, 2 to 9 percent slopes; DcD, 9 to 15 percent slopes; DcE, 15 to 30 percent slopes; DcE2, 15 to 30 percent slopes, eroded; DcF, 30 to 50 percent slopes; DcF2, 30 to 50 percent slopes, eroded)

- Felta very gravelly loam (FaD, 5 to 15 percent slopes; FaE 15 to 30 percent slopes; FaF 30 to 50 percent slopes)
- Gravel pits (GP)
- Guenoc gravelly silt loam (GrG, 30 to 75 percent slopes)
- Haire clay loam (HcC, 0 to 9 percent slopes)
- Laniger loam (LaF, 30 to 50 percent slopes)
- Positas gravelly loam(PsD, 9 to 15 percent slopes)
- Riverwash (RnA)
- Spreckels loam (SkC, 2 to 9 percent slopes; SkD, 9 to 15 percent slopes; SkE, 15 to 30 percent slopes; SkE2, 15 to 30 percent slopes, eroded; SkF, 30 to 50 percent slopes)
- Toomes rocky loam (ToE, 2 to 30 percent slopes; ToG, 30 to 75 percent slopes)
- Yolo loam (YnA, 0 to 2 percent slopes; YlA, 0 to 2 percent slopes; YsA, 0 to 2 percent slopes; YtA, 0 to 2 percent slopes)
- Zamora silty clay loam (ZaA, 0 to 2 percent slopes)

Project area soils include soils found in basins, flood plains, and alluvial fans. The Arbuckle Series consists of well drained, nearly level to gently sloping terraces above stream channels. The Clear Lake Series consists of poorly drained, expansive clays found in basins and flood plains. The Haire Series consists of poorly drained, expansive, nearly level to gently sloping clays to clay loams. The Positas Series consists of well drained gravelly loams that have a clay subsoil, underlain by old alluvium and basic igneous material, found in river valleys terraces. Riverwash and gravel pits are very recently deposited gravel, sand, and silt alluvium found along major streams and gravel bars. The Yolo Series consists of well drained to excessively drained, nearly level to moderately sloping very gravelly sandy loams to clay loams found on flood plains, alluvial fans, and low terraces. The Zamora Series consists of well drained clay loams with clay loam subsoil formed in recent alluvium from mixed sedimentary sources, found in large valleys and drainages.

The project area soils also include soils of the high terraces, foothills, uplands, and mountains. The Dibble Series consists of well drained clay loams with a clay subsoil, found on rolling hills and uplands. The Laniger Series consists of well drained loams underlain at depth by weathered rhyolite and rhyolitic tuff, found on mountainous uplands. The Spreckels and Felta series consist of well drained, gently sloping to very steep very gravelly loams and clay loams on foothills and high terraces. The Toomes and Guenoc series consist of well drained, gently sloping to very steep clay loams to loams found on uplands.



LEGEND

- Substation
- Shiloh-Fitch Segment
- - - Fulton-Shiloh Segment
- Fitch Mountain #1 Tap
- Fault Lines

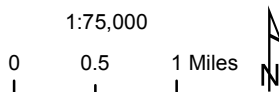
MAP SYMBOLS

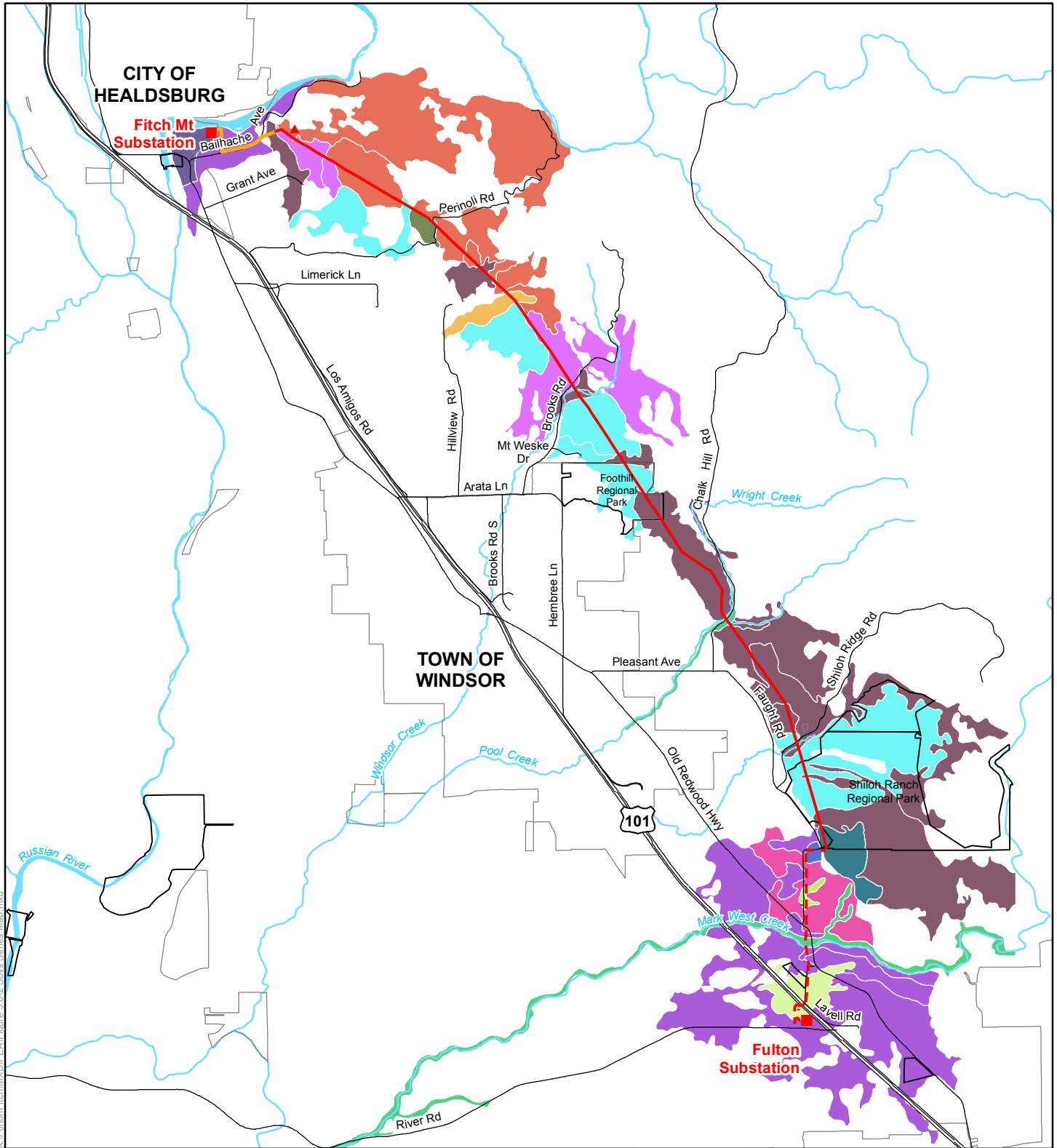
- Contact** Depositional or intrusive contact or large melange block edge; dashed where approximately located; dotted where concealed
- Fault** Dashed where approximately located; small dashes where inferred; dotted where concealed; queried where location is uncertain; magenta denotes Quaternary active fault

LIST OF MAP UNITS

- | | |
|---|--|
| <ul style="list-style-type: none"> Other Deposits Surficial Deposits Qal - Alluvial fan and fluvial deposits Qls - Landslide deposits Qpoaf - Older alluvial fan deposits Clear Lake Volcanics QTge - Glenn Ellen Formation QTget - Tuffaceous member | <ul style="list-style-type: none"> Sonoma Volcanics Tsa - Andesite Tsb - Basalt Great Valley Complex KJgvc - Sandstone, shale, and conglomerate KJgvs - Sandstone, silstone, and shale Coast Range Ophiolite sp - Serpentinite |
|---|--|

Figure 3.6-1
Geologic Map
Fulton-Fitch Mountain Reconductoring Project

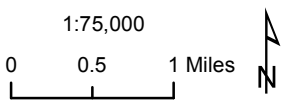




X:\Fulton\Fitch\MXD\PEA\Figure 3.6-2 Soils Series Map.mxd

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|--|--|--|
| ■ Substation | ■ Clear Lake clay | ■ Positas gravelly loam |
| — Shiloh-Fitch Segment | ■ Dibble clay loam | ■ Riverwash |
| - - - Fulton-Shiloh Segment | ■ Felta very gravelly loam | ■ Spreckels loam |
| — Fitch Mountain #1 Tap | ■ Gravel pits | ■ Toomes rocky loam |
| Soil Series | ■ Guenoc gravelly silt loam | ■ Yolo loam |
| ■ Arbuckle gravelly loam | ■ Haire clay loam | ■ Zamora silty clay loam |
| | ■ Laniger loam | |

Figure 3.6-2
Soil Series Map
Fulton-Fitch Mountain Reconductoring Project



3.6.3.4 Seismicity

Fault Zones

Faults are geologic hazards because of surface fault displacement and seismic ground shaking, which are distinct but related properties. Surface fault displacement results when the fault plane ruptures and that rupture surface extends to, or intersects, the ground surface. Surface fault rupture can be very destructive to structures constructed across active faults. However, the zone of damage is limited to a relatively narrow area along either side of the fault, as opposed to seismic ground-shaking damage that can be quite widespread.

The only fault in Sonoma County with known surface displacement in historic times is the San Andreas fault. During the magnitude 8.3 earthquake of 1906, horizontal displacements along this fault averaged 15 feet and surface rupture was mapped along the fault's extent through Sonoma County, from the Gualala area to the Bodega Bay area. Lateral displacement was reported to be as much as 12 feet near Fort Ross, and in the Bodega Bay area lateral displacements of up to eight feet with 18 inches of vertical displacement were reported. In addition to the San Andreas fault, the Healdsburg, Rodgers Creek, and Maacama faults all show evidence of surface displacement during the past 11,000 years (i.e., Holocene epoch), but not during the last 200 years. These faults are considered active faults for planning purposes. The Healdsburg fault, which is a northern extension of the Rodgers Creek fault, has recently been removed from the list of active faults by the State of California Alquist-Priolo earthquake fault zoning maps.

The strongest earthquake since 1906 occurred in 1969, on the Healdsburg fault near Santa Rosa. The Santa Rosa Earthquakes, occurring on October 1, 1969, were moderate earthquakes with magnitudes of 5.6 and 5.7 on the southern end of the Healdsburg fault, north of Santa Rosa.

The Alquist-Priolo Act requires the establishment of “earthquake fault zones” along known active faults in California. A fault is considered active if it has generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) or has shown evidence of fault displacement during the Holocene period (approximately the last 11,000 years) (Bryant and Hart 2007). A fault is considered potentially active if there is evidence of fault displacement during the Quaternary period (approximately the last 1.6 million years). A fault is considered inactive if the most recent documented fault displacement pre-dates the Quaternary period. For the purposes of this report, multiple sources were used to identify faults within a distance of 50 miles that may potentially affect the site, including the USGS, CGS, and Sonoma County. A regional map of the fault zones in proximity to the site using data from a CGS source is included in Figure 3.6-1: Geologic Map.

San Andreas Fault System

The nearest faults of major historical significance are the San Andreas fault, which passes within a distance of approximately 20 miles west of the project site (distances calculated from a point due east of the Town of Windsor, which is the approximate midway point of the project). The northern segment of the Hayward fault, which is believed to be associated with the Rodgers Creek Fault, is located approximately 33 miles south of the project, and the associated Calaveras fault passes within a distance of approximately 60 miles southeast of the project site. These

active right-lateral, strike-slip faults extend in a northwest-southeast direction to the west, south, and southeast of Sonoma County.

The San Andreas fault zone extends from the Gulf of California in Mexico to the Mendocino coast in northern California, and accommodates the majority of movement between the Pacific and North American plates. Several active faults along the section of the San Andreas in closest proximity to the project site are not generally considered to be independent seismic sources, but rather, to experience movement triggered by seismic events on the San Andreas. These include the Maacama fault, approximately 4.3 miles east of the project; the Healdsburg fault, the northern continuation of the Rodgers Creek fault beyond Healdsburg; and the West Napa fault, approximately 17 miles southeast of the project site (Working Group on Northern California Earthquake Potential 1996; Working Group on California Earthquake Probabilities 2007).

The active faults within Sonoma County are the San Andreas fault, which lies along the coastline of the county, and the Rodgers Creek fault, which is a north-northwest-striking, right-lateral strike-slip fault believed to be an extension of the Hayward fault zone generally located to the south, on the eastside of the San Francisco Bay (see Table 3.6-2: Known Active Faults in the Project Vicinity). Additionally, a potentially active fault further north, the Maacama fault, is also considered to be part of the Hayward Fault subsystem. The project crosses the active Rodgers Creek fault crosses in two locations (see Figure 3.6-1: Geological Map).

Table 3.6-2: Known Active Faults in the Project Vicinity

Fault	Approximate Distance from the Site (miles)	Estimated Maximum Moment Magnitude	Slip Rate (mm/yr)	Approximate Recurrence Interval (years)	30-year rupture prob $M \geq 6.7$ [Min-Max]	Estimated Site Intensity Mod Mercalli
Rogers Creek	0	7.0	9	200	31% [12-67]	X
Maacama	4.3	6.9	9	220	13% [9-15]	X
Collayomi	16	6.5	0.6	1200	-	VII
West Napa	17	6.9	1	700	-	VI
San Andreas	20	7.9	24	220	59% [22-94]	VIII
Hunting Creek-Berryessa	24	7.1	6	200	9% [5-12]	VII
Bartlett Springs	27	7.1	6	218	9% [7-11]	VII
Hayward	33	7.1	9	160	31% [12-67]	VI
Calaveras	60	6.2	15	35	7% [1-22]	V

Sources: UCERF 2007 and Blake 2006

The Rodgers Creek fault is a significant component of the San Andreas fault system north of San Francisco. As such, it has been classified as an active Earthquake Fault Zone by the State of California, with a 31 percent probability of earthquake rupture in the next 30 years (UCERF 2 2008). It is also referred to as the Rodgers Creek Healdsburg fault, which extends 51 miles from

approximately 1 mile northeast of Sears Point to approximately 3 miles south of Cloverdale. The Rodgers Creek fault is a right-lateral strike-slip fault with an approximate slip rate of 9 millimeters/year. The last major earthquake events were estimated to have occurred in 1758, and two smaller magnitude 5.6 and 5.7 earthquakes occurred along the Rodgers Creek fault near Santa Rosa in 1969. Other faults in proximity to the site include right-lateral strike-slip faults associated with the San Andreas fault system, including the potentially active Maacama fault, northeast of Healdsburg. On August 24, 2014, a 6.0 magnitude earthquake occurred on the West Napa fault, causing light to moderate shaking in the project vicinity. The epicenter of this earthquake was approximately 35 miles south-southeast of the Town of Windsor.

Other predominantly active, northwest-striking right-lateral faults of the San Andreas fault system associated with historic seismic activity in proximity to the project include the Hunting Creek-Berryessa fault, approximately 24 miles to the east, along with the Bartlett Springs fault, approximately 27 miles to the east.

Strong Ground Motion

Portions of the project site are located within the Rogers Creek fault active fault zone, as defined by the Alquist-Priolo Act. The project is within an area that would be subject to ground shaking from earthquakes generated on the Rodgers Creek fault and other faults associated with the Coast Ranges, in particular the San Andreas and Hayward faults. Shaking from an earthquake can result in structural damage and can trigger other geologic hazards, such as liquefaction and landslides. Ground shaking is controlled by the earthquake magnitude, duration, and distance from the source. Ground conditions will also influence impacts from strong ground motions. Seismic waves attenuate with distance from their sources, so estimated bedrock accelerations are highest in areas closest to the source. Local soil conditions may amplify or dampen seismic waves as they travel from the underlying bedrock to the ground surface.

Ground motions for the site were calculated using the USGS Probabilistic Seismic Hazard Assessment online tool to calculate ground motions for firm rock, soft rock, and alluvium along the project area, corrected for site class by soil type. The peak ground acceleration (PGA) was obtained for the ground motion with a 10 percent probability of being exceeded in 50 years. The firm rock values were taken for the steep terrain northeast of Fulton at a latitude of 38.525 N and longitude 122.746 W. The soft rock values were taken for moderate slopes southeast of Windsor at a latitude of 38.535 N and longitude 122.766 W. The alluvium values were obtained for the low, mild slope near Fulton Substation at a latitude of 38.606 N and longitude 122.843 W. According to available information and the calculated PGA values provided in Table 3.6-3: Peak Ground Acceleration, the majority of the project site will likely be categorized as soft rock with a PGA of 0.952 g. This is considered a high value for California, which typically has values that range from about 0.1 g to over 1.0 g. Therefore, the majority of the project area may experience strong ground motion during an earthquake generated on the Rogers Creek fault.

Table 3.6-3: Peak Ground Acceleration

Ground Motion	Firm Rock	Soft Rock	Alluvium
Peak ground acceleration (PGA)	0.762 g	0.952 g	0.644 g

3.6.3.5 Landslides

The most frequent and widespread type of ground failure in Sonoma County is landslide. In the broadest sense, a landslide is a downward and outward movement of slope, forming materials composed of rock, soils, artificial fills, or a combination of these. Because of the highly fractured rock formations, steep topography, long coastline, and the area's seismicity, extensive land areas of the county are subject to this destructive hazard. Virtually all parts of the county, with the exception of the flat-lying alluvial valleys, are subject to damaging landslides of various kinds. Landslides vary in size, speed of movement, and mechanism. Many landslides occur as smaller slumps or flows within older larger slide masses; however, there have been landslides in the county that were as long as 2 miles, including the Mill Stream landslide 2 miles northwest of Mount St. Helena. During very high rainfall years in the San Francisco Bay area, large numbers of damaging landslides were common in Sonoma County. The California Geological Survey reported nine damaging landslides in Sonoma County in February and March of 1998, as a result of that winter's storms. Many of these landslides were the reactivation of pre-existing landslides. Figure 3.6-1: Geologic Map shows the geology of the project vicinity, including units mapped as landslides in steep terrain crossed by the project. The USGS (1997) landslide map for Sonoma County depicts the southern portion of the project area as relatively free of landslide susceptibility, whereas the northern portion of the project traverses numerous areas susceptible to landslides and earthflows.

Beyond the immediate area of surface fault rupture, ground deformation can distort the surface, secondary ground cracks can open, and both can damage structures. These kinds of ground failures are caused by the torsion effects on the ground adjacent to the fault trace as blocks of the earth move past each other. Seismic lurching is the movement of a soil or rock mass toward an unsupported free face, such as a road cut or steep natural hillside. These kinds of ground failures are caused by seismic accelerations and are transitional to seismically triggered landslides.

3.6.3.6 Subsidence

Subsidence, which is the downward displacement of a large portion of land, is caused by the withdrawal of fluids (e.g., ground water or oil) from subsurface reservoirs. As the water is removed, fluid pressure is reduced and the pore spaces between the grains in the aquifer collapse. Because the majority of the project is situated on sloping soft rock to stiff well-drained soil, the probability of subsidence is minimal.

3.6.3.7 Erosion

Erosion is the process by which rocks, soil, and other land materials are abraded or worn away from the Earth's surface over time. The rate of erosion depends on many factors, including soil type and geologic parent materials, slope and placement of soils, and human activity. The potential for erosion is highest in loose, unconsolidated soils. The steepness of slopes and absence of vegetation are also factors that increase the natural rates of erosion. Thus, erosion potential is high in steep, unvegetated areas, especially those disturbed by grading or other construction activities.

A soil's susceptibility to erosion varies and is a function of its characteristics, such as soil texture, soil structure, topography, amount of vegetative cover, and climate. Erosion from water

mainly occurs in loose soils on moderate to steep slopes, particularly during high-intensity storm events. Because the topography along the project in several area is relatively steep, erosion potential is high.

3.6.3.8 Liquefaction

Seismic ground-shaking causes liquefaction by increasing pore water pressure between the sand or silt grains, which temporarily transforms certain water saturated soils to a semi-liquid state. This results in loss of shear strength, thereby removing support from foundations and causing differential settlement, subsidence, or collapse of buildings, roadways, or other structures. Deposits that are susceptible to liquefaction are areas underlain by saturated unconsolidated alluvium that has fairly uniform grain size. In general, liquefaction hazards are most severe in saturated soils within the upper 50 feet of the ground surface. The potential for liquefaction increases with shallower groundwater. Thus, in alluvial basins within Sonoma County, the potential for liquefaction failures will tend to increase in the winter and spring, when the ground water table is higher. These areas include the largest population centers and most intensely developed areas of Sonoma County, as shown on maps prepared by the USGS.

The majority of the project is located on mildly to steeply sloped areas composed of stiff soil to soft rock with very low liquefaction potential. Areas of susceptibility to liquefaction occur in drainages crossed by the project, including Windsor, Pool, Wright, and Mark West creeks. The Fulton-Shiloh segment is located within an area identified as having medium liquefaction susceptibility. The northern end of the project, in the vicinity of Fitch Mountain Substation, is located in an area mapped as having a high susceptibility for earthquake-induced liquefaction.

3.6.4 APPLICANT-PROPOSED MEASURES AND POTENTIAL IMPACTS

The following sections describe significance criteria for impacts related to geology and soils derived from Appendix G of the CEQA Guidelines, provide APMs, and assess potential project-related construction and operational geologic impacts.

3.6.4.1 Significance Criteria

According to Section 15002(g) of the CEQA Guidelines, “a significant effect on the environment is defined as a substantial adverse change in the physical conditions which exist in the area affected by the proposed project.” As stated in Section 15064(b) of the CEQA Guidelines, the significance of an activity may vary with the setting. Per Appendix G of the CEQA Guidelines, the potential significance of project impacts related to geology and soils were evaluated for each of the criteria listed in Table 3.6-1, as discussed in Section 3.6.4.3.

3.6.4.2 Applicant-Proposed Measures

PG&E will implement the following APM (see Section 3.9, Hydrology and Water Quality, for APMs related to erosion control):

APM GS-1: Minimization of Construction in Soft or Loose Soils

Where soft or loose soils are encountered during project construction, appropriate measures will be implemented to avoid, accommodate, replace, or improve such soils. Depending on site-specific conditions and permit requirements, these measures may include:

- locating construction facilities and operations away from areas of soft and loose soil;
- over-excavating soft or loose soils and replacing them with engineered backfill materials;
- increasing the density and strength of soft or loose soils through mechanical vibration and/or compaction;
- installing material over access roads such as aggregate rock, steel plates, or timber mats; and
- treating soft or loose soils in place with binding or cementing agents.

APM GS-2: Reduction of Slope Instability during Construction

Existing natural or temporarily constructed slopes affected by construction will be evaluated for stability by qualified construction staff at the beginning of each construction day that employees may be exposed to the areas immediately upslope or downslope from the area of concern. In developing grading and construction procedures for access roads, the stability of both temporary and permanent cut, fill, and otherwise affected slopes will be analyzed. Construction slopes and grading will be designed to limit the potential for slope instability and minimize the potential for erosion and flooding during construction. During construction, slopes affected by construction activities will be monitored by qualified construction staff and maintained in a stable condition. Construction activities likely to result in slope instability will be suspended, as necessary, during and immediately following periods of heavy precipitation when unstable slopes are more susceptible to failure.

APM GS-3: Site-Specific Geotechnical Investigation

A geotechnical investigation will be conducted to evaluate the potential for surface fault rupture for poles within and adjacent to potentially active fault traces and earthquake fault zones, and seismic-induced ground failure in soil and rock materials underlying pole sites. Where significant potential for surface fault rupture exists, pole locations will be adjusted, where possible, to minimize any potential for damage based on the conclusions in the report.

3.6.4.3 Potential Impacts

Potential project impacts related to geology and soils were evaluated against the CEQA significance criteria and are discussed below. The impact analysis evaluates potential project impacts during the construction phase and the operation and maintenance (O&M) phase.

The project includes reconductoring existing 60 kV and 230 kV electric utility lines between Fulton Substation and Fitch Mountain #1 Tap. The O&M activities required for the recondored power and transmission lines will not increase from those currently required for the existing system; thus, no operation-related impacts related to geology and soils will occur. Therefore, the impact analysis is focused on construction activities that are required to install the

new conductor, replace and remove poles, perform minor substation modifications, and establish required access and work areas, as described in Chapter 2.0, Project Description.

a) Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault as 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, strong seismic ground shaking, seismic-related ground failure, including liquefaction, or landslides?

i) Rupture of a known earthquake? *Less-than-Significant Impact*

The Alquist-Priolo (A-P) Special Studies Zones Healdsburg Quadrangle Revised Official Map dated July 1, 1983, shows the Rodgers Creek fault as a series of fault segments that are approximately located, offset, and concealed under alluvial canyon outlets. The fault traces are located in the center of the A-P Zone. The project is at a shallow angle to the A-P Zone such that the project is within the active fault zone in two locations.

The project includes the reconductoring of existing power lines and replacement of existing poles; thus the project will not increase the risk of loss, injury, or death involving rupture of a known earthquake fault, and the impact will be less than significant. With the implementation of APM GS-3, a site-specific geotechnical investigation will be performed for poles within and adjacent to potentially active fault traces and earthquake fault zones, which will further reduce the less-than-significant impact.

ii) Strong seismic groundshaking? *Less-than-Significant Impact*

Based on the activity of major regional seismic sources (as shown in Tables 3.6-2 and 3.6-3), it is likely that the project will be exposed to at least one moderate or greater earthquake located close enough to produce strong ground shaking in the project area. The greatest potential for strong seismic ground shaking within the general project area comes from the active Rodgers Creek fault. In the event of a maximum credible earthquake event on the Rodgers Creek fault, estimated horizontal peak ground acceleration for firm rock, very dense soil/soft rock, and stiff soil sites within the project area ranges from approximately 0.762 g, 0.952 g, and 0.644g, respectively (USGS 2015).

Because seismic waves attenuate with distance from their source, estimated bedrock accelerations are highest for portions of the project near the fault zone, and decrease with distance from the fault. Local soil conditions may amplify or dampen seismic waves as they travel from underlying bedrock to the ground surface. In addition to the Rodgers Creek fault, other active or potentially active faults within the project area present significant potential for strong ground shaking within the region. Fault data for potential seismic sources in the project area are presented in Table 3.6-2. The project includes reconductoring existing power lines and replacing or removing existing poles; thus, the project will not increase the risk to the public from strong seismic shaking. With implementation of APM GS-3, use of site-specific seismic data will further reduce less-than-significant impacts.

iii) Seismic-related ground failure, including liquefaction? *Less-than-Significant Impact*

Modes of potential seismic-induced ground failure in the project area include liquefaction, lateral spreading, seismic slope instability, and ground cracking.

Liquefaction and Lateral Spreading

A review of USGS liquefaction susceptibility maps (USGS 2012) indicated that the majority of the project area has liquefaction hazards characterized as very low, moderately low, and moderate in the event of a magnitude 7.0 earthquake along the Rodgers Creek fault, which is mapped roughly parallel to the project alignment. Moderate to very high levels are mapped in very localized areas where the power line crosses perpendicularly over alluvium-filled stream channels. However, these areas are spanned by the project, and no poles are located within alluvium stream channels. Fitch Mountain Substation is within an area mapped as having high liquefaction potential; however, all construction will be within the fence line of the existing substation and the surface of this area has previously been improved and is covered with 95 percent compacted fill, which reduces potential impacts from seismic ground shaking. Therefore, this impact will be less than significant.

Lateral spreading is related to liquefaction in areas of free slopes. Such free-slope areas are confined to stream banks in the project area, and are generally spanned by the existing power line. The potential for lateral spreading to affect project facilities is very low given the relatively low potential for liquefaction, and will be a less than significant impact.

Seismic Slope Instability

Beyond the immediate area of surface fault rupture, ground deformation can distort the surface, secondary ground cracks can open, and both can damage structures. These types of ground failures are caused by the torsion effects on the ground adjacent to the fault trace as blocks of the earth move past each other. Seismic lurching is the movement of a soil or rock mass toward an unsupported free face such as a road cut, or steep natural hillside. These kinds of ground failures are caused by seismic accelerations and may transition to seismically triggered landslides. The project consists of replacing an existing power line and poles, and will not increase the risk of injury from seismic slope instability. Therefore, the impact will be less than significant. Implementation of APM GS-3 will further reduce less-than-significant impacts.

Ground Cracking

Ground cracking is typically a problem only on narrow-crested, steep-sided ridges. Incorporation of standard engineering practices as part of the project will ensure that people or structures are not exposed to geological or seismic hazards. Therefore, the potential impacts of ground cracking on project facilities will be less than significant.

iv) Landslides? *Less-than-Significant Impact*

Although portions of the project traverse areas that are susceptible to slope failure as a result of strong seismic ground shaking, existing poles are primarily located on stable hilltops, with the power line spanning the canyon and ravine slopes, minimizing the risk of slope failure to the project. Hilltop positions can also be at risk of encroachment by a landslide head scarp. However, the project will replace existing conductor and poles and will not change their

susceptibility from landslide beyond the existing condition of the power line. Therefore, the impact will be less than significant. Implementation of APM GS-2 will further reduce less-than-significant impacts.

b) Would the project result in substantial soil erosion or the loss of topsoil? *Less-than-Significant Impact*

Replacing existing poles will require excavation to accommodate the new poles, some of which will occur in soils on slopes that have a moderate to high wind and/or water erosion potential (see Figure 3.6-2: Soil Series Map and Section 3.6.3.3, Soils). In addition, minimal grading and/or scraping and vegetation clearing may be required for pole replacement and establishing construction work areas and access roads. Construction sites will be accessed using existing access roads, some of which are unpaved. However, because of the limited extent of earth-moving activities, substantial erosion or loss of topsoil is not expected to occur. Implementation of APM WQ-1: Stormwater Pollution Prevention Plan and APM WQ-2: Best Management Practices Inspection will further reduce the project's less-than-significant impacts related to soil erosion or loss of topsoil.

c) Would the project 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? *Less-than-Significant Impact*

Geologic units that have been mapped as being susceptible to slope failure may become unstable as a result of construction activities under adverse circumstances, such as prolonged storm events that saturate the ground. Because the new poles will replace the old poles in the same approximate locations, the need for excavating deep cuts for road building and work zones will be avoided. The use of helicopters will also reduce the heavy traffic along the steeper, more susceptible terrain. Implementation of APMs GS-1 and GS-2 will further reduce the project's less-than-significant impact.

d) Would the project be located on expansive soil, as defined in Section 1802.3.2 of the California Building Code (2007 or 2010), creating substantial risks to life or property? *No Impact*

As discussed previously in Section 3.6.3, expansive soil behavior is a condition in which clay soils react to changes in moisture content by expanding or contracting. Only two of the natural soil types identified within the project area are characterized as having high clay content and being poorly drained with moderate to high shrink-swell potential. These are both located in the flood plain, north of Fulton Substation along the Fulton-Shiloh segment of the alignment. Because poles will not be replaced along this segment, there will be no change from existing conditions and no impact will occur.

e) Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste-water disposal systems where sewers are not available for the disposal of waste water? *No Impact*

The project does not include a waste disposal system; therefore, no impact will occur.

3.6.5 REFERENCES

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