2.6 Geology, Soils, and Seismicity

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less Than Significant with Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
6. GEOLOGY, SOILS, AND SEISMICITY— Would the project:				
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 ground shaking?	☐	☐	☒	☐
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 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 soil, as defined in Table 18-1-B 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?	☐	☐	☐	☒

Setting

The Proposed Project and Weed Segment are located within Shasta Valley in Siskiyou County in central-northern California. Shasta Valley, extending northward from the north face of Mount Shasta, is a 340 square-mile basin that is a relatively flat-lying semi-arid plain punctuated by hundreds of hills, ridges, and small closed depressions (not connected by surface streams). The Shasta River drains northward through the valley to join the Klamath River near the Oregon border.

Shasta Valley lies between two geomorphic provinces, the Klamath Mountains on the west, and the Cascade Range on the east. Geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform. Eleven provinces are distinguished in California with each region displaying unique, defining features based on geology, faults, topographic relief and climate.

The Klamath Mountains on the west are characterized by complexly folded and faulted metamorphic, sedimentary, volcanic, and ultramafic rocks of Paleozoic age and by marine

sandstone and conglomerate of Cretaceous age. East of Shasta Valley the Cascade Range is dominated by Cenozoic age volcanic rock. The Cascade Range is a mountainous region famous for its chain of tall volcanoes that run north-south along the west coast of North America from British Columbia through Washington and Oregon to Shasta Mountain and Lassen Peak in northern California. The Cascades are part of the Pacific Ring of Fire, the ring of volcanoes around the Pacific Ocean. All of the known historic eruptions in the contiguous United States have been from volcanoes in the Cascade Range.

Shasta Valley and the Proposed Project and Weed Segment alignment are underlain by Quaternary age deposits of an exceptionally large debris avalanche that extends northward from the base of Mount Shasta underlying the valley floor. The debris avalanche probably originated in a quick succession of huge landslides of water-saturated rock on the northwest flank of ancestral Mount Shasta, each of which cut progressively deeper into the volcano. Evidence is lacking of contemporaneous volcanic activity, and the cause of the landslides is not known (Crandell, 1989).

Mount Shasta has continued to erupt at least once every 600-800 years for the past 10,000 years. Its most recent eruption probably was in 1786. Evidence for this eruption, recorded from sea by the explorer La Perouse, is somewhat ambiguous, but his description could only have referred to Mount Shasta. A small craterlike depression in the summit dome, containing several small groups of fumaroles and an acidic hot spring, might have formed during that eruption; lithic ash preserved on the slopes of the volcano and widely to the east yields charcoal dates of about 200 years (Wood and Kienle, 1990).

Topography

The Proposed Project and Weed Segment lies within Shasta Valley in the central portion of Siskiyou County. Shasta Valley is of relatively slight relief and, in general, drains towards the north. Elevations in the valley range from roughly 2,500 feet (MSL) near the City of Montague, near the northern end of the Proposed Project to 3,500 feet relative to Mean Sea Level (MSL) near the City of Weed, at the southern end of the Weed Segment.

Seismicity

There are no known active faults in areas underlying, or adjacent to, the Proposed Project and Weed Segment. The nearest known active fault is the north to north-northwest trending Cedar Mountain-Mahogany fault zone mapped approximately 28 miles east of the Proposed Project and Weed Segment area. The nearest significant seismic sources are the Cedar Mountain-Mahogany (CM-MFZ) and Hat Creek-McArthur-Mayfield (HC-M-MFZ) fault zones mapped approximately 28 miles and 38 miles, respectively, to the east and southeast and the Big Lagoon-Bald Mountain fault zone (BL-BMFZ), mapped approximately 85 miles to the southwest. The assigned maximum earthquakes for the CM-MFZ and the HC-M-MFZ are 7.1 and 7.2, respectively (USGS/CGS, 2002). The BL-BMFZ has an assigned maximum earthquake magnitude of 7.5. Based on a Probabilistic Seismic Hazard Assessment Model by United States Geological Survey and the California Geological Survey (2002) horizontal ground accelerations due to earthquakes that range from 0.1g (10 percent of the acceleration due to gravity) to 0.2g have a 10 percent

probability of exceedance in 50 years in the central Siskiyou County area. This also means that there is a 90 percent probability that these ground accelerations will not be experienced in the next 50 years. The ground accelerations that have 10 percent probability of occurrence in 50 years are usually considered in the seismic design of typical structures. As a comparison, potential ground accelerations that are three to four times higher than those assigned to the central Siskiyou County area having a similar probability of occurrence are present in the San Francisco Bay area, based on the Probabilistic Seismic Hazard Assessment Model.

Geologic Hazards

Expansive Soils

Expansive soils possess a “shrink-swell” behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils.

Soil Erosion

Erosion is the wearing away of soil and rock by processes such as wind and precipitation runoff. Soils containing high amounts of silt or clay can be easily erodible, while sandy soils are less susceptible. Excessive soil erosion can eventually lead to damage of building foundations and roadways. Typically, soil erosion potential is reduced once the soil is graded and covered with gravel, concrete, structures, or asphalt.

Settlement

Settlement is the depression of the bearing soil when a load, such as that of a structure or new fill material, is placed upon it. If not properly engineered, loose, soft, soils comprised of sand, silt, and clay have the potential to settle after a building or other load is placed on the surface. Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid compaction and settling of subsurface materials (particularly loose, uncompacted, and variable sandy sediments) due to the rearrangement of soil particles during prolonged ground shaking.

Landslides

A landslide is the sliding of a mass of loosened rock and/or soil down a hillside or slope. Based on the review of background information and the geologic field reconnaissance landslides do not underlie the Proposed Project or Weed Segment areas.

Volcanic Eruptions

An eruption from Mount Shasta could impact the Proposed Project and Weed Segment areas. The potential for an event with unavoidable adverse impacts is considered low and is no different than for existing conditions.

Seismic Hazards

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to movement on the fault plane. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Ground rupture is considered more likely along active faults. Because there are no known active faults underlying, or adjacent to the Proposed Project and Weed Segment areas, the likelihood of surface fault rupture is very low and would not be a design consideration.

Ground Shaking

Ground shaking at the Proposed Project and Weed Segment area could occur due to earthquakes on the regions active faults. However, ground motions attenuate with distance from the causative fault. There are no known active faults in the nearby vicinity of the Proposed Project and Weed Segment. Generally, Siskiyou County is an area of low seismic activity. There is no record of any death or injury resulting from earthquakes within the region and damage to buildings has been very minor (Siskiyou County General Plan, Seismic Safety and Safety Element, 1976). Accordingly, ground shaking in the Proposed Project and Weed Segment area can be expected to have low to moderate intensities.

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at depths less than 50 feet. Due to the relatively low potential for strong ground motions and a general lack of significant deposits of saturated loose soils, such as alluvium, the liquefaction potential, if any, can be addressed in the geotechnical design phase of the project.

Regulatory Context

State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zones Act), signed into law in December 1972, requires the delineation of zones along active faults in California. The main purpose of the Alquist-Priolo Act is to prevent the construction of buildings to be used for human occupancy (2,000 person hours or more per year) on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. Cities and counties must regulate certain development projects within the zones, which includes withholding permits until geologic investigations demonstrate that development sites are not threatened by future ground surface displacement

(Hart and Bryant, 1997). Surface fault rupture is not necessarily restricted to the area within a Fault Rupture Hazard Zone, as designated under the Alquist-Priolo Act.

California Building Code

The California Building Code (CBC) is another name for the body of regulations found in the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 2001). Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 or they are not enforceable. The purpose of the CBC is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. Published by the International Conference of Building Officials, the Uniform Building Code is a widely adopted model building code in the United States. The CBC incorporates by reference the Uniform Building Code (UBC) with necessary California amendments. These amendments include significant building design criteria that have been tailored for California earthquake conditions (CBSC, 2001).

The Proposed Project and Weed Segment are located within Zone 3, one of the four seismic zones designated in the United States. Zone 4 is expected to experience the greatest effects from earthquake ground shaking and therefore has the most stringent requirements for seismic design. Zone 3 still has a relatively high level of potential seismic activity, particularly when compared to much of the rest of the nation, but is somewhat less than Zone 4. The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies.

Local

Siskiyou County General Plan

The Siskiyou County General Plan Land Use Element contains the following policies that could be applicable to the Proposed Project and Weed Segment.

> *Policy 1.* No development will be allowed in identified and potential landslide area unless certified by a licensed California Geologist, as reasonably safe for the development proposed.
>
> *Policy 2.* Road cuts and development near gullies, extensive fill and ponded drainage, and further road widening in slide areas shall be in accordance with the recommendations of a licensed California Geologist and a Registered California Civil Engineer when deemed necessary by the Department of Public Works or the Planning Department.
>
> *Policy 7.* Specific mitigation measures will be provided that lessen soil erosion, including contour grading, channelization, revegetation of disturbed slope and soils, and project timing (where feasible) to lessen the effect of seasonal factors (rainfall and wind).

Additionally, the objective of the Seismic Safety Element which applies to the Proposed Project and Weed Segment is “to introduce safety considerations into the planning process in order to

reduce loss of life, injuries, damage to property, and economic and social dislocation resulting from fire and dangerous geologic occurrences".

City of Weed General Plan

The City of Weed General Plan Safety Element contains the following goals that could be applicable to the Proposed Project and Weed Segment:

> *Goal I.* Protection of the residents of the City of Weed from naturally and human caused accidents or hazards.
>
> *Goal II.* Protection of the property within the Weed planning area from naturally and human caused accidents or hazards.
>
> *Goal III.* Protection for future residents and property located in the Weed planning area from naturally or human caused hazards.

Additionally, the City of Weed has adopted all of the provisions of the Uniform Building Code (UBC), 1994 Edition, which cover all major aspects of building design and construction.

Geology, Soils, and Seismicity Impacts and Mitigation Measures

a.i) 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 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: *Less than significant.*

There are no known active faults underlying, or adjacent to, the Proposed Project and the Weed Segment. Moreover, the State of California Alquist-Priolo Earthquake Fault Zones has not been established in the vicinity of the Proposed Project and Weed Segment; therefore, the potential impact of fault rupture to the Proposed Project and Weed Segment would be less than significant.

a.ii) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking: *Less than significant.*

As discussed in the Setting section above, ground shaking in the vicinity of the Proposed Project and Weed Segment areas could occur due to earthquakes of the regions active faults. However, the active faults are relatively distant from the project site. Ground shaking due to seismic events is expected to have low to moderate intensities. The potential for seismic ground shaking to impact the Proposed Project and Weed Segment would be less than significant.

Transmission Line

Strong ground shaking could cause wires to swing and contact each other causing short-circuiting. However, observations from past earthquakes have shown that overhead transmission lines can accommodate strong ground shaking. In fact, the required separation distance to reduce wires touching in wind is sufficient to accommodate movement associated with ground shaking. Although ground shaking could cause wires to swing, existing design criteria for wind loads are adequate to preclude wires contacting and thus, this impact is less than significant.

Lucerne and Weed Substation

Substation improvements would be designed in accordance with the UBC and the seismic design criteria developed for the UBC Seismic Zone 3. Use of standard seismic engineering design criteria, and accepted construction methods would ensure that impacts associated with strong ground shaking at the Lucerne and Weed Substation would remain less than significant.

a.iii) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction: *Less than significant.*

Based on background information and the geologic field reconnaissance the Proposed Project and Weed Segment would not be expected to be adversely impacted by seismic-related ground failure, such as liquefaction. The liquefaction potential is expected to be further addressed in the design-level geotechnical investigation. The potential impact due to seismic-related ground failure is considered less than significant.

a.iv) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides: *Less than significant.*

Background data and the geologic field reconnaissance did not indicate the presence of landslides underlying, or adjacent to, the Proposed Project and Weed Segment. Shallow slope failures, such as slumps or debris flows can occur in virtually any sloping terrain. However, design-level geotechnical investigation, avoidance of potentially sensitive slopes and/or appropriate engineering and construction measures would avoid or reduce potential impacts of landslides. Additionally, the expected relatively deep embedment of the poles that would be replaced or installed, shallow soil failures would be unexpected. Accordingly, the potential impact to the Proposed Project and Weed Segment due to landslides and shallow soil failures would be less than significant.

b) Soil erosion or the loss of topsoil: *Less than significant.*

Surface soil erosion and loss of topsoil could occur from soil disturbance associated with pole installation, grading, work areas, the staging area, and the construction and use of new access roads. In cases such as this (i.e., constructed-related impacts), increased

runoff or entrainment of sediment in runoff is just as much a concern as soil erosion. It is *both* processes (surface runoff and disturbed soils) that must be managed, and the principle concern for the Proposed Project and the Weed Segment for this issue relates more to water quality impacts than to the effect of losing topsoil. Thus, the potential impact of the Proposed Project and the Weed Segment upon soil erosion is discussed and analyzed in Section 2.8, *Hydrology and Water Quality*.

c) Located on 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.*

Destabilization of natural or constructed slopes could occur as a result of construction activities. Excavation, grading, and fill operations associated with providing access to proposed pole locations as well as excavation associated with the Weed Substation upgrade, could alter existing slope profiles making them unstable as a result of over-excavation of slope material, steepening of the slope, or increased loading. However, standard engineering design features and construction procedures would be implemented to maintain stable slopes and excavations during construction, and therefore, impacts associated with destabilized slopes would be less than significant.

d) Located on expansive soil, creating substantial risks to life or property: *Less than significant.*

Shrink-swell or expansive soil behavior is a condition in which soil reacts to changes in moisture content by expanding or contracting. Expansive soils can cause structural damage particularly when concrete structures are in direct contact with the soils. Appropriate design features to address expansive soils may include excavation of potentially problematic soils during construction and replacement with engineered backfill, ground-treatment processes, direction of surface water and drainage away from foundation soils, and the use of deep foundations such as piers or piles. Implementation of these standard engineering methods would ensure that impacts associated with expansive soils would remain less than significant.

e) 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 Proposed Project and Weed Segment would not include any components that would include the construction of any septic tank or other wastewater disposal system into project area soils. Therefore, there would be no potential impact to soils in the project area from wastewater disposal.

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