4.6.1 Introduction

This section describes effects on geology and soils that would be caused by implementation of the proposed North Sky River Wind Energy Project and Jawbone Wind Energy Project (project). The following discussion addresses existing environmental conditions in the affected area, identifies and analyzes environmental impacts, and recommends measures to reduce or avoid adverse impacts anticipated from project construction, operation, and decommissioning activities. In addition, existing laws and regulations relevant to geology and soils are described. In some cases, compliance with these existing laws and regulations would serve to reduce or avoid certain impacts.

The analysis in this section is largely based on the Draft Geologic Hazard and Limited Geotechnical Review for the Proposed Jawbone Wind Energy Project (Kleinfelder, 2010) and the Preliminary Geotechnical & Geological Evaluation Report for the Proposed Hoffman Summit Wind Farm Project (PSI, 2008) which covers the site of the proposed North Sky River Wind Energy Project. The complete geotechnical reports are provided as Appendix G of this EIR.

4.6.2 Environmental Setting

Regional Setting

The proposed project is located in northeastern Kern County, 16 miles north of the City of Mojave and 40 miles east of City of Bakersfield. The site sits on rugged terrain at the base of the Tehachapi Mountains, just west of the Fremont Valley in the Mojave Desert. The Tehachapi Mountains are an east-west trending mountain range at the southern end of the Sierra Nevada which separates the Great Valley from the Mojave Desert. The mountain range has been sheared into this east-west trend by left-lateral fault movement of the Garlock fault which runs near the southern boundary of the range. The Tehachapi Mountains are primarily composed of Mesozoic Quartz monzonite with local lenses of hornblende diorite and are also characterized by deeply incised valleys, steep hillsides, and mountains that lie on the eastern side of the Pacific Crest line descending towards the Mojave Desert.

The project site is encompassed by the Jawbone Canyon Watershed. The general area in and around the project site is hilly, with mountain ridges, valley areas, and canyons. Ground cover is comprised of woodland and desert scrub, native and non-native grasses, and bare soil (Kleinfelder, 2010; PSI, 2008).

Geologic Setting and Soils

The overall geologic setting is similar for the Jawbone and North Sky project sites. However, the sites are discussed separately, based on specific information from the sites’ respective geotechnical reports.

Jawbone Project Site

The Jawbone tower sites would be located along the narrow ridge tops of an irregularly shaped hill, which is flanked by drainage channels and valleys. The site is primarily composed of Cretaceous
granite bedrock, along with a continuous exposure of marble traversing the ridgeline in its central portions. Alluvial soils (anticipated at less than a few feet thick) form a thin surface veneer where bedrock is not directly exposed. The adjacent hills have northerly oriented exposures of older metamorphic roof pendant rocks. (Kleinfelder, 2010)

North Sky Project Site

The site is predominantly made up of granitic rocks that consist chiefly of granodiorite, which is a hard, crystalline, igneous, quartz, feldspar and mica bearing rock that is present in most areas where the proposed wind turbine generators (WTGs) would likely be sited. Also, many of the lower slopes and valley bottoms are primarily underlain by massive, highly weathered rock with a few large outcrops of fresh rock. Portions of the southwestern area of the site (as well as localized areas in the northern and western areas) are occupied by metamorphic rock, consisting primarily of poorly to well-foliated schist, quartzite, and massive limestone. In some cases, the limestone has undergone a higher degree of metamorphism to create coarsely crystalline marble present as small, relatively thin north to northeasterly trending roof pendants within the granitic rocks.

Surficial soils consist of stream alluvium, colluviums, residuum, and topsoil, and are present locally throughout the site. Young alluvium deposits (coarse-grained; made primarily of angular quartz and feldspar grains) occupy the active stream beds, whereas the older alluvial deposits (more consolidated; made up of light brown silty sand with few cobble to boulder sized clasts) underlie stream terraces in the larger drainages. The modern stream channels have often cut into the older stream terraces, leaving vertical or near vertical channel walls between 5 and 10 feet in height.

Colluvium consists of thick accumulations of topsoil-like material, and is located at or near the base of steep slopes, on the lower portions of the hills. This clayey to silty sand with cobble to boulder-sized rocks and rock fragments is subject to significant consolidation with the addition of water.

Residuum is persistently found on or near ridge tops, and is typically composed of sand-sized decomposed granitic particles, and often with some silt or gravel. These soils are typically over-consolidated and very dense except for within 5 to 10 feet of the ground surface, where medium dense soils were observed.

On or near the tops of ridges (where the WTGs would most likely be sited), topsoil is thin to essentially non-existent. Topsoils on the lower slopes are poorly developed, consisting primarily of loose, dry, brown, silty sands with rock fragments. (PSI, 2008)

Faults and Seismic History

The proposed sites for the Jawbone and North Sky projects are not located within a State-designated Alquist-Priolo Earthquake Fault Zone, where site-specific studies addressing the potential for surface fault rupture are required. Major or active fault zones near the proposed project site include the Garlock Fault Zone (six miles to the south of North Sky; 12.6 miles to the southeast of Jawbone), San Andreas Fault Zone (43 miles to the southwest), and White Wolf Fault (19 miles to the west of North Sky; 9.5 miles to the southwest of Jawbone) (PSI, 2008; Kleinfelder, 2010).

- **Garlock Fault.** This near-vertical, active fault has primarily left lateral displacements. It trends east-northeast for 170 miles from its intersection with the San Andreas Fault (in the vicinity of Interstate Highway 5) toward Death Valley. The western segment of the Garlock Fault is located along the southern perimeter of the Tehachapi Mountains. In this segment, stream channels have been displaced by left slip movement. The north branch of the Garlock
Fault is considered an active fault, and is a high-angle shear zone with predominant strike slip movement to the west. (Kleinfelder, 2010)

- **San Andreas Fault.** This near-vertical and active fault, with primarily right lateral displacements, generally trends northwest for 320 miles. Many related faults, including the Tylerhorse Fault and the Cottonwood Fault, offset alluvial deposits and are active or potentially active. Several of the regionally related faults, including the Galway Lake and Homestead Valley Faults, have caused earthquakes and ground ruptures (right slip) in 1975 and 1979, respectively. All of these faults are considered part of the San Andreas Fault system. (Kleinfelder, 2010)

- **White Wolf Fault.** This shorter, left lateral, reverse fault has evidence of historic displacement. It is located at the western edge of Tehachapi Mountains. (Kleinfelder, 2010)

Several smaller, inactive, or potentially active faults are also located relatively close to the site. The southern segment of the inactive Sierra Nevada Fault System extends to within 9.5 miles east of the site. The Jawbone fault (inactive) may be a segment or splay off of this fault system (Kleinfelder, 2010; PSI, 2008). In addition, minor, inactive faults are present in the southern portion of the Jawbone project site (PSI, 2008).

### Slope Stability

In steep areas, strong ground shaking could activate landslides on hillsides, slope failures on creek banks (lurch cracking), and tension cracking in areas underlain by loose, low-density soils. Also, loose, highly jointed and fractured rock exposures at the edges of the ridge tops may mobilize such that local rock and debris falls may occur. Review of aerial photographs and geologic literature and site reconnaissance indicates the presence of only one suspected landslide in a remote, eastern portion of the North Sky site (PSI, 2008). No landslides were determined present in the Jawbone site (Kleinfelder, 2010).

The North Sky and Jawbone project sites could contain locally steep portions, hillsides, and creek banks, and areas underlain by loose, low-density soil – with the potential for landslides or other slope failures. Site specific slope stability will need to be addressed in the facility’s design level engineering and geotechnical investigations, and in development of grading plans and cut slopes.

### Soil Hazards

Geologic hazards associated with soil characteristics include erosion, expansion (“shrink-swell” patterns), and settlement, as described below.

**Erosion.** Soil erosion occurs when surface materials are worn away from the earth’s surface due to land disturbance and/or natural factors such as wind and precipitation. The potential for soil erosion is determined by characteristics including texture and content, surface roughness, vegetation cover, and slope grade and length. Wind erosion typically occurs when fine-grained non-cohesive soils are exposed to high velocity winds, while water erosion tends to occur when loose soils on moderate to steep slopes are exposed to high-intensity storm events. At the proposed sites, erosion would primarily occur within existing drainage channels and washes, with periodic sedimentation (transport) during and following periods of intense rainfall. The proposed towers, however, would be located on bedrock ridge tops, where the potential for erosion is considered to be low. There is low potential for erosion at localized shear zones in the bedrock and in areas of decomposing granite exposed at the ground surface (Kleinfelder, 2010). The potential for wind erosion to affect the structural integrity of project features is low, due to these soil characteristics.
Expansion. Soils which expand and contract in volume (“shrink-swell” pattern) are considered to be expansive, and may cause damage to aboveground infrastructure as a result of density changes that shift overlying materials. Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay. During geologic reconnaissance of the site, no expansive soils were observed; however, future subsurface exploration at the specific tower sites may encounter shear zones in the near surface granitic bedrock that may contain clay (Kleinfelder, 2010).

Settlement. The settlement of soils is characterized by sinking or descending soils that occurs as the result of a heavy load being placed on underlying sediments, and may be triggered by seismic events. However, seismically induced settlement is dependent on the relative density of the subsurface soils, and would not occur on surface or near surface bedrock, where the WTGs would most likely be sited.

Faults and Seismicity

The Mojave Desert region, including the proposed project site, is a geologically young and seismically active area. The uplift of the Tehachapi Mountains and the San Gabriel Mountains, as well as associated seismic activity, is the result of movement along the San Andreas and Garlock Fault systems (SEI, 2008). Significant relatively nearby seismic events with a magnitude greater than 6.5 are shown below, in Table 4.6-1.

<table>
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<th>Name</th>
<th>Year</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Magnitude</th>
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<td>-117.65</td>
<td>7</td>
</tr>
<tr>
<td>Owens Valley</td>
<td>1872</td>
<td>36.70</td>
<td>-118.10</td>
<td>7.4</td>
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<tr>
<td>Kern County</td>
<td>1952</td>
<td>35</td>
<td>-119.0167</td>
<td>7.5</td>
</tr>
<tr>
<td>San Fernando</td>
<td>1971</td>
<td>34.4112</td>
<td>-118.4007</td>
<td>6.6</td>
</tr>
<tr>
<td>Northridge</td>
<td>1994</td>
<td>34.213</td>
<td>-118.537</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Source: Kleinfelder, 2010

As described above in Section 4.6.2 (Geologic Setting – Faults and Seismic History), the proposed project is not crossed by an Alquist-Priolo Special Study Zone.

Strong Ground Shaking

Strong ground shaking from an earthquake can result in damage associated with landslides, ground lurching, structural damage, and liquefaction. A major seismic event on the Garlock or San Andreas faults (and possibly other active faults in the region) would likely cause moderate to significant ground shaking at the proposed project site (Kleinfelder, 2010). In-depth geotechnical study of final WTG locations would be conducted prior to implementation of the proposed project, in order to ensure proper design and compliance with applicable building codes and geotechnical requirements associated with the potential for strong ground shaking.

Fault Rupture

Ground surface rupture along an earthquake fault may cause damage to aboveground infrastructure and other features. The State of California has mapped known active faults that may cause surface fault rupture in inhabited areas as part of the Alquist-Priolo Earthquake Fault Zoning Act. As
mentioned, the project site is not located within or adjacent to an Earthquake Fault Zone regulated under the Alquist-Priolo Earthquake Fault Zoning Act. Since no known active or potentially active faults cross or project toward the site, the potential for fault-related surface rupture at the site is very low (PSI, 2008; Kleinfelder, 2010).

**Liquefaction**

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong ground shaking. Liquefaction can produce excessive settlement, ground rupture, lateral spreading, or failure of shallow bearing foundations. To determine the liquefaction susceptibility of a region, factors to analyze include: (1) the density and textural characteristics of the alluvial sediments, (2) the intensity and duration of ground shaking, and (3) the depth to groundwater.

On the North Sky site, depth to groundwater is greater than 50 feet; in accordance with Special Publication 117 (SP 117), published by the California Department of Conservation, Division of Mines and Geology (CGS, 2008), standard geotechnical engineering analyses in California are not required to assess liquefaction where the depth to groundwater is greater than 50 feet. The potential for seismically induced liquefaction to occur on the North Sky site is minimal (PSI, 2008).

On the Jawbone site, the proposed tower sites are located where surface or near surface bedrock is present (Kleinfelder, 2010) and bedrock is a lithified formational material which is not considered liquefiable. Liquefaction potential on the rest of the Jawbone site is considered comparable to that described above for the North Sky site. Therefore, the potential for seismically induced liquefaction to occur on the Jawbone site is minimal.

**Lateral Spreading**

Lateral spreading is a potential hazard commonly associated with liquefaction where extensional ground cracking and settlement occur as a response to lateral migration of subsurface liquefiable material. These phenomena typically occur adjacent to free faces such as slopes and creek channels. With little to no potential for liquefaction, and bedrock sites for the wind towers, lateral spreading would be highly unlikely.

### 4.6.3 Regulatory Setting

Geologic resources and geotechnical hazards are governed primarily by local jurisdictions. The conservation elements and seismic safety elements of city and county general plans contain policies for the protection of geologic features and avoidance of hazards.

The California Environmental Quality Act (CEQA) is the major environmental statute that guides the design and construction of projects on non-federal lands in California. This statute sets forth a specific process of environmental impact analysis and public review. In addition, the project proponent must comply with other applicable State and local applicable statutes, regulations and policies. Relevant and potentially relevant statutes, regulations and policies are discussed below.