3.6 GEOLOGY AND SOILS

GEOLOGY AND SOILS – Would the Project:	**Potentially Significant Impact**	**Less Than Significant with Mitigation**	**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 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 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 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 waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒

3.6.1 Environmental Setting

Geology and Topography

The Project area is located in the Imperial Valley, a part of the Salton Trough in the Colorado Desert physiographic province of California. With surface elevations as low as 270 feet below sea level, the Salton Trough formed as a structural depression resulting from tectonic boundary adjustment between the Pacific and the North American plates. The Salton Trough is bounded on the east and northeast by the San Andreas Fault and on the west by the San Jacinto fault zone. The trough is filled with more than 15,000 feet of Miocene and younger, marine and non-marine sediments capped by approximately 100 feet of Pleistocene and later lacustrine deposits that have been deposited by intermittent filling of the ancient fresh-water Lake Cahuilla.

According to the Geologic Map of California: Salton Sea Sheet (Jennings 1967), two geologic units are mapped within the Project area. The units consist of Quaternary (Holocene) alluvium (Qal), inter-fingered (over-lapping) with Quaternary (Holocene) lacustrine (lake) deposits (Ql). The Qal Holocene alluvium consists of unconsolidated clay, silt, sand, and gravel, occurring primarily as alluvial fan and stream wash deposits that are dominant above the 12-meter (40-foot) elevation. The Ql Holocene lake deposits are described as tan and gray fossiliferous clay, silt, sand, and gravel sediments of ancient Lake Cahuilla, and associated beach and playa lake deposits that are dominant at and below the approximately 12-meter (40-foot) elevation level. The Qal and Ql deposits are over-lapping within the Project area, and the Qal deposits extend below (southwest of) the 12-meter (40-foot) contour elevation in drainage channels. The geologic maps show that the paleo-shoreline of Lake Cahuilla rests at approximately 12-meter (40-foot) elevation, and is present within the Salvation Mountain Project area as a distinct escarpment. Lake Cahuilla sediments were deposited below this elevation during the early to late Holocene.

Soils

According to the Soil Survey of Imperial County (U.S. Department of Agriculture, Soil Conservation Service 1981), the soil types that occur within the Project area include Rositas fine sand, wet, 0-2 percent slopes, and Vint and Indio very fine sandy loams, wet. Rositas soil is very deep, nearly level, and located on flood plains and in alluvial basin floors. Rositas soil originated from eolian and alluvial sediments of mixed origin. It is typically reddish-yellow colored fine sand to a depth of 60 inches or more. The soil is nonsaline or slightly saline throughout. Permeability is rapid, surface runoff is slow, and the hazard of erosion is slight. Irrigation or seepage causes a perched water table at a depth of 36 to 60 inches, and can rise to a depth of 18 inches during periods of heavy irrigation. Limitations for septic tank absorption fields are a high water table and possible ground water contamination from septic tank effluent.

Vint and Indio very fine sandy loam is an undifferentiated unit consisting of deep, nearly level soils on the bed of ancient Lake Cahuilla. Vint very fine sandy loam formed in alluvial and eolian sediments from diverse sources. The surface layer is typically light brown colored, very fine sandy loam, about 10 inches thick. This is underlain by stratified light brown and pink colored, loamy, fine sand that has thin lenses of silt loam to a depth of 40 inches. From 40 to 60 inches, the soil is pinkish gray and light brown colored silty clay. Vint soil is nonsaline to moderately saline, and has moderately rapid permeability to a depth of 40 inches. Below this depth, the soil is slightly saline, and has low permeability. Surface runoff is slow, and the hazard of erosion is slight.

Indio very fine sandy loam was formed in alluvial and eolian sediments originating from diverse sources, and is a very deep soil. The surface layer is typically light brown colored, very fine, sandy loam about 12 inches thick. This is underlain by stratified light brown and pink colored silt loam and very fine sandy loam to a depth of 40 inches. From 40 to 60 inches, the soil is pinkish gray and light brown colored silty clay. The soil is nonsaline and has moderate permeability to a depth of about 40 inches, and is slightly saline with slow permeability below that. Surface runoff is slow, and the hazard of erosion is slight.

Vint and Indio very fine sandy loam has a perched water table at a depth of 36 to 60 inches, due to irrigation or seepage, which can rise to a depth of 18 inches during periods of heavy irrigation. Limitations for septic tank absorption fields are a high water table and slow permeability in the clayey substratum.

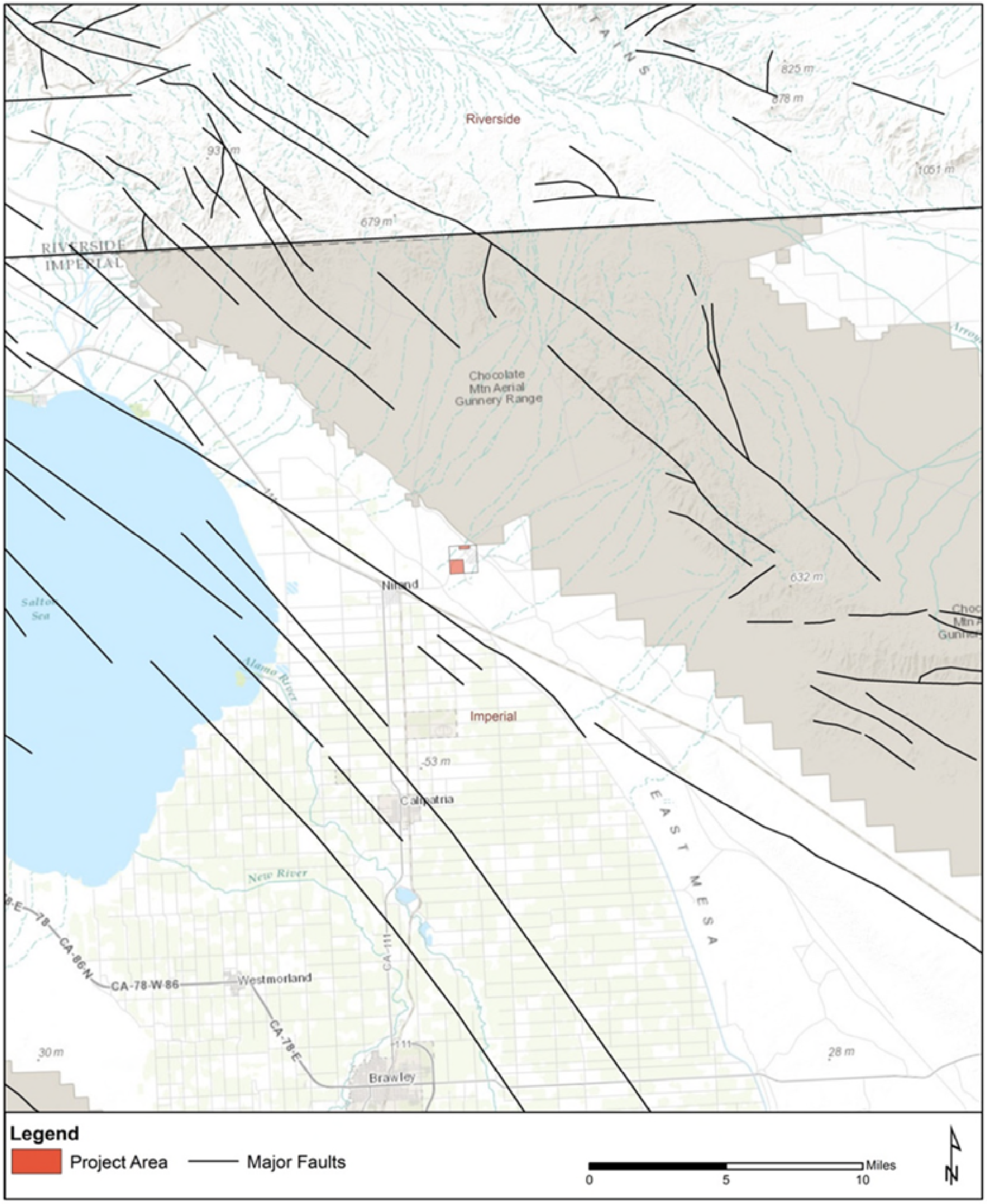
Faults and Seismicity

Much of the western United States is within a region that has moderate to intense seismicity related to tectonic plate movement. The most active regions in California are related to the San Andres Fault system that occurs within Imperial County (Figure 3.6-1). Imperial County has nine fault zones, primarily northwest-trending, including the San Andres, Imperial, Algodones Sand Dunes, Calipatria, Boundary, Superstition Hills, Superstition Mountain, Laguna Salada, and Elsinore. (Imperial and Superstition Hills faults comprise the San Jacinto fault zone). The most significant fault in Imperial County is the San Andres fault, which is quite active in the region. A greater amount of small to moderately sized earthquakes have Greater amounts of small to moderately sized earthquakes have occurred within Imperial County than along any other section of the San Andreas Fault System. During the current century, Imperial County has experienced eleven earthquakes of magnitude 6.0 or greater on the Richter scale, with the strongest being a magnitude of 7.2 in 2010. Furthermore, the deep, sediment-filled geologic structure of the Salton Trough makes the area particularly susceptible to severe seismic hazards such as ground shaking, surface ruptures, liquefaction, and landslides (Imperial County Multi-Jurisdictional Hazard Mitigation Plan Update 2013).

Surface Ruptures

Under the Alquist-Priolo Earthquake Fault Zoning Act, Earthquake Fault Zones were established by the California Division of Mines and Geology along "active" faults, or faults that have a potential for surface ruptures. Surface ruptures occur when movement on a fault deep within the earth breaks through to the surface. The Alquist-Priolo Earthquake Fault Zoning Act requires the State Geologist to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps (Earthquake Fault Zones maps).

Figure 3.6-1. Major Faults in the Project Vicinity



The Alquist-Priolo Earthquake Fault Zoning Act only addresses the hazard of surface fault ruptures and is not directed toward other earthquake hazards. Based on the Fault Activity Map of California (Department of Conservation 2010), faults in the Project vicinity are considered active. However, no fault structures are mapped within or adjacent to the Project area, so surface rupture hazards within the Project area are low.

Ground Shaking

Ground movement intensity during an earthquake is related to the overall magnitude of the quake, distance to the fault, depth of quake and focus of earthquake energy. Due to the presence of active faults in the area, one of the seismic hazards most likely to impact the Project area is ground shaking resulting from an earthquake on a major active fault in the vicinity.

Liquefaction

The type of soil within an area also plays a role in the intensity of ground shaking during an earthquake. For example, bedrock, or other dense or consolidated materials, are less prone to intense movement than soils such as alluvium. Liquefaction is a transformation of the soil from a solid to a liquefied state during which saturated soil temporarily loses strength due to the buildup of excess pore water pressure, especially during an earthquake. It occurs primarily in saturated, loose, fine-to medium-grained sands, and most commonly occurs in areas where the groundwater table is less than 10 to 30 feet below the ground surface. Four conditions can cause liquefaction to occur: 1) relatively shallow groundwater (high water table) with the potential to saturate the soil; 2) loosely packed soil (low to medium relative density); 3) unconsolidated soil (not clayey); and, 4) ground shaking of sufficient intensity must occur to function as a trigger mechanism. All these conditions exist at some degree at within the Project area.

Landslides

Landslides are caused by slopes becoming unstable and collapsing. Landsliding or slope instability may be caused by natural factors such as fractured or weak bedrock, heavy rainfall, erosion, earthquake activity, and fire, as well as by human modification of the land and water table. The Project area is relatively flat with no steep topography, and therefore the hazard of landslides is slight.

Soil Erosion

Erosion is the wearing away of soil and rock by natural and human induced processes such as mechanical or chemical weathering, mass wasting, and the action of waves, wind and water. Excessive soil erosion can eventually lead to damage of buildings and roadways. Areas in Imperial County that are most susceptible to natural erosion are the

Algondones Sand dunes paralleling the East Mesa and Superstition Mountain, and the Chocolate, Picacho, Cargo Muchacho, and Coast Range Mountains. The remainder of the County, including the Project area, is generally flat and experiences low levels of natural soil erosion.

Expansive Soil

Expansive soils display a shrink-swell behavior, which is a cyclic change in volume (expansion and contraction) caused by the process of wetting and drying that occurs in certain fine-grained clay sediments. The higher the percentage of expansive minerals present in near surface soils, the greater potential for significant expansion. Fine-textured soils have a tendency to expand as the amount of moisture increases and to contract as moisture decreases. Coarse-textured soils, such as sand and loamy sand, are quite stable during both dry and wet conditions. Expansive soils can exert enough force on a building or other structure to eventually cause structural damage. Deposits that underlie the Project site include fine grained sand and sandy loams that are underlain by silty clay from 40 to 60 inches below the surface in some areas; and overall are stable with a low expansion potential.

3.6.2 Regulatory Setting

Federal and State laws and regulations pertaining to this issue area and relevant to the Project are identified in Table 3.6-1.

Table 3.6-1. Laws, Regulations, and Policies (Geology and Soils)

CA	Alquist-Priolo Earthquake Fault Zoning Act (Pub. Resources Code, §§ 2621-2630)	This Act requires that "sufficiently active" and "well-defined" earthquake fault zones be delineated by the State Geologist and prohibits locating structures for human occupancy across the trace of an active fault.
	California Building Code (Cal. Code Regs., tit. 23)	This code contains requirements related to excavation, grading, and construction of pipelines alongside existing structures. A grading permit is required if more than 50 cubic yards of soil are moved. Sections 3301.2 and 3301.3 contain provisions requiring protection of adjacent properties during excavations and require a 10-day written notice and access agreements with adjacent property owners.
	California Seismic Hazards Mapping Act (Pub. Resources Code, § 2690 and following as Division 2, Chapter 7.8)	This Act and the Seismic Hazards Mapping Regulations (Cal. Code Regs., tit. 14, Div. 2, Ch. 8, Art. 10) are designed to protect the public from the effects of strong ground shaking, liquefaction, landslides, other ground failures, or other hazards caused by earthquakes. The Act requires that site-specific geotechnical investigations be conducted identifying the hazard and formulating mitigation measures prior to permitting most developments designed for human occupancy. Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (California Geological Survey 2008), constitutes guidelines for evaluating seismic hazards other than surface fault rupture and for recommending mitigation measures as required by section 2695, subdivision (a).

At the local level, the Seismic and Public Safety Element of the Imperial County General identifies potential natural and human-induced hazards and provides policy to avoid or minimize the risk associated with hazards. Imperial County's General Plan policies related to geology, soils, and seismicity are listed below.

- Implement codified ordinances and procedures which require the review and restriction of land use due to possible natural hazards.
- Monitor, evaluate, and analyze existing seismic and geological data as it pertains to Imperial County to determine future regulations and programs.
- Implement the geologic hazards section of the County's Codified Ordinances pursuant to the requirements of the Alquist-Priolo Geologic Hazards Zone Act.
- Ensure that no structure for human occupancy, other than one-story wood frame structures, shall be permitted within fifty feet of an active fault trace as designated on maps compiled by the State Geologist under the Alquist-Priolo Geologist Hazards Zone Act.
- The County should require suppliers of all existing utilities which cross active faults to file with the County an operation plan describing the probable effects of failures at the fault and the various emergency facilities and procedures which exist to assure that failure does not threaten public safety.
- Ensure that proposed highway construction which falls within an Alquist-Priolo Act Special Studies Zone shall be reviewed to ensure that grade-separated interchange structures are not located on or near an active fault.
- Periodically update maps of existing faults, slide areas, and other geographically unstable areas in the unincorporated area of the County.
- Support the safety awareness efforts of the Office of Emergency Services of Imperial County and other agencies through public information and educational activities.
- Continue to implement the Alquist-Priolo requirements in designated special study zones in the Imperial County Ordinance.

3.6.3 Impact Analysis

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.

No Impact. Based on the Fault Activity Map of California (Department of Conservation 2010, http://maps.conservation.ca.gov/cgs/fam/), no fault structures are mapped within or adjacent to the Project area. Furthermore, the proposed sale of School Lands does not include any construction or modification of existing conditions that could subject buildings, structures or people to surface ruptures.

ii) Strong seismic ground shaking?

No Impact. The Project area is located within a seismically active region that is well known for active faulting and historic seismicity. Consequently, the Project area is periodically subjected to seismic shaking and strong ground movement resulting from seismic activity along local and more distant active faults. The proposed sale of School Lands does not include any construction or modification of existing conditions that could subject buildings, structures or people to strong ground shaking.

iii) Seismic-related ground failure, including liquefaction?

No Impact. The Project area contains loosely packed, unconsolidated soil with low to medium density and a high water table; and these are conditions that create the potential for liquefaction within the Project area should ground shaking of sufficient intensity occur. However, the proposed sale of School Lands does not include any construction or modification of existing conditions that could subject buildings, structures or people to the hazard of liquefaction during an earthquake.

iv) Landslides?

No Impact. The Project area is relatively flat with no steep topography; therefore the hazard of landslides is unlikely. Furthermore, the proposed sale of School Lands does not include any construction or modification of existing conditions that could subject buildings, structures or people to land sliding.

b) Result in substantial soil erosion or the loss of topsoil?

No Impact. The proposed sale of School Lands does not include any construction or modification of existing conditions; therefore, there is no potential to cause soil erosion, or loss of topsoil resulting from the Project.

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?

No Impact. The proposed sale of School Lands does not include ground-disturbance, construction, or modification of existing conditions. Therefore, there is no potential for building on a geological unit or soil that is unstable and that could result in a 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?

No Impact. The soil types within the Project area have a low expansion potential. Furthermore, the proposed sale of School Lands does not include any construction or modification of existing conditions that could subject buildings, structures or people to hazards resulting from soil expansion.

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?

No Impact. The Project area contains soil types that have limitations for septic tank absorption fields, including a high water table and slow permeability in some areas. However, the proposed sale of School Lands does not include any construction or modification of existing conditions or propose the installation of septic tanks or alternative wastewater disposal systems.

3.6.4 Summary

Based upon the above considerations, no impacts to geology and soils are expected to occur as a result of the proposed sale of School Lands.