5.4 Geological Hazards and Resources

This section evaluates Rice Solar Energy Project (RSEP) in terms of potential exposure to geological hazards and potential to affect geologic resources of commercial, recreational, or scientific value. Section 5.4.1 describes the existing environment that could be affected, including regional and local geology and geological hazards. Section 5.4.2 identifies potential environmental effects from project development. Section 5.4.3 discusses potential cumulative effects. Section 5.4.4 discusses possible mitigation measures. Section 5.4.5 presents the laws, ordinances, regulations, and standards (LORS) applicable to geological hazards and resources. Section 5.4.6 identifies regulatory agencies and agency contacts. Section 5.4.7 describes the required permits. Section 5.4.8 provides the references used to develop this section.

5.4.1 Affected Environment

The RSEP site is located in a rural area on private land in a sparsely settled portion of the Mojave Desert/Sonoran Desert of eastern Riverside County. RSEP lies approximately 15 miles west-southwest of Vidal Junction. Between 1942 and 1944, the project site was occupied by Rice Army Airfield, which was part of the World War II Desert Training Center. After the war, the airfield was used as a private airport from 1949 to sometime between 1954 and 1958, when it was abandoned. The site is located on a bajada, or alluvial fan, along the southern end of the Turtle Mountains. The proposed RSEP site and proposed generator tie-lines would run across gently sloping topography of the Rice Valley. The RSEP site and linears are in the southeastern part of California, which is characterized by relatively low seismicity in a state which is considered to have moderate-to-high seismic activity.

5.4.1.1 Regional Geology

The Rice Valley area is in the Mojave Desert physiographic province of California. The Mojave Desert region is dominated by broad alluviated basins that are mostly aggrading surfaces receiving non-marine continental deposits from adjacent uplands. The deposits are burying the old topography, which was previously more mountainous. Throughout the Mojave, small hills rise above the alluvial valley fill, island-like in seas of sediment and gravel. These are remnants of the mountainous topography that is partly erased by erosion or buried by debris (Norris and Webb, 1990).

5.4.1.2 Local Geology and Stratigraphy

The vicinity of the project site is relatively flat, with an elevation of approximately 832 feet. The site slopes gently to the south, southeast (CDMG, 1963 and 1967).

The local area is underlain by a likely thick series of alluvial sediments derived from the surrounding highlands. Quaternary Dune Sands (Qs) are underlain by Recent Alluvium (Qal) that is composed of sand, silt, clay, and gravel. Older rocks composed of PreCambrian igneous and metamorphic rock complexes (PЄc) are present in the local mountains to the north and southwest of the site (CDMG, 1963). The surficial geology within 2 miles of the project site and the proposed generator tie-lines is shown on Figure 5.4-1.

Groundwater within the Rice Valley is relatively deep at an approximate depth of 150 feet below ground surface (bgs) (DWR, 2004)

A recent geotechnical investigation (see Appendix 2B) has shown that near-surface soils consist of damp, dense silty sands and poorly graded sands interpreted from borings drilled at the site. Boring depths ranged from approximately 10 to 85 feet bgs (Terracon, 2009). Groundwater levels were reported at a depth of approximately 360 feet bgs, based on pump test results (Terracon, 2009).

5.4.1.3 Seismic Setting

The modern tectonic setting of southern California is dominated largely by the transform plate boundary contact between the Pacific and North American plates south of the Mendocino triple junction. The Pacific plate is slipping in a north-northwest direction (N35°W to N38°W) at a rate of about 1.81 to 1.95 inches per year (46 to 47 millimeters per year) with respect to the North American plate. Right-lateral strike-slip displacement along the major branches of the San Andreas Fault system accommodates most of this plate motion, with the remainder generating Holocene tectonism and seismicity at the western continental margin.

The site is not within a designated Alquist-Priolo zone (Hart and Bryant, 1999). The Pinto Mountain fault is the nearest fault at 65 miles away. Because of the distance from the faults, ground rupture at the site is unlikely. The seismicity of the RSEP site area can be characterized as an area of low seismic activity, with potentially low-magnitude earthquakes (Figure 5.4-2).

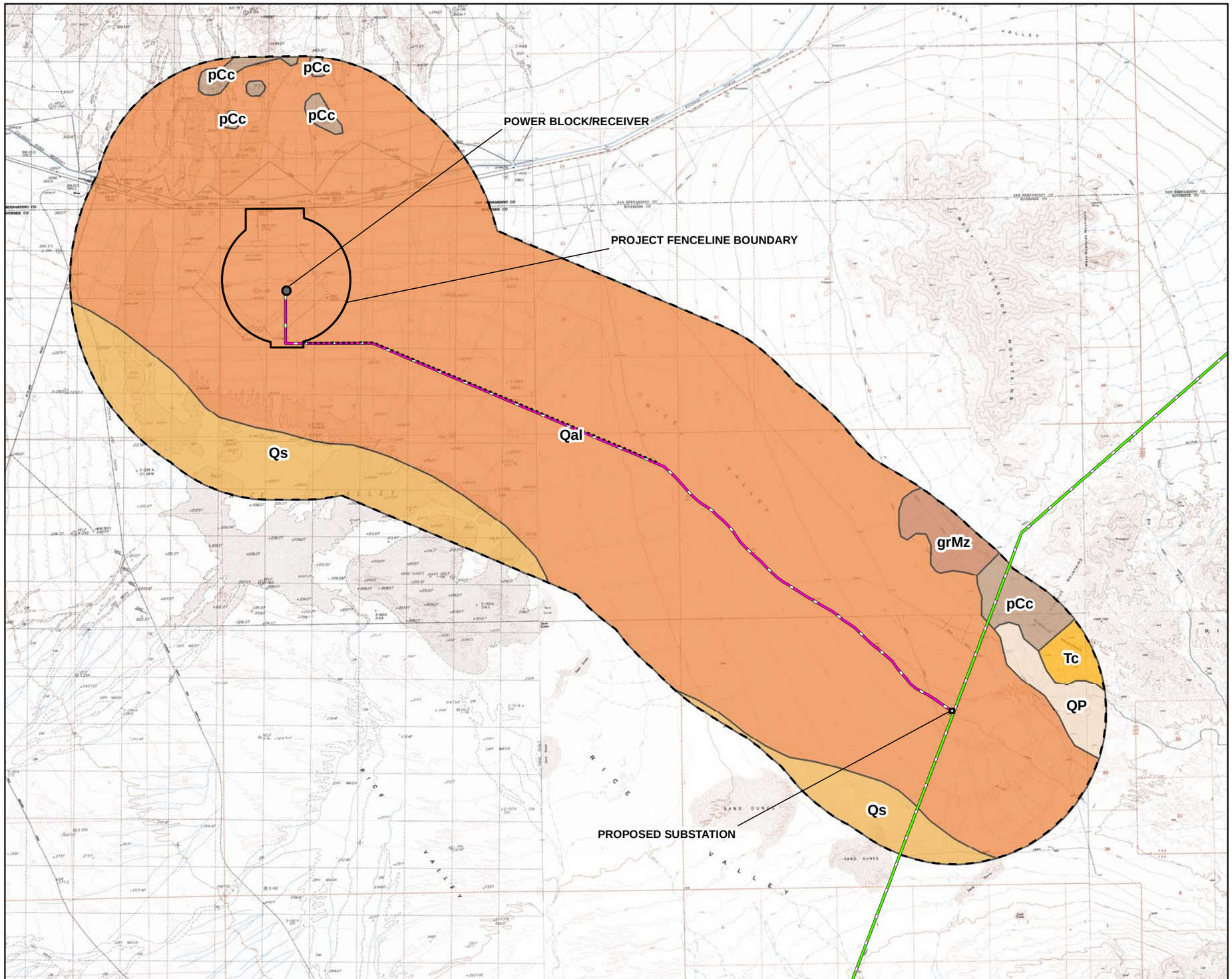
Table 5.4-1 presents the active faults within 100 miles of the project site that are capable of a deterministic peak site acceleration of at least 0.07g using EQFAULT (Blake, 2004a). These faults have the most potential to cause ground shaking at the site.

TABLE 5.4-1
Significant Seismic Sources

Fault	Fault Type[a]	CGS Fault Class[a]	Slip Rate (millimeters per year)[a]	Maximum Moment Magnitude (M_w)[a]	Approximate Site-to-Source Distance (miles)[b]
Pinto Mountain	Left Lateral Strike Slip	B	2.5	7.2	64.9
Pisgah-Boullion Mountain-Mesquite Lake	Right Lateral Strike Slip	B	0.6	7.3	68.5
San Andreas (Coachella)	Right Lateral Strike Slip	A	25.0	7.2	71.9

[a]California Geological Survey, 2002

[b]EQFAULT (Blake, 2004a)



LEGEND

- ACCESS ROAD ALONG T-LINE
- GENERATOR TIE-LINE
- PARKER-BLYTHE TRANSMISSION LINE
- TWO MILE BUFFER
- PROJECT FENCELINE BOUNDARY
- PROPOSED SUBSTATION
- POWER BLOCK/RECEIVER

GEOLOGY TYPE

- QP - PLIO-PLEISTOCENE NON-MARINE
- Qal - ALLUVIUM
- Qc - PLEISTOCENE NON-MARINE
- Qs - DUNE SAND
- Tc - TERTIARY NON-MARINE
- grMz - MESOZOIC GRANITIC ROCKS
- pCc - PRE-CAMBRAIN IGNEOUS AND METAMORPHIC ROCK COMPLEX

SOURCE: Riverside County Planning Department, General Plan Update, 2008. San Bernardino County GIS, General Plan Data, 2006.

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

N

0 3,500 7,000
Feet

FIGURE 5.4-1
SURFICIAL GEOLOGY WITHIN TWO MILES OF PROJECT SITE
RICE SOLAR ENERGY PROJECT
RIVERSIDE COUNTY, CALIFORNIA

Source: Fault Activity Map of California and Adjacent Areas,
Jennings, C.W. (compiler) with assistance from G.J. Sauce,
California Department of Conservation, Division of Mines and Geology, 2000.

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

FIGURE 5.4-2
PRINCIPAL FAULT MAP
RICE SOLAR ENERGY PROJECT
RIVERSIDE COUNTY, CALIFORNIA

CH2MHILL

SAC\\ZION\SACGIS\PROJ\SOLARPROJECTS\SOLARRESERVE_377714\MAPFILES\FAULTMAP.MXD MHASKELL 9/8/2009 16:29:23

There is a long history of minor seismic activity at the site. Table 5.4-2 includes the notable historic earthquake events from 1800 to 1999. The faults presented in Table 5.4-2 were limited to earthquake events that created a deterministic ground acceleration of greater than 0.025g according to EQSEARCH (Blake, 2004b).

TABLE 5.4-2
Significant Historic Earthquakes

Fault	Date	Maximum Moment Magnitude (Mw)[a]	Site Acceleration (g)[a]	Estimated Modified Mercalli Intensity	Approximate Site-to-Source Distance (miles)[a]
Landers Earthquake[b]	June 28, 1992	7.6	0.046	VI	93.3
Joshua Tree Earthquake[b]	October 16, 1999	7.1	0.036	V	90.7
Twenty Nine Palms Earthquake[a]	May 2, 1949	5.9	0.031	V	50.1
Salton Earthquake[a]	May 1868	6.3	0.029	V	70.2
Desert Hot Springs Earthquake[c]	December 4, 1948	6.5	0.026	V	90.6

[a]EQSEARCH (Blake, 2004b)

[b]USGS ShakeMap Archive for Southern California (USGS, 2009)

[c]California Geological Survey. Historic Earthquake Database (CGS, 2009)

5.4.1.4 Potential Geological Hazards

The following subsections discuss the potential geological hazards that might occur in the project area.

5.4.1.4.1 Ground Rupture

Ground rupture is caused when an earthquake event along a fault creates rupture at the surface. Because no known active faults cross the project site, the likelihood of ground rupture to occur is considered low.

5.4.1.4.2 Seismic Shaking

The project area has experienced seismic activity with relatively moderate ground motion during past earthquakes, and it is likely that strong earthquakes causing seismic shaking will occur in the future. The significant geological hazard at the RSEP site is moderate ground-shaking due to an earthquake. Ground shaking from a magnitude 7.3 earthquake could occur within an approximately 70-mile radius of the site (Blake, 2004b).

Based on the proximity to active faults and the site's earthquake history, the site could be subject to minor to moderate ground accelerations. The National Seismic Hazard Maps 2002 (USGS, 2008a) indicate that the peak bedrock acceleration (PBA) at the site is 0.14 g for a 2,475 years recurrence interval or 2 percent probability of exceedance in 50 years. Based on the PSHA Interactive Deaggregation (USGS, 2008b), the San Andreas Fault is the controlling fault impacting the potential ground motion at the site.

5.4.1.4.3 Liquefaction

During strong groundshaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength and act as a fluid. This phenomenon is known as liquefaction. Liquefaction depends on the depth to water, grain size distribution, relative soil density, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement. Soil conditions at the RSEP site predominantly consist of alluvial clay, silt, sand, and gravel. However, given the deep groundwater table (approximately 150 feet bgs) at the site, the potential for liquefaction to impact the site is negligible.

5.4.1.4.4 Mass Wasting

Mass wasting depends on steepness of the slope, underlying geology, surface soil strength, and moisture in the soil. Significant excavating, grading, or fill work during construction might introduce mass wasting hazards at the project site. Because the project site is relatively flat and no significant excavation is planned, the potential for direct impact from mass wasting at the site is considered low to negligible.

5.4.1.4.5 Subsidence

Subsidence can be caused by natural phenomena during tectonic movement, consolidation, hydrocompaction, or rapid sedimentation. Subsidence also can occur from human activities, such as withdrawal of water or hydrocarbons in the subsurface soils. No known subsidence problems exist in the project area. The Riverside County General Plan (Safety Element chapter) does not indicate that the project area is within an area prone to subsidence (Riverside County, 2008).

5.4.1.4.6 Expansive Soils

The soil profile at the project site consists of thick units of silty sands and poorly graded sands. Expansive soils were not encountered in any site borings drilled to a depth of 85 feet bgs (Terracon, 2009). As a result, the potential for expansive soils to impact the project is negligible.

5.4.1.4.7 Seiches and Tsunamis

Seiches are wave oscillations in enclosed bodies of water that may be caused by earthquakes. Since there are no large bodies of water near the project site, there is no chance that a seiche could occur at the site.

Tsunamis are seismically induced sea waves that can be triggered by submarine earthquakes, landslides, or volcanic eruptions. Since the project site is more than 160 miles from the Pacific Ocean, there is no potential for a tsunami along the coast of California to affect the project site.

5.4.1.5 Geologic Resources of Recreational, Commercial, or Scientific Value

At the project site, the geologic units at the surface and in the subsurface are widespread alluvial deposits that occur throughout the southeastern part of the Mojave/Sonoran Deserts region; these units are not unique in terms of recreational, commercial, or scientific value.

The State Mining and Geology Board has classified California land in terms of Mineral Resources Zones (MRZ) to designate lands that contain mineral deposits. The Rice,

California area of Riverside County has been mapped as "MRZ-4" which is defined as "Areas where there is not enough information available to determine the presence or absence of mineral deposits" (Riverside County, 2008). There are no active permitted mines in the Rice, California area (Riverside County, 2009).

There are no known oil or natural gas deposits in the wider project area of the site (CDOGGR, 2009). The project would have no effect on any potential oil and gas production or on other geologic resources of commercial value or on the availability of such resources. Thus, no information was found to suggest that the proposed RSEP would adversely affect geologic resources of recreational, commercial, or scientific value.

5.4.2 Environmental Analysis

The potential environmental effects from construction and operation of RSEP on geologic resources and risks to life and property from geological hazards are presented in the following sections.

5.4.2.1 Significance Criteria

According to Appendix G of the California Environmental Quality Act statutes, a project would have a significant environmental impact in terms of geological hazards and resources if it would do the following:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault (Alquist-Priolo Fault Zone)
  - Strong seismic ground shaking
  - Seismic-related ground failure, including liquefaction
- 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 offsite landslide, lateral spreading, subsidence, liquefaction, or collapse.
- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local plan, specific plan, or other land use plan.

5.4.2.2 Geological Hazards

There is significant potential for seismic groundshaking to affect the project site in the event of a large-magnitude earthquake occurring on fault segments near the project. Neither the RSEP nor its generator tie-line, however, are located within an Alquist-Priolo Special Studies Zone or within the trace of any known active fault. The project would, therefore, not be likely to cause direct human exposure to ground rupture. Seismic hazards will be minimized by conformance with the recommended seismic design criteria of the 2007 California Building Code (CBC) (California Building Standards Commission, 2007).

The probability of liquefaction, impact from expansive soils, mass wasting, subsidence, or flooding at the project site is low to negligible.

In summary, compliance with the 2007 CBC requirements will reduce the exposure of people to the risks associated with large seismic events to less-than-significant levels. In addition, major structures will be designed to withstand the strong ground motion of a Design Basis Earthquake (DBE), as defined by the 2007 CBC. By complying with CBC standards, impacts associated with geological hazards will be less than significant.

5.4.2.3 Geological Resources

The proposed RSEP would not result in a loss of availability of a known mineral resource that would be of value to the region and the residents of the state. In addition, RSEP would not result in the loss of availability of a locally important mineral resource recovery site delineated on a local plan, specific plan, or other land use plan. There are no such resources that have been identified on or near the site, and so there will be no adverse impacts on geological resources.

5.4.3 Cumulative Effects

A cumulative impact refers to a proposed project's incremental effect together with other closely related past, present, and reasonably foreseeable future projects whose impacts may compound or increase the incremental effect of the proposed project (Public Resources Code §21083; California Code of Regulations, Title 14, §15064(h), 15065(c), 15130, and 15355).

The proposed RSEP will not cause adverse impacts on geological resources and will not cause an exposure of people or property to geological hazards. There are no minor impacts, in addition, that could combine cumulatively with those of other projects. Thus, the project will not result in a cumulatively considerable impact.

5.4.4 Mitigation Measures

To address potential impacts related to geological hazards, the following mitigation measures are proposed for the project:

- Structures will be designed to meet seismic requirements of the 2007 CBC. Moreover, the design of plant structures and equipment will be in accordance with 2007 CBC earthquake design requirements to withstand the ground motion of a DBE.
- A geotechnical engineer will be assigned to the project to carry out the duties required by the CBC to assess geologic conditions during construction and approve actual mitigation measures used to protect the facility from geological hazards.

With the implementation of these mitigation measures, RSEP will not result in significant direct, indirect, or cumulative geology-related impacts.

5.4.5 Laws, Ordinances, Regulations, and Standards

The LORS that may apply to geologic resources and hazards are summarized in Table 5.4-3. The local LORS discussed in this section are certain ordinances, plans, or policies of the County of Riverside. There are no federal LORS that apply to geological hazards and resources.

TABLE 5.4-3
Laws, Ordinances, Regulations, and Standards for Geological Hazards and Resources

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
State			
CBC, 2007 as amended by the County of Riverside	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity	California Building Standards Commission, State of California, and Riverside	Section 5.4.2.2
Alquist-Priolo Earthquake Fault Zoning Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, California Code of Regulations)	Identifies areas subject to surface rupture from active faults	California Building Standards Commission, State of California, and County of Riverside	Section 5.4.2.2
The Seismic Hazards Mapping Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, California Code of Regulations.)	Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides	California Building Standards Commission, State of California, and County of Riverside	Section 5.4.2.2
Local			
County of Riverside General Plan (Riverside County, 2008)	Riverside County Code	County of Riverside	Section 5.4.2.2

5.4.6 Agencies and Agency Contacts

Compliance of building construction with CBC standards is covered under engineering and construction permits for the project. There are no other permit requirements that specifically address geologic resources and hazards. However, excavation/grading and inspection permits may be required prior to construction and will be included in the overall project construction permit (see Section 5.6, Land Use).

5.4.7 Permits and Permit Schedule

No permits are required for compliance with geological LORS. However, Riverside County Code Enforcement is responsible for inspections and ensuring compliance with building standards.

5.4.8 References

Blake, T. 2004a. EQFAULT V. 3.00b. Thomas F. Blake Computer Services and Software, Thousand Oaks, CA.

Blake, T. 2004b. EQSEARCH V. 3.00. Thomas F. Blake Computer Services and Software, Thousand Oaks, CA.

California Geological Survey (CGS). 2002. Probabilistic Seismic Hazard Assessment Maps (probabilistic site hazard analysis) http://www.conservation.ca.gov/cgs/rghm/psha/index.htm.

California Geological Survey (CGS). 2009. California Historical Earthquake Online Database. http://redirect.conservation.ca.gov/cgs/rghm/quakes/historical/Index.htm.

California Division of Mines and Geology (CDMG). 1963. *Geologic Map of California, Needles Sheet.* 1:250,000 Scale. Geologic Atlas of California. Compiled by C. Bishop.

California Division of Mines and Geology (CDMG). 1967. *Geologic Map of California, Salton Sea Sheet.* 1:250,000 Scale. Geologic Atlas of California. Compiled by C. W. Jennings.

California Building Standards Commission. 2007. *2007 California Building Code*, California Code of Regulations, Based on 2006 International Building Code.

California Department of Water Resources (DWR). 2004. *Colorado River Hydrologic Region. Rice Valley Groundwater Basin.* California's Groundwater, Bulletin 118.

California Division of Oil, Gas, and Geothermal Resources (CDOGGR). 2009. Oil and Gas Field Maps. http://www.consrv.ca.gov/dog Accessed May 2009.

Hart, E. and W. A. Bryant. 1999. Fault-Rupture Hazard Zones in California (Alquist-Priolo Special Studies Zones Act of 1972 with Index to Special Studies Zones Maps), *California Division of Mines and Geology Special Publication 42*, Revision 2.

Norris, R. M. and Webb, R. W. 1990. *Geology of California (second edition*). John Wiley and Sons. New York. 365 pp.

Riverside County. 2008. Riverside County Draft General Plan (including the Land Use chapter).

Riverside County. 2009. Riverside County Planning Department. *Online listing of permitted surface mines*. www.rctlma.org/planning/content/geninfo/surface_mine_list.aspx Website accessed August 2009.

Terracon. 2009. *Preliminary Geotechnical Engineering Report. Proposed 10MW Solar Energy Project. Former Rice Airfield, Rice CA.* Prepared for SolarResource. July.

United States Geological Survey (USGS). 2008a. National Seismic Hazard Maps. http://gldims.cr.usgs.gov/nshmp2008/viewer.htm.

United States Geological Survey (USGS). 2008b. 2002 Interactive Deaggregations http://eqint.cr.usgs.gov/deaggint/2002/index.php.

United States Geological Survey (USGS). 2009. ShakeMap for Southern California Archive. http://earthquake.usgs.gov/eqcenter/shakemap/list.php?y=2009.