DOCKETED

Docket Number:	15-AFC-02
Project Title:	Mission Rock Energy Center
TN #:	207151-11
Document Title:	5.4 Geological Hazards and Resources
Description:	N/A
Filer:	Sabrina Savala
Organization:	Mission Rock Energy Center, LLLC
Submitter Role:	Applicant
Submission Date:	12/30/2015 3:48:08 PM
Docketed Date:	12/30/2015

5.4 Geological Hazards and Resources

This section presents an evaluation of the MREC 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 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 MREC site is located in an industrial area within unincorporated Ventura County, California, near Santa Paula, California along the southern side of the Santa Clara River Valley, just north of the Santa Clara River. The property lies approximately 0.5 mile southeast of the intersection of Todd Road and SR 126. The MREC site and proposed gas and water supply pipelines will run across relatively flat terrain. The proposed generator tie-line will be placed on towers and will extend into the southern slopes of the Sulphur Mountains to the northwest of the MREC site.

5.4.1.1 Regional Geology

The MREC is located within the Transverse Ranges geomorphic province of southern California in the Ventura Basin. The Transverse Ranges are an east-west trending series of steep mountain ranges and valleys that have formed as a result of intense north-south compression. This compression, as well as the overall structural framework of the region is generally considered the result of the right-lateral, strike-slip movement on the “Big Bend” segment of the San Andreas Fault.

Folded and faulted Pliocene to Quaternary sedimentary rocks mark the structure of the Santa Paula Quadrangle. Major faults in the region are west to southwest trending and include the Oak Ridge Fault and the Pintas Point-Ventura Fault.

The Santa Clara River Valley is the surface expression of a deep synclinal trough into which an enormous thickness of Plio-Pleistocene sediments was deposited contemporaneous with folding. The limbs of the Santa Clara Syncline are truncated and overturned by the San Cayetano Fault on the north and by the Oak Ridge Fault on the south. The great thicknesses of folded and faulted Cenozoic petroleum-rich sedimentary rocks make this region one of the important oil-producing areas of the U.S. (CGS, 2002).

Oak Ridge Fault

The Oak Ridge Fault is predominantly a south-dipping thrust fault that extends for more than 60 miles from the Santa Barbara Channel eastward. Locally, the fault trends along the north side of South Mountain and Oak Ridge to the western end of the Santa Susana Mountains. Between Saticoy and Santa Paula, the Oak Ridge Fault trends northeast, dips as steeply as 80 degrees to the southeast, and is characterized by left-lateral oblique slip in the subsurface. The surface trace of the Oak Ridge thrust is easily found on just about any map of the area as it forms a ridge (hence its name) to the south of its trace (South Mountain), and is roughly paralleled by both the Santa Clara River and SR-126, from the town of Piru to the coast, just southeast of Ventura. The Oak Ridge thrust continues offshore, out to a point about 20 kilometers due south of Santa Barbara. The offshore segment is associated with a definite zone of active seismicity, though the only known Holocene surface rupture is found well onshore, between the towns of Bardsdale and Fillmore. At its eastern end, the Oak Ridge thrust becomes progressively more difficult to trace, and appears to be overthrust by the Santa Susana fault, thus becoming a blind thrust fault. The fault associated with the 1994 Northridge earthquake is probably part of the Oak Ridge fault system, as it shares many of the characteristics of this fault. This blind thrust

fault is known either as the Pico Thrust, named for the Pico Anticline (a geologic fold it is creating), or as the Northridge Thrust (SCEDC, 2015). According to the California Geological Survey (CGS), this fault exhibits late Quaternary fault displacement (within last 700,000 years) (CGS, 2010). An Alquist-Priolo (AP) Earthquake Fault Zone (EFZ) has not been established for the Oak Ridge Fault in the vicinity of the site (CGS, 2007). The Oak Ridge Fault System probably contains many branching faults and is believed to be associated with one or more faults of similar trend present in the Santa Barbara Channel west of the Oxnard Plain (Ventura County, 2013).

Ventura-Pitas Point Fault

The Ventura-Pitas Point Fault is located approximately 6 miles to the west of the MREC site. This fault lies within a mapped AP EFZ (CGS, 2007). The EFZ does not extend to near the MREC site (CGS, 2007). The mapped trace of the Ventura Fault extends along the base of the hills to the northwest of the project site, on the north side of the Santa Clara River from Santa Paula westerly to the mouth of the Ventura River, then westerly into the Santa Barbara Channel area. The fault is a north dipping, left-lateral reverse fault.

Evidence for the existence of the Ventura Fault is based mainly upon minor faulting of terrace deposits north of San Buenaventura and evidence of faulting from oil well drilling logs. The Ventura-Pitas Point fault system is an oblique left lateral reverse fault with a slip rate of 1.0 mm/yr, a maximum moment magnitude of 6.8 and a recurrence interval of 1,112 years (Ventura County, 2013).

Wright Road Fault

Approximately 3 miles south of the MREC site, beyond South Mountain, the north-northwest-trending Wright Road Fault separates the Oxnard Plain from the western ends of the South Mountain Anticline, Las Posas Valley, and Camarillo Anticline. It is postulated that the fault is a tear fault that forms the boundary between two blocks that are deforming at different rates. This fault is expressed at the surface by a youthful-appearing scarp in the alluvium of the Las Posas Valley and is included in the Official AP EFZ list prepared by CGS (2007).

5.4.1.2 Local Geology and Stratigraphy

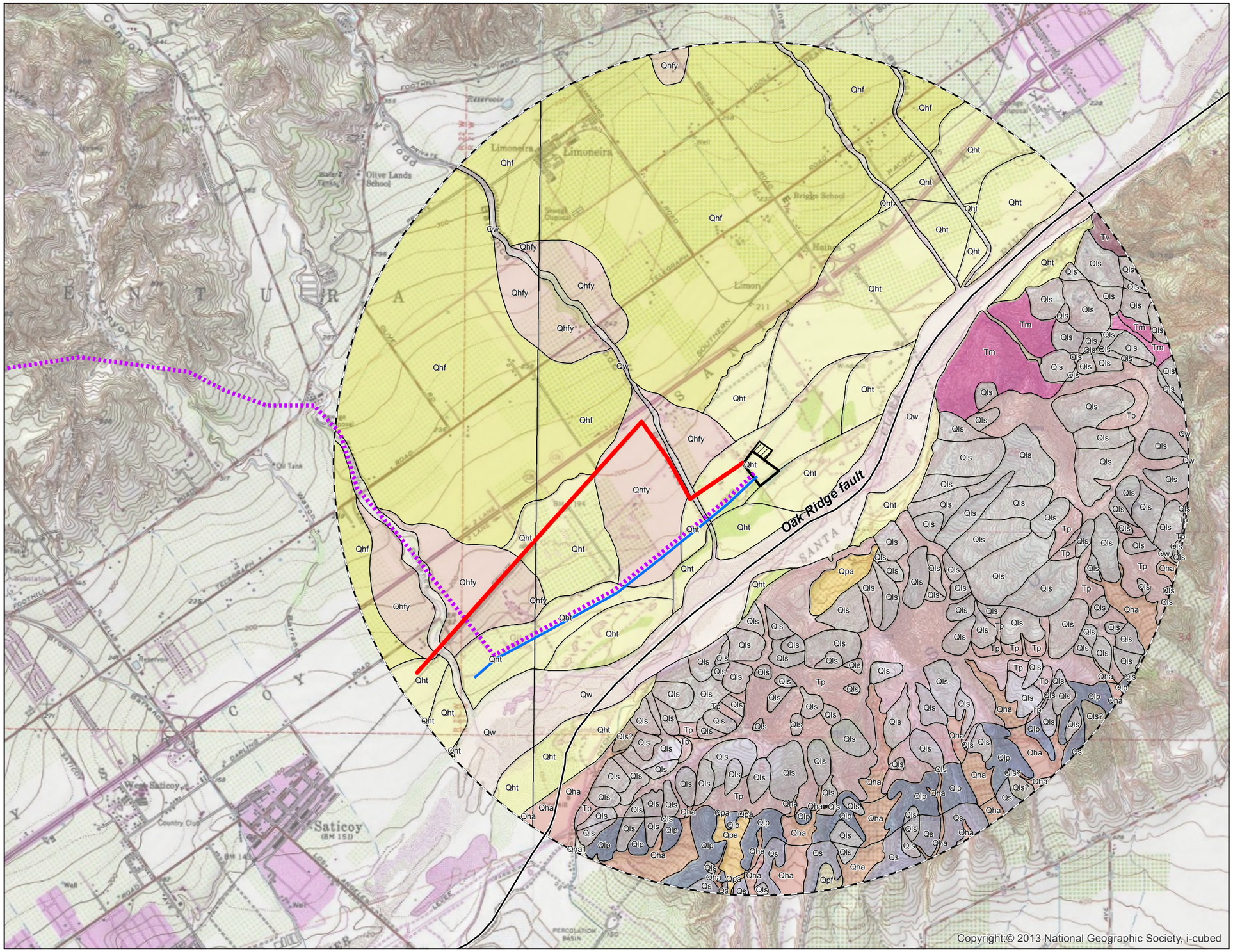
The vicinity of the MREC site is relatively flat, with a gentle southwesterly grade. The elevation of the site varies from approximately 180 to 185 feet above mean sea level.

The surficial geology in the immediate vicinity of the MREC site is composed entirely of late Quaternary to Holocene alluvial deposits. Further east and south, Pliocene Marine and undivided pre-Cenozoic metasedimentary and metavolcanic rocks are present in the 2-mile radius (Figure 5.4-1 and Figure 5.4-2) that comprises South Mountain.

An MREC site-specific preliminary geotechnical report has not yet been completed. A geotechnical investigation will be completed prior to commencement of detailed design activities.

5.4.1.3 Seismic Setting

The tectonic setting of Southern California is complex, made up of numerous fault systems, including strike-slip, oblique, thrust, and blind thrust faults. Therefore, any specific area is subject to seismic hazards of varying degree, depending on the proximity and earthquake potential of nearby active faults, and the local geologic and topographic conditions. Seismic hazards include primary hazards from surface rupturing of rock and soil materials along active fault traces, and secondary hazards resulting from strong ground shaking, such as liquefaction and lateral spreading.



VICINITY MAP

LEGEND

- Project Site
- Laydown Area
- Natural Gas Pipeline Route
- Generator Tie-Line
- Process Water Supply Line
- Oak Ridge Fault
- 2-Mile Site Buffer

Qw	Wash deposits within major river channels (Holocene, historic)
Qhfy	Alluvial fan deposits (latest Holocene)
Qha	Alluvial deposits (Holocene)
Qha1	Alluvial deposits (Holocene)
Qha2	Alluvial deposits (Holocene)
Qht	Stream terrace deposits (Holocene)
Qhf	Alluvial fan deposits (Holocene)
Qf	Alluvial fan deposits (late Pleistocene to Holocene)
Qpf	Undivided fan deposits (Pleistocene)
Qpa	Undivided alluvial deposits (Pleistocene)
Qoa	Alluvial deposits (early to middle Pleistocene)
Qls	Landslide deposits (Holocene to Pleistocene)
Qs	Saugus Formation (Pleistocene)
Qsbc	Santa Barbara Formation, conglomerate
Qlp	Las Posas Formation (Pleistocene)
Qsb	Santa Barbara Formation (Pleistocene)
Tp	Undivided Pico Formation (Pliocene)
Tm	Modelo Formation (Miocene)
Tv	Vaqueros Sandstone (early Miocene)
alf	Artificial levee fill
water	Water

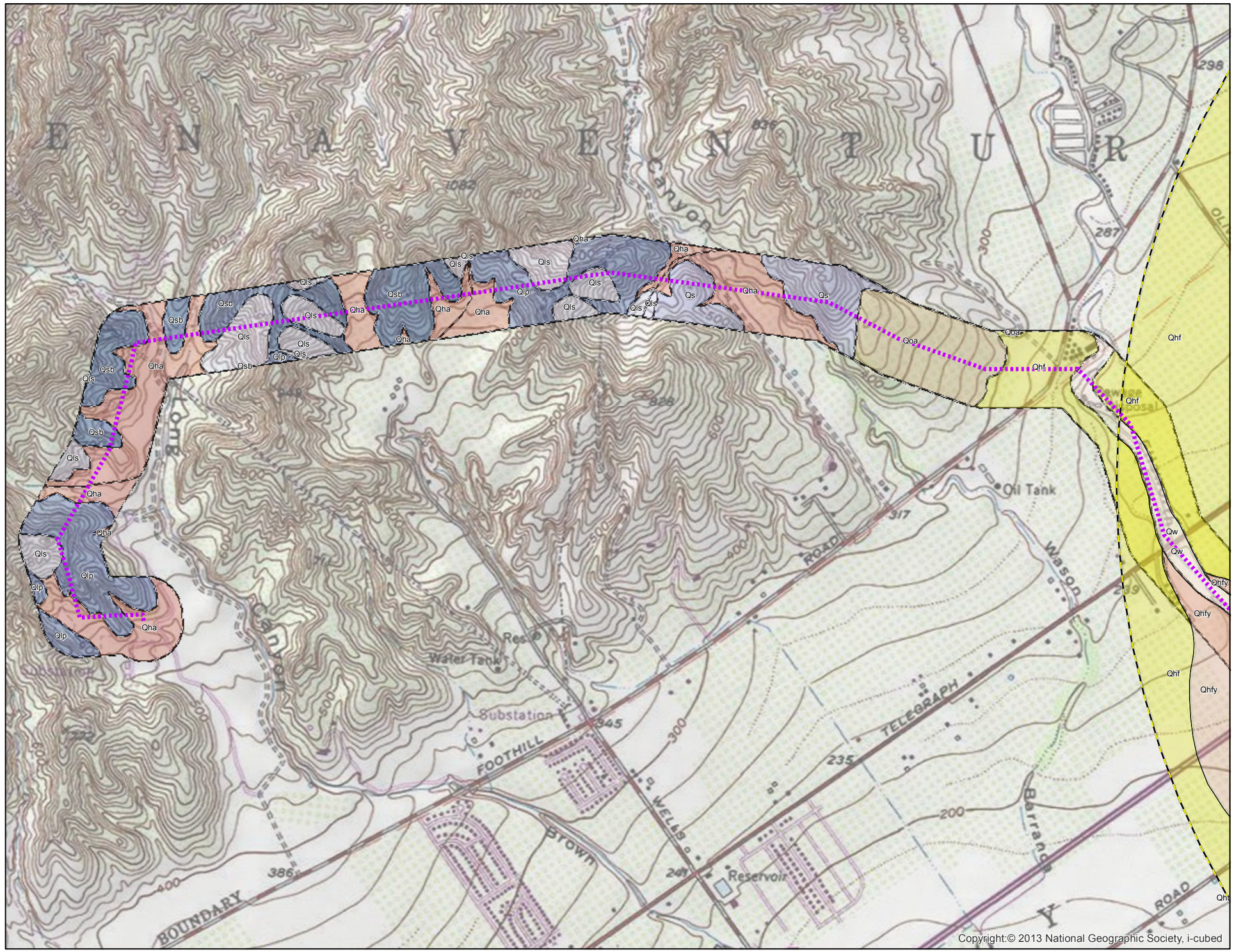
USGS Geologic Map of the Santa Paula, Saticoy 7.5' Quadrangle, Ventura County, California
USGS, (2010).

0 1,500 3,000
Feet

N

Figure 5.4-1
Surface Geology
Within Two Miles of Project Site
Mission Rock Energy Center
Ventura County, California

ch2m



VICINITY MAP

LEGEND

- Project Site
- Laydown Area
- Natural Gas Pipeline Route
- Generator Tie-Line
- Process Water Supply Line
- 500-ft Linear Buffer
- 2-Mile Site Buffer

Qw	Wash deposits within major river channels (Holocene, historic)
Qhfy	Alluvial fan deposits (latest Holocene)
Qha	Alluvial deposits (Holocene)
Qha1	Alluvial deposits (Holocene)
Qha2	Alluvial deposits (Holocene)
Qht	Stream terrace deposits (Holocene)
Qhf	Alluvial fan deposits (Holocene)
Qf	Alluvial fan deposits (late Pleistocene to Holocene)
Qpf	Undivided fan deposits (Pleistocene)
Qpa	Undivided alluvial deposits (Pleistocene)
Qoa	Alluvial deposits (early to middle Pleistocene)
Qls	Landslide deposits (Holocene to Pleistocene)
Qs	Saugus Formation (Pleistocene)
Qsbc	Santa Barbara Formation, conglomerate
Qlp	Las Posas Formation (Pleistocene)
Qsb	Santa Barbara Formation (Pleistocene)
Tp	Undivided Pico Formation (Pliocene)
Tm	Modelo Formation (Miocene)
Tv	Vaqueros Sandstone (early Miocene)
alf	Artificial levee fill
water	Water

USGS Geologic Map of the Santa Paula, Saticoy 7.5' Quadrangle, Ventura County, California

N

0 625 1,250
Feet

Figure 5.4-2
Surface Geology
Around Project Linears
Mission Rock Energy Center
Ventura County, California

The MREC site area can be characterized as an active seismic area, with potentially large-magnitude earthquakes. Principal faults in the vicinity of MREC are shown on Figure 5.4-3.

5.4.1.4 Potential Geological Hazards

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

Ground Rupture

Ground rupture is caused when an earthquake event along a fault creates rupture at the surface. The Oak Ridge Fault is mapped approximately one-third of a mile south of the MREC site. According to Fisher (2005), the segment of the Oak Ridge fault through the Santa Clara River Valley should be considered for further evaluation by the CGS as it is a potential regional earthquake threat. Data suggest that more recent late Pleistocene or early Holocene activity may have occurred (Fisher, 2005). The likelihood of a ground rupture at the MREC to occur is considered low to moderate; however, further fault-induced ground rupture evaluation and analysis should be conducted as part of the project's forthcoming geotechnical investigation.

Seismic Shaking

The MREC site area has experienced seismic activity with strong 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 MREC site is strong ground-shaking due to an earthquake. Peak horizontal ground acceleration (PGA), based on 10 percent probability of exceedance in 50 years, of up to 0.75 g from a magnitude 6.9 Mw design level earthquake could affect the MREC site (Ventura County, 2013).

Liquefaction

During strong ground shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength and act as a fluid. This phenomenon is known as liquefaction. Liquefaction typically occurs within the upper 50–75 feet below ground surface, and is dependent on the depth to water, grain size distribution, relative soil density, degree of saturation, and intensity and duration of the earthquake. The potential hazards associated with liquefaction are ground deformation (soil densification) and lateral spreading.

Soil conditions at the MREC site predominantly consist of quaternary alluvial deposits that could include liquefiable materials. Depth to water at an adjacent property to the MREC has been measured to be relatively shallow (10 feet below ground surface) (Earth Systems, 2007). Although an MREC site-specific geotechnical investigation has not been performed and liquefaction conditions have not been determined, the site area has been mapped by Ventura County to be within mapped liquefaction potential area (Ventura County 2013). Further analysis of liquefaction potential will be evaluated in an MREC site-specific geotechnical investigation.

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 MREC 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.

Subsidence

Subsidence is any settling or sinking of the ground surface over a regional area arising from surface or subsurface causes, such as earthquakes or groundwater and/or oil extraction. A very significant area in Ventura County, the Oxnard Plain (to the south-southwest of the MREC), is experiencing subsidence. Data suggest that groundwater has been extracted from the aquifers underlying the Oxnard Plain at a

rate that exceeds the rate of replenishment; causing a condition referred to as “overdraft.” Overdraft of water for agricultural, domestic and industrial uses has caused a significant drop in the water table in the Oxnard Plain. The Ventura General Plan (Hazards Appendix) indicates that the MREC site is within an area prone to subsidence (Ventura County, 2013).

Expansive Soils

Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. The Ventura County General Plan states that some parts of the county exhibit expansive soils, but it is not pervasive or widespread throughout the county (Ventura County, 2013). The potential for expansive at MREC is most likely low, but will be further evaluated in a site-specific geotechnical investigation. Expansive soils, if present, can be readily mitigated by either soil amendments or by removal and replacement with non-expansive soils.

Seiches and Tsunamis

Tsunamis are seismically induced ocean waves with very long periods. Tsunamis may be manifested in the form of wave bores or a gradual upwelling of sea level and can be caused by offshore landslides or earthquakes. Because the MREC is located roughly 180 feet above mean sea level, the potential for a significant tsunami event that would affect the site is negligible.

Seiches are defined as oscillations in confined or semi-confined bodies of water due to earthquake shaking. Because there are no large bodies of water near the project site, there is no potential for a seiche to impact the MREC.

5.4.1.5 Geologic Resources of Recreational, Commercial, or Scientific Value

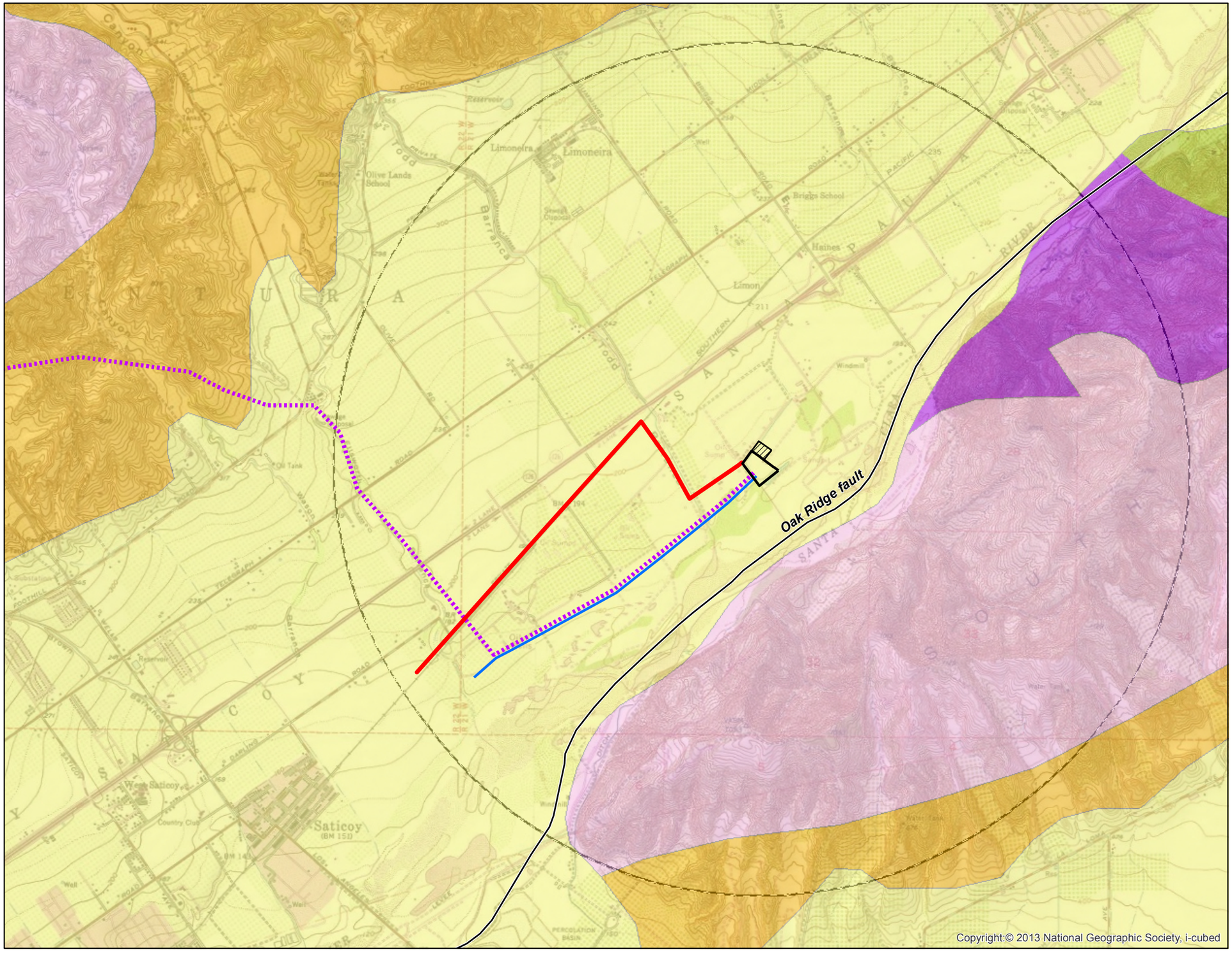
At the MREC site, the geologic units at the surface and in the subsurface are widespread alluvial deposits that occur throughout the Ventura Basin area; these units are unique in terms of commercial value. However, the potential for recreational or scientific (e.g. rare mineral or fossil) deposits is very low, given the geologic environment in the area. Known commercial petroleum deposits and aggregate deposits are present in the MREC area.

There are numerous petroleum wells located near the MREC site. According to online maps of the California Division of Oil, Gas and Geothermal Resources (2015), petroleum deposits are present in the immediately project area. Numerous active or abandoned wells are present and generally align with the Oak Ridge Fault trace that traverses the southern part of the basin and though the MREC area (Figure 5.4-4).

In 1993, the California Division of Mines and Geology published a comprehensive mineral land classification for aggregate materials in the Southern Ventura County area. Based on this investigation, the MREC area is mapped as Mineral Resource Zone 2. Mineral Resource Zone 2 is defined as areas where the “likelihood exists for significant aggregate deposits” (CDOC, 1993).

5.4.2 Environmental Analysis

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



VICINITY MAP

LEGEND

- Project Site
- Laydown Area
- Oak Ridge Fault
- 2-Mile Site Buffer

Sedimentary Rocks

- Alluvium (mostly Holocene, some Pleistocene), Quaternary Non-marine and Quaternary Marine
- Oligocene non-Marine
- Plio-Pleistocene non-Marine and Pliocene non-Marine
- Pliocene Marine

Plutonic, Metavolcanic and Mixed Rocks

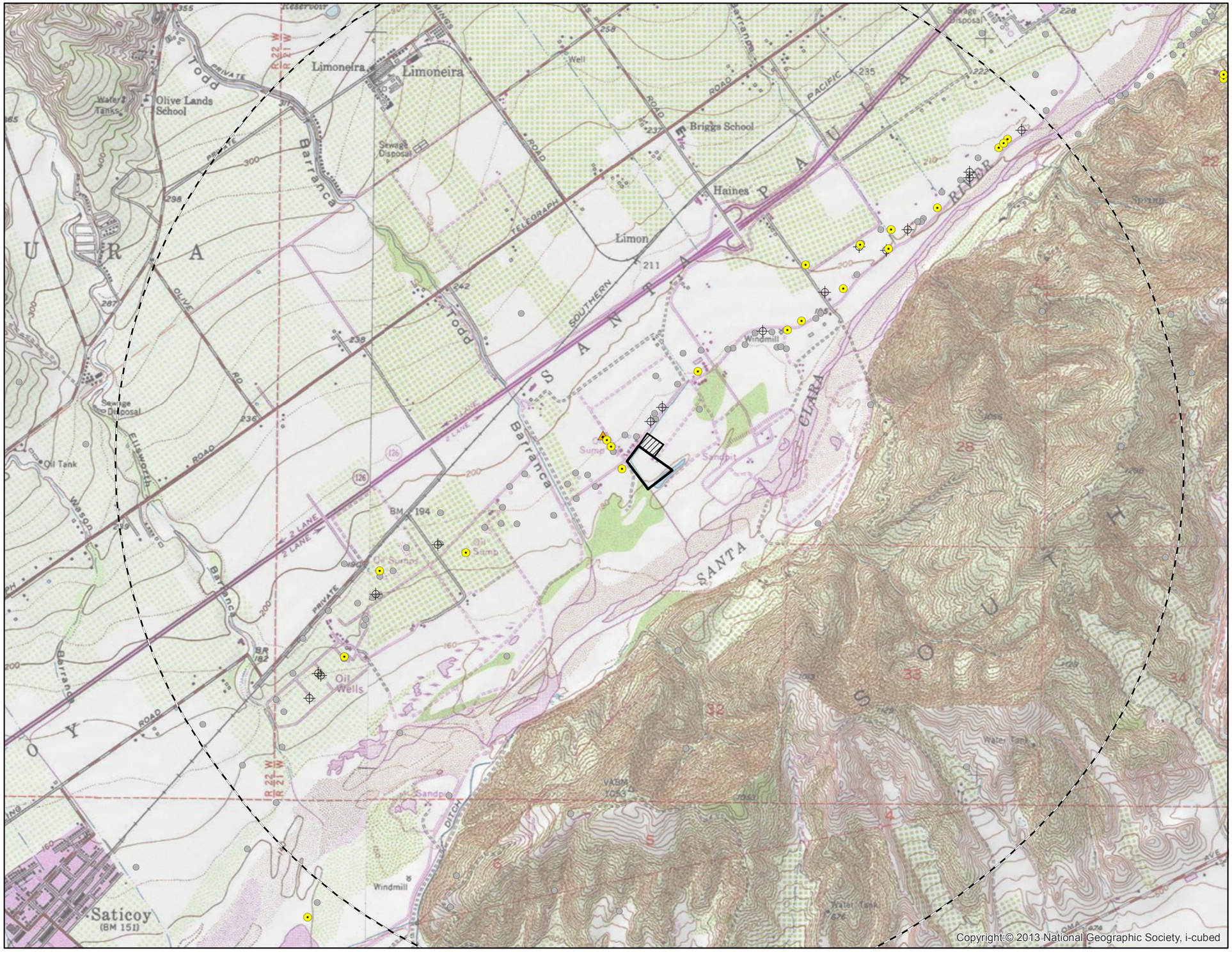
- Undivided pre-Cenozoic Metasedimentary and Metavolcanic Rocks

Source:
Ventura County GIS, (2015).
- Division of Mines and Geology, CD-ROM 2000-007 (2000), GIS Data for the Geologic Map of California.
- CA Department of Conservation Division of Oil, Gas and Geothermal Resources.
- Debby Millais, Planning Division, Resource Management Agency

0 1,500 3,000
Feet

N

Figure 5.4-3
Site in Relation to Principal Faults
Mission Rock Energy Center
Ventura County, California



VICINITY MAP

LEGEND

- Project Site
- Laydown Area
- Buffer

Well Status

- New
- Active
- Buried
- Idle
- Plugged & Abandoned

Source:
Ventura County GIS, (2015).
- Debby Millais, Planning Division, Resource Management Agency

N

0 1,000 2,000
Feet

Figure 5.4-4
Oil and Gas Resources Within Two Miles of Project Site
Mission Rock Energy Center
Ventura County, California

5.4.2.1 Significance Criteria

According to Appendix G of the CEQA 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 (AP EFZ)
  - 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 off-site landslide, subsidence, or liquefaction
- 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 MREC site and linears in the event of a large-magnitude earthquake occurring on fault segments near the site. The MREC, however, is not located within a mapped AP EFZ area. The project will, 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 2013 or more recent and applicable CBCs (CBC, 2013). Liquefaction and subsidence potential present at the site will need to be considered during MREC design.

The probability of mass wasting or flooding at the MREC site is low to negligible.

In summary, compliance with the applicable CBC requirements will reduce the exposure of people to the risks associated with large seismic events, liquefaction potential, and expansive soils to less-than-significant levels. Additionally, major structures will be designed to withstand the strong ground motion of a Design Basis Earthquake, as defined by the applicable CBC. Through compliance with CBC standards, impacts associated with geological hazards will be less than significant.

5.4.2.3 Geological Resources

The MREC will 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. Additionally, MREC will 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. Although the MREC site contains oil and gas and aggregate mineral resources, the MREC itself will not result in the removal of such resources and will not prevent the development of significant oil and gas or aggregate 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 MREC (PRC § 21083; CCR, Title 14, § 15064[h], 15065[c], 15130, and 15355).

The MREC will not cause adverse impacts on geological resources and will not cause an exposure of people or property to geological hazards. Additionally, there are no minor impacts that could combine

cumulatively with those of other projects. Thus, the MREC 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 MREC:

- Structures will be designed to meet seismic requirements of the applicable CBC. Moreover, the design of plant structures and equipment will be in accordance with applicable CBC earthquake design requirements to withstand the ground motion of a Design Basis Earthquake.
- A geotechnical engineer and/or engineering geologist 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, MREC 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 5.4-1. The local LORS discussed in this section are certain ordinances, plans, or policies of Ventura County. There are no federal LORS that apply to geological hazards and resources.

Table 5.4-1 LORS for Geological Hazards and Resources

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
State			
CBC, 2013 as amended by Ventura County	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity	California Building Standards Commission, State of California, and Ventura County	Section 5.4.2.2
AP EFZ Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, CCR)	Identifies areas subject to surface rupture from active faults	California Building Standards Commission, State of California, and Ventura County	Section 5.4.2.2
The Seismic Hazards Mapping Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, CCR)	Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides	California Building Standards Commission, State of California, and Ventura County	Section 5.4.2.2
Local			
Ventura County General Plan (Ventura County, 2013)	Ventura County	Ventura County	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 MREC. 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, Ventura County Code Enforcement is responsible for inspections and ensuring compliance with building standards.

5.4.8 References

California Building Standards Commission. 2013. *2013 California Building Code*, California Code of Regulations.

California Department of Natural Resources. 1954. *Geology of Southern California, Bulletin, 170, Chapter VI, Hydrology*.

California Department of Conservation (CDOC). 1978. *Saticoy Quadrangle, Special Studies Zones. Official Map*. July.

California Department of Conservation (CDOC). 1993. *Generalized Mineral Land Classification Map of Southern Ventura County, Aggregate Resources Only. Open File Report 93-10, Plate 1.*

California Department of Conservation (CDOC). 2002. *Seismic Hazard Zone Report for the Santa Paula 7.5 Minute Quadrangle, Ventura County California,* Report 061*.*

California Division of Oil, Gas, and Geothermal Resources. 2015. Oil and Gas Field Maps. http://www.consrv.ca.gov/dog.- Accessed September 29, 2015.

California Geological Survey (CGS). 2010. *Fault Activity Map. Geologic Data Map No. 6.* California Department of Conservation. http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html (accessed 29 September 2015)

California Geological Survey (CGS). 2007. *Special Publication 42 (Interim Revision 2007). Fault-Rupture Hazard Zones in California. Alquist-Priolo Earthquake Fault Zoning Act*. California Department of Conservation.

California Geological Survey (CGS). 2002. *California Geomorphic Provinces, Note 36.* California Department of Conservation. December.

Fisher A.H. et al. (Fisher) 2005. *Neotectonics of the Offshore Oak Ridge Fault Near Ventura, Southern California*. Included in the Bulletin of the Seismological Society of America, Vol 95, No. 2, pp. 739-744. April.

Southern California Earthquake Data Center (SCEDC), 2015. *Oak Ridge Fault Data and Information*. http://scedc.caltech.edu/significant/oakridge.html website accessed October 2, 2015.

Ventura County, 2013. *Ventura County General Plan, Hazards Appendix*. October

Earth Systems, 2007. *Geotechnical Report for Granite Construction Asphalt Plant, Santa Paula Area of Ventura County, California*. Prepared for West Coast Environmental and Planning. June.