5.4 Geological Hazards and Resources

This section evaluates CPV Vaca Station (CPVVS) 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 CPVVS site is located in a rural area within the City of Vacaville. The property lies approximately 1.8 miles east of Vacaville proper, and approximately 1 mile southwest of the town of Elmira. It is adjacent to the city wastewater treatment plant. The site is located in the Sacramento Valley, east of the Coast Range foothills, along the western boundary of the Great Valley (California Division of Mines and Geology [CDMG], 1987). The proposed CPVVS site and proposed transmission and utility lines would run across flat plains. The CPVVS site is near areas of Central California known to be seismically active.

5.4.1.1 Regional Geology

The Vacaville area is located near the boundary of the Coast Ranges and the Great Valley physiographic provinces. The Great Valley and the adjacent Sierra Nevada to the east form a relatively stable crustal block (Sierran block) composed of Mesozoic crystalline basement that dips gently to the west. The western edge of the Sierra Nevada block, beneath the sediments of the Great Valley, may be coincident with the western margin of the Great Valley (Anderson, 1943).

The Great Valley physiographic province separates the Coast Ranges to the west from the Sierra Nevada to the east. This province is composed of two elongated northwest- to southeast-trending basins: the Sacramento basin to the northwest and the San Joaquin basin to the southeast. The present-day basin evolved from a late Jurassic to middle Tertiary (40-150 million years ago [Ma]) marine fore-arc basin. In the late Tertiary (25–30 Ma), a change in the relative motion between the Pacific and North American plates resulted in the gradual uplift of the Coast Ranges and the eventual isolation of the basin from the ocean. More recent Miocene and lower Pliocene sediments were derived from the neighboring Coast Ranges and the Sierra Nevada. By the late Pliocene (2–3 Ma), subaerial depositional conditions prevailed and Sierra Nevada–derived sediments were deposited in the basins (Olmsted & Davis, 1961).

The Coast Ranges are a north-northwest- to northwest-trending series of mountains and intervening valleys. Physiographically, the Coast Ranges can be divided into two subprovinces, the northern and southern subprovinces, separated by the San Francisco Bay and the Sacramento River Delta. The Coast Ranges are underlain by uplifted and intensely deformed Upper Jurassic (150 Ma) and younger rocks of the Franciscan ophiolite complex and the Salinian metamorphic and granitic complex (Olmsted and Davis, 1961). These

Mesozoic bedrocks are highly fractured and folded to form steeply dipping ridges with long parallel faulting patterns. The Franciscan Group consists of marine clastics, mafic volcanics, and mafic and ultra-mafic intrusives with lesser amounts of chert and limestone (Kleinfelder, 1999).

5.4.1.2 Local Geology and Stratigraphy

The vicinity of the project site is relatively flat, with an overall slope of approximately a 0.25-percent grade to the east. Local drainage is directed toward the east. The elevation of the Site varies from approximately 58 to 65 feet (CDMG, 1987).

The local area is underlain by a series of sedimentary and volcanic rocks ranging in age from Jurassic to Quaternary. These deposits dip from the Vaca Mountains of the Coast Range beneath the site towards the east. The Mesozoic bedrock of the Great Valley physiographic province is overlain by the Quaternary Tehama Formation. The Tehama Formation consists of sandstones and siltstones with lenses of cross-bedded pebble stone and conglomerate, the source materials of which were shed from the Coast Range to the west and deposited during Pliocene (Kleinfelder, 2008). These rocks are folded beneath Vacaville, and are faulted at approximately 4 miles to the east and 5 miles to the west of the CPVVS site.

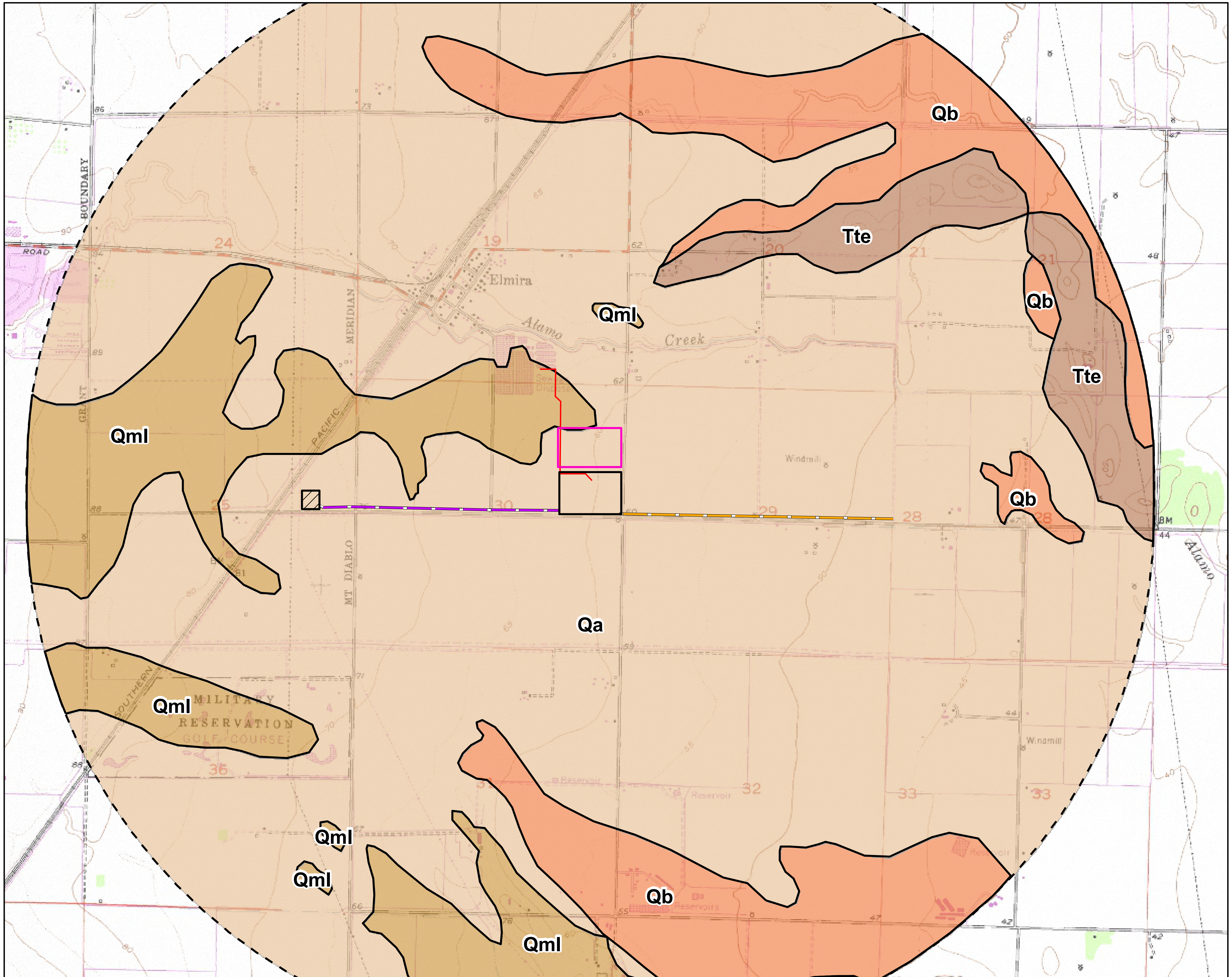
Overlying the consolidated material are thick Quaternary alluvial fan deposits derived from Coast Range source rock (Figure 5.4-1). Holocene-aged stream deposits of interbedded gravel, sand, silt, and clay lie unconformably above the lithified Tehema Formation (Kleinfelder, 2008).

A recent geotechnical investigation (report included as Appendix 2H to this AFC) has shown that the subsurface at the site consists of expansive clays (Kleinfelder, 2008). The expansive clay layers form complex stratigraphies with variable thickness. Occasional layers of materials that are not expansive (sand and gravel) are present to the depths explored. The subsurface clays and silts are typically stiff to hard (Kleinfelder, 2008). Groundwater levels were measured from recent soil borings and ranged between 4 and 11 feet below ground surface (52 to 61 feet above mean sea level), with a local flow direction toward the southeast (Kleinfelder, 2008).

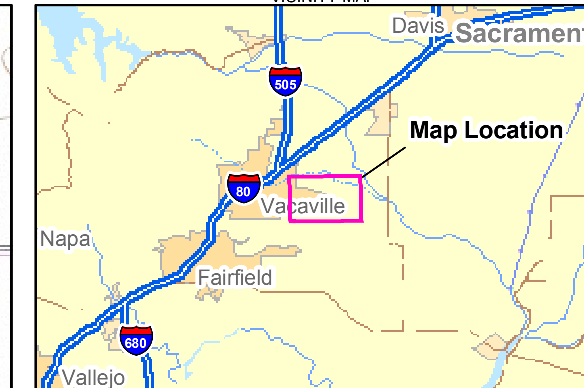
5.4.1.3 Seismic Setting

The modern tectonic setting of central 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 and to the east in the Sierra Nevada and Basin and Range Provinces.

The seismicity of the CPVVS site area can be characterized as an area of moderate seismic activity, with potentially large-magnitude earthquakes (Figure 5.4-2). Principal faults within 25 miles of the CPVVS include the Great Valley Fault (0.5 mile west), the Green Valley-Concord Fault (14 miles west), Hunting Creek-Berryessa Fault (18 miles west), and



VICINITY MAP



LEGEND

- Utility Corridor to WWTP
- Natural Gas Pipeline Route
- Electrical Transmission Line Route
- Construction Laydown Area
- Project Site
- New Substation
- Two Mile Buffer

Geology Type

- Geologic Contact (approximate)
- Qa - Quaternary Alluvium
- Qb - Quaternary Basin Deposit
- Qml - Quaternary Modesto Formation, Lower Member
- Tte - Tehama Formation

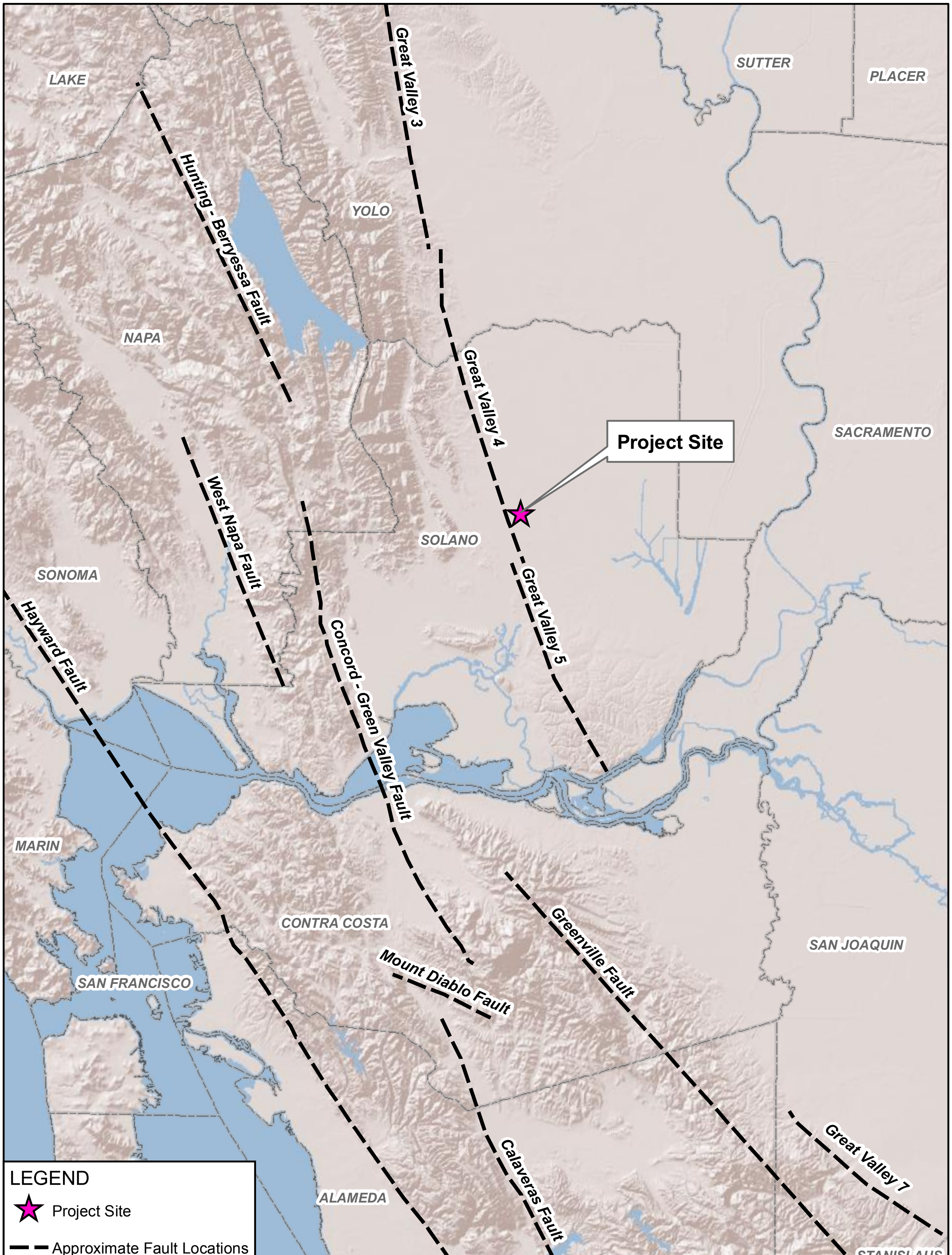
Notes:
1. Area of interest subject to change.
2. Source: Geologic map of the Late Cenozoic Deposits of the Sacramento Valley and Northern Sierra Foothills, California. by E.J. Helley and D.S. Harwood, 1985. USGS MF-1790

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 1,000 2,000
Feet

FIGURE 5.4-1
GEOLOGY WITHIN TWO MILES OF SITE
CPV VACA STATION
VACAVILLE, CA



Notes:
1. Source: Blake, 2004.

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
CPVVS IN RELATION TO PRINCIPAL FAULTS
CPV VACA STATION
VACAVILLE, CA

CH2MHILL

the West Napa Fault (22 miles west). Other faults located between 25 and 50 miles farther to the west, north, and south include Mount Diablo, Rodgers Creek, Hayward, Calaveras, Greenville-Marsh Creek, Healdsburg, and Maacama-Gerberville faults. Some of these faults are capable of generating maximum earthquake magnitudes of 6.3 to 7.5 (Blake, 2004). These fault zones represent a significant potential seismic hazard to the project site. No faults have been mapped crossing the CPVVS site, and the site is not within an Alquist-Priolo Special Studies Zone (California Geological Survey [CGS], 2007).

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. Since 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 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 CPVVS site is strong ground-shaking due to an earthquake. Ground shaking from a magnitude 7.9 earthquake could occur within an approximately 50-mile radius of the site (Blake, 2004).

The controlling fault affecting the CPVVS site is Segment 4 of the Great Valley Fault, located approximately 0.5-mile west of the site. This is a reverse-type fault dipping approximately 15 degrees west with a slip rate of approximately 1.5 millimeters per year (CGS, 2002) and is capable of generating a peak bedrock acceleration (PBA) of 0.43g (Blake, 2004) based on the maximum credible earthquake (MCE) event. Other faults that are located within a 24-mile radius of the CPVVS site are capable of generating a PBA range of 0.10g to 0.37g (Blake, 2004).

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 CPVVS site predominantly consist of dense clay and silt. However, the shallow groundwater table (between 2.5 and 12 feet below ground) at the site, coupled with the presence of thin sand layers in the upper 12 feet, may be susceptible to liquefaction. (Kleinfelder, 2008).

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 (Kleinfelder, 2008).

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 Solano County General Plan (Public Health and Safety chapter) does not indicate that the project area is within an area prone to subsidence (Solano County, 2008). Subsidence due to groundwater extraction is not known to be an issue at the project site (Olmstead and Davis, 1961).

5.4.1.4.6 Expansive Soils

The soil profile at the project site consists of thick units of expansive clays. Kleinfelder (2008) advanced numerous borings, and liquid limit, and plastic limits results were obtained from multiple soil samples between 2 and 8.5 feet deep. The results indicate that soils have a moderate to high expansion potential (Appendix 2H). Expansive soils change volume with variations in their moisture content. As the moisture content increases, expansive soils swell; as they dry, these soils shrink. Moisture content increases during winter months and from heavy irrigation. Moisture content decreases from summer drying and extraction by tree root systems. Structures located directly on expansive soils may heave and settle in response to these movements. The potential for expansive soil to be present and affect the project site is high. This topic is also addressed in the Section 5.11.

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 virtually no chance that a seiche could occur.

Tsunamis are seismically induced sea waves that can be triggered by submarine earthquakes, landslides, or volcanic eruptions. Since the project site is more than 45 miles from the Pacific Ocean, and surface elevations are greater than 50 feet above sea level, the potential for a tsunami along the coast of California to affect the project site is negligible.

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 southwestern part of the Sacramento Valley; these units are not unique in terms of recreational, commercial, or scientific value. The potential for rare mineral or fossil deposits is very low, given the geologic environment in the area. In addition, the site was at one time used for agricultural production. Significant mineral and petroleum deposits are not present in the project area as identified in the Solano County General Plan (Resources chapter) (Solano County, 2008).

All oil and natural gas deposits in the wider project area appear to several miles west of the site. Only abandoned dry oil wells are located near the project site (California Division of Oil, Gas, and Geothermal Resources [CDOGGR], 2008). The project would have no effect on 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 CPVVS would adversely affect geologic resources of recreational, commercial, or scientific value.

5.4.2 Environmental Analysis

The potential effects from construction and operation of CPVVS 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. The proposed CPVVS, however, is not 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). Liquefaction potential and expansive soils present at the site will need to be considered during project design.

The probability of 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, liquefaction potential, and expansive soils 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 CPVVS 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, CPVVS 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 CPVVS 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.
- Expansive soils that are present at the site will be mitigated by removal and replacement with non-expansive soil.
- 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, CPVVS 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 the County of Solano. There are no federal LORS that apply to geological hazards and resources.

TABLE 5.4-1
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 Solano	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity	California Building Standards Commission, State of California, and County of Solano	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 Solano	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 Solano	Section 5.4.2.2
Local			
County of Solano General Plan (Solano County, 2008)	County of Solano Code	County of Solano	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, Solano County Code Enforcement is responsible for inspections and ensuring compliance with building standards.

5.4.8 References

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

California Division of Oil, Gas, and Geothermal Resources (CDOGGR). 2008. Oil and Gas Field Maps. http://www.consrv.ca.gov/dog. Accessed January 2008.

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Kleinfelder. 2008. *Preliminary Geotechnical Investigation Report, CPV Vacaville Power Plant. NWC Fry and Lewis Roads. Elmira, Solano County, California.* August.

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