8.11 GEOLOGIC HAZARDS & RESOURCES

8.11.1 INTRODUCTION

This section evaluates the effect of geologic hazards and resources that might be encountered during development of the proposed Kings River Conservation District Community Power Plant (KRCD CPP). The objective of this evaluation is to identify site conditions and potential impacts incurred as a result of construction, maintenance, or operation of the KRCD CPP. Proposed measures to mitigate any adverse environmental impacts of the KRCD CPP will also be discussed along with the effectiveness of the proposed measures and any monitoring plans proposed to verify the effectiveness of the mitigation.

8.11.2 AFFECTED ENVIRONMENT

KRCD is proposing to develop the KRCD CPP, a nominal 565-megawatt (MW) natural gas-fired combined-cycle base load power plant. The plant will be located near the City of Parlier, in Fresno County on an approximately 32-acre project site. The site is located in an area currently zoned for agriculture and being used predominately for agricultural purposes (vineyards). Existing structures on the project site include a vacant rural dwelling, detached garage and barn. Approximately 15 acres of a 40-acre parcel to the immediate south of the project site will be used for temporary staging and parking during construction. The KRCD CPP project site, construction staging area and associated linear facilities as described below are shown on Figure 8.11-1, Geologic Resources, and are collectively referred to herein as the project area or KRCD CPP project area.

Fuel for the KRCD CPP will be natural gas supplied from a new approximately 26-mile long 20 inch underground pipeline interconnection to the Southern California Gas Company (SCG) Line 7000 near the City of Visalia, California. The gas pipeline closely follows existing road right-of-way corridors and be primarily located in public right-of-way. Five construction staging areas have also been identified for use during construction of the gas pipeline, each with an approximate size of 200 feet by 200 feet.

Electric transmission for the KRCD CPP will be provided by a new interconnection from the plant site to the Pacific Gas and Electric Company (PG&E) McCall Substation located on the west side of Leonard Avenue and north of Manning Avenue. A new approximately five mile-long 230-kilovolt (kV) radial transmission line will connect the KRCD CPP to McCall Substation. The transmission line will cross both private property and public right-of-way.

The primary source of process makeup water for the KRCD CPP will be recycled water delivered by new underground pipeline interconnections to the Parlier Wastewater Treatment

Plant (WWTP) and the Sanger WWTP effluent percolation and evaporation ponds located on Lincoln Avenue (i.e., Lincoln Ponds). The Parlier WWTP is located adjacent to the north of the plant site, and the interconnection will be located at the northern plant site boundary. The proposed interconnection to the Sanger Lincoln ponds is approximately five miles north and will be located primarily along existing roadways. Currently, two options are being considered for the water pipeline interconnection to Lincoln Ponds (i.e., Water Supply Pipeline Option 1 and Option 2). Up to four new shallow wells recovering percolated effluent will provide a back-up cooling water supply.

Potable water for domestic use will be supplied by a new groundwater well to be installed on the project site. There is no offsite linear associated with the potable water supply. Domestic wastewater will be discharged to the Parlier WWTP. The sewer interconnection is located on the northern boundary of the project site with no offsite linear.

The project area lies along the eastern side of the southern Central Valley, known as the San Joaquin Valley. The foothills of the Sierra Nevada Range emerge from the sediments of the Central Valley about 12 miles east of the project area. Surface water in the area originates from the Sierra Nevada Mountains and drains west. The Kings River emerges from the Sierra Nevada north of the property and drains to the south. The river is about five miles east of the project area and crosses diagonally across the proposed gas pipeline route south of the project site.

8.11.2.1 Regional Geology

The geology of the region is defined by the structural trough of the Great Valley geomorphic province, which is bounded on the east by the Sierra Nevada Mountains and on the west by the Coast Ranges. The valley rises gradually eastward toward the western foothills of the Sierra Nevada Mountains. The granitic bedrock of the Sierra Nevada is tilted gently westward and extends far out under the valley. The rise to the Coast Ranges on the west is much more abrupt, and the formations of the Coast Range dip steeply eastward under the valley. Boulders, cobbles, gravels, sand, silt, and clay derived mainly from the Sierra Nevada Mountains and, to a lesser extent, the Coast Ranges fill the valley. The sediments of the valley are deepest along the western side and gently decrease in thickness to the east with the rising basement of the underlying Sierra Nevada bedrock.

The only drainage for the Great Valley is the San Francisco Bay. The Great Valley is divided into the Sacramento Valley, north of the San Francisco Bay, and the San Joaquin Valley, south of the San Francisco Bay. The San Joaquin River drains the San Joaquin Valley to the San Francisco Bay. The southern portion of the San Joaquin Valley, south from Fresno, drains to a topographic low near Buena Vista Lake.

8.11.2.2 Local Geology and Stratigraphy

The KRCD CPP project area resides on the distal portions of the Kings River alluvial fan with a small portion of the south end of the natural gas pipeline resting on portions of the Kaweah River alluvium fan. The sediments are divided into quaternary dune sand, fan deposits and basin deposits (California Division of Mines and Geology (CDMG), 1966). The dune sands consist of windblown loose sand with very low organic matter and are present along about a two-mile reach of the gas pipeline route. The remaining portions of the gas pipeline route and the remainder of the KRCD CPP project area resides on fan deposits. Underlying the dune sand and fan deposits are basin deposits. These sediments were deposited during flood stages of major streams in the area between natural stream levees and fans. Figure 8-11.1 show the location of these sediments in relationship to the KRCD CPP project area.

Little information is available regarding the sediments underlying the dune, fan, and basin deposits. Most authors show continental rocks and deposits (Oligocene to Holocene), which consist of a heterogeneous mix of generally poorly sorted clay, silt, sand, gravel, some beds of claystone, siltstone, sandstone, and conglomerate (Page, 1986). These sediments were deposited, lapping onto the underlying Sierra Nevada bedrock. Sierra Nevada bedrock is about -4,000 to -5,000 feet elevation MSL beneath the southern end of the natural gas pipeline route (Croft and Gordon, 1968). The bedrock may be as shallow as -2000 feet elevation beneath the project site and proposed water pipelines (Option 1 and Option 2).

8.11.2.3 Groundwater

Groundwater in the project area varies in depth from the north to the south and is generally shallower to the north and deeper to the south. Appendix 8.11-1 shows hydrographs for selected wells in the project area along with long-term records of groundwater levels (California Data Exchange Center (CDEC), internet 2007).

The depth to groundwater evaluation is based on the highest groundwater level measurements obtained in the spring of each year. Near the KRCD CPP project site groundwater levels have been as shallow as four feet below ground surface (bgs) but for the last 50 years have remained at about 15 to 55 feet bgs. In 2006, when geotechnical boring conducted at the project site, groundwater was encountered at a depth of about 35 to 45 feet bgs (Twining, 2007).

Appendix 8.11-1, Hydrographs for Selected Wells, shows groundwater levels for well 16S23E18A001M, which is located south of the KRCD CPP project site, near the Kings River. The depth to water at this well is about 25 to 40 bgs. Near the river shallow groundwater may be encountered as part of the groundwater mound created by river recharge. South of the Kings River, the depth to water increases. Appendix 8.11-1, also show hydrographs for other wells in

this area. Near the end of the natural gas pipeline route the depth to water has ranged between 50 to 180 feet bgs. Seasonally, the groundwater changes are due to variations in precipitation and groundwater pumping.

8.11.2.4 Seismicity

The KRCD CPP project area lies within the seismically stable Great Valley geomorphic providence. The project site is not located in an earthquake fault zone designated pursuant to the Alquist-Priolo Earthquake Fault Zoning Act (1972). The nearest active fault is over 40 miles from the project area. The closest potentially active fault (the Clovis fault) is about 13.6 miles from the project site. The potential for seismic shaking is moderate to high. Potentially active faults are described further in the sections below.

Clovis Fault

The Clovis fault is considered to be potentially active and is located about 13.6 miles from the KRCD CPP project site. The Clovis fault is about 9.7 miles to the nearest offsite linear facility associated with the project.

Great Valley Fault

The Great Valley fault is an active blind thrust fault that is present beneath the western edge of the Great Valley. The 1983 Coalinga earthquake, which registered a 6.7 magnitude on the Richter Scale, occurred along this fault. There were no apparent surface features or ground ruptures to indicate the presence of this fault (Mualchin, 1996). The fault is located about 40 miles from the project area. The fault (Segment 12) has been assigned individual maximum movement magnitude (Mmax) of 6.3 by the Working Group on California Earthquake Potential (WGCEP) (WGCEP, 2002).

Nunez Fault

Following the 1983 Coalinga earthquake, an aftershock with a magnitude of 5.5 occurred on the Nunez fault. The Nunez fault is located about 54-miles west of the KRCD CPP project area. The fault has been not assigned an individual Mmax by the WGCEP (WGCEP, 2002).

San Andreas Fault Zone

The San Andreas fault zone is an active fault located about 66-miles west of the KRCD CPP project area. The San Andreas is the largest active fault in California and extends from the Gulf of California to Cape Mendocino in northern California. The segment nearest the KRCD CPP is the Parkfield segment and has been assigned an individual Mmax of 6.5 by the WGCEP (WGCEP, 2002, after Wakabayashi and Smith (1994)).

Owens Valley Fault Zone

The Owens Valley fault is an active fault located about 82 miles to the east of the project site, on the east side of the Sierra Nevada Mountains, with a fault length of about 75 miles. The fault has been assigned an individual Mmax of 7.6 by the WGCEP (WGCEP, 2002).

8.11.2.5 Geologic Hazards

A site-specific geotechnical investigation has been performed for the KRCD CPP project site (Twining, 2007). A copy of the geotechnical report is included as Appendix 2-7, Geotechnical Design Criteria, in Chapter 2, Project Description. The primary geotechnical hazards that will potentially affect the KRCD CPP project site are:

1) The potential for excessive collapse settlement (hydroconsolidation) of soils in the upper five feet;
2) The potential for excessive static settlements of some of the proposed structures and tanks which have relatively large foundations and bearing loads;
3) The potential for post construction seismic settlements; and
4) The potential for excessive organics in the near surface soils resulting from the current and previously agricultural crops.

Similar hazards are also likely to exist along portions of the proposed offsite linear facilities.

Ground Rupture

Ground rupture is caused when an earthquake event along a fault creates rupture. Because there are no earthquake faults (designated pursuant to the Alquist-Priolo Earthquake Fault Zoning Act) within 40 miles of the project area the potential for ground rupture is low.

Seismic Shaking

The KRCD CPP project area is located within the 2004 California Building Code, seismic Zone 3. A review of the probabilistic peak ground acceleration (PGA) for alluvium shows the PGA will be 0.16 to 0.18g (California Geologic Survey (CGS), 2003). The potential for seismic settlement has been estimated to be about three quarters of an inch at the KRCD CPP project site (Twining, 2007).

Tsunami, Tsunami Run-up and Seiches

The KRCD CPP project area is not located near the coast or any significant bodies of water; therefore, tsunamis, tsunami run-up and seiches are not considered to be a potential hazard.

Liquefaction

During strong ground shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength. The phenomenon is known as liquefaction. Liquefaction is dependent on grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential for liquefaction is greatest when groundwater occurs within 70 feet of ground surface and loose silty sediments are present. The potential hazard associated with liquefaction is seismically induced settlement. The depth to groundwater at the project site and beneath the northern portions of the offsite linear facilities over the last 50 years is about 15 to 55 feet bgs. The sediments in the subsurface (based on onsite geotechnical borings) generally consist of loose to stiff silt to silty sand and poorly sorted sand. Therefore, based on the soil type and depth to water there is a moderate potential for liquefaction.

Specific analysis for the project site indicates liquefaction will not occur as a result of the Upper Bound Earthquake horizontal ground acceleration of 0.17g and a predominant earthquake magnitude of 6.3, with a depth to groundwater of 20 feet (Twining, 2007).

Mass Wasting

Mass wasting depends on steepness of the slope, underlying geology, surface soil strength and moisture in the soil. Because the KRCD CCP project area is in relatively flat areas, (a slope of less than 0.002 feet/feet) and no deep excavations are planned during site construction, the potential for mass wasting at the site or along the pipeline alignments is considered low to negligible.

Landslides

The term landslide includes a wide range of ground movement such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, other contributing factors include erosion by water bodies, rock and soil slopes weakened through saturation, earthquakes creaking stresses that make weak slopes fail, volcanic eruptions, and excess weight from accumulation of stockpiling of rock or ore, waste piles, or from man–made structures may stress weak slopes to failure (United States Geological Survey (USGS), 2003). The potential for landslides in the KRCD CPP project area is low to negligible based on the relatively flat topography.

Subsidence

Subsidence can be a natural or man-made phenomenon resulting from tectonic movement, consolidation, hydrocompaction, groundwater extraction, decomposition of organic material, or rapid sedimentation. The KRCD CPP project area is on the Kings River alluvial fan where organic deposits could not accumulate. Sediments deposited in fan environments can be rapidly

deposited. Along the eastern side of the Great Valley the fan deposits were generally deposited by water with repeat wetting that assists in their compaction at the time of deposition. Windblown sediments such as the dune sands have a high potential for hydrocompaction. Potential seismic settlement of the dry soils should be anticipated in the event of moderate to strong ground shaking (Twining, 2007).

Fully recoverable deformation occurs in all aquifer systems, and the land surface may fluctuate about an inch seasonally. Confined aquifers with significant thicknesses of partially consolidated silts and clays are susceptible to irreversible and significant compaction. Groundwater occurs in the project area at a depth of about between 15 to 170 feet bgs under unconfined conditions (CDEC, 2007). The potential for subsidence due to groundwater extraction is relatively low because there are few clay layers within the fan deposits that could consolidate with groundwater extraction. Some consolidation of the coarse sediments is possible if groundwater levels are lowered beyond their historic lows, but this should be more regional and not affect the individual structures or pipelines.

Overall, the potential for subsidence is low to moderate and can be mitigated through proper engineering design and controls (as discussed further below). The potential for hydrocompaction along the southern reaches of the natural gas pipeline where it crosses the dune sands is moderate to high. Potential seismic settlement of dry soils should also be anticipated.

Expansive Soils

Expansive soils shrink and swell with wetting and drying. The soils developed on the fan deposits are generally silty sandy loams to sand that are not expansive. Expansive soils are not present in the KRCD CPP project area. Soil types in project area are further described in Section 8.12, Soils. The potential for expansive soils affecting the KRCD CPP is low.

Volcanism

The closest area of volcanism is the Long Valley Caldera, along the eastern side of the Sierra Nevada Mountains and in Owens Valley, approximately 70 to 80 miles northeast of the project area. Volcanism consisting of cinder cones and volcanic flows are only 100 to 200 years old (Jennings, 1994). No other areas of volcanism are known within 100 miles of the site. Based on the distance to these sites, the potential for lava flows or accumulation of ash deposits in the KRCD CPP project area is low.

Geologic Resources of Recreational, Commercial, or Scientific Value

Geologic resources of recreational or scientific value are not present in the project area and, therefore, could not be affected by the KRCD CPP. Fan-type deposits, because of their coarse-

grained nature, do not preserve fossils. Because of the large sediment volume, economic accumulations gemstones or precious metals are not present. Commercial geologic resources are discussed in the following sections.

Aggregate Resources

The KRCD CPP is located in an area containing mineral deposits (MRZ -3), as shown on Figure 8.11-1. The significance of the deposits or lack of cannot be evaluated from available information (CGS, 2003). For aggregate deposits to be economically viable the deposits need to consist of coarse grained sand and gravel, be relatively thick and be mostly above the groundwater level. Boring logs show the project area to be underlain by mostly fine grained sediments with a few sand beds and the groundwater is at a relatively shallow depth. Therefore, the potential for aggregate resources being affected by the project is low.

Natural Gas

No oil or gas fields are present in the vicinity of the KRCD CPP project area (California Division of Oil, Gas and Geothermal Resources (CDOGGR), 2004). Continental deposits are present in the area, which are not conducive for development and accumulation of oil or gas.

8.11.3 ENVIRONMENTAL CONSEQUENCES

Potential impacts of the KRCD CPP on the geologic environment are discussed below.

8.11.3.1 Impacts

Ground-shaking and the potential for excessive collapse settlement of soils in the upper five feet due to dry unconsolidated soils or hydrocompaction are the most significant potential geologic hazards in the KRCD CPP project area. There is also a moderate potential for liquefaction along the offsite linear facilities; however, with further geotechnical investigation and analysis the potential may be lower.

There are no known natural resources that will be affected by construction of the KRCD CPP.

Construction and Operation

During construction of the KRCD CPP loose soils may be encountered that will need to be over-excavated and recompacted.

During operation of the KRCD CPP, there is the potential that a water leak could occur in the water pipeline. This additional water could potentially hydrocompact soils and cause settlement.

8.11.3.2 Mitigation Measures

The following discussion presents mitigation measures that would be implemented during KRCD CPP construction and operation to mitigation potential impact to geologic resources and hazards.

Project Site

Considering the potential for soil collapse by seismic consolidation and hydrocompaction, the near surface soils will not provide adequate support for foundation and interior slab-on-grade. Geotechnical recommendations for grading, compaction and foundations, as provided in the Geotechnical Report, which is included as Appendix 2-7, Geotechnical Design Criteria in Chapter 2, Project Description, will be implemented as appropriate to mitigate these potential impacts (Twining, 2007).

Gas Pipeline

Prior to project design and construction, a geotechnical investigation will be performed along the pipelines alignment where loose soil conditions are expected, especially where the proposed natural gas pipeline route crosses the sand dunes. A minimum of two borings will be drilled into the sand dunes and another two to three borings spaced along the natural gas pipeline alignment. At least two of the borings will be drilled to 70 feet to assess the potential for liquefaction. Based on the results of the geotechnical investigations, mitigation measures may include over excavation and compaction with engineered fill to obtain adequate structural support.

Water Pipeline

Flow meters will also be installed on both ends of the water pipeline route at Lincoln Ponds at the northern end of the pipeline route and at the KRCD CPP project site at the southern end of the pipeline route. The meters will be read on a monthly basis and compared to assess whether there are leaks in the pipeline. Repairs will be made as soon as practical.

Transmission Line

Prior to project design and construction of the transmission pole foundations, further geotechnical investigations will be performed to determine the exact size and depth of drilled piers suitable for the soil conditions encountered.

8.11.3.3 Cumulative Impacts

There are no cumulative impacts of the construction of the KRCD CPP that will affect the natural resources.

8.11.4 LAWS, ORDINANCES, REGULATIONS, AND STANDARDS (LORS)

Applicable federal, state and local LORS that are applicable to geologic resources and hazards are summarized below in Table 8.11-1 and in the following paragraphs.

Table 8.11-1
Geologic Hazards and Resources LORS
KRCD CPP

Regulation/Administering Agency	Description	Project Applicability/AFC Section Reference
Federal		
None		
State/Local		
California Building Code, 2004	Requires acceptable design criteria for structures with respect to seismic design and load-bearing capacity.	The KRCD CPP will be designed in accordance with applicable requirements. See Chapter 2, Project Description and appendices.
Alquist-Priolo Earthquake Fault Zoning Act of 1994 California Code of Regulations Section 25523(a), Section 1752(b) and (c)	Act identifies areas subject to surface rupture from active faults.	The KRCD CPP is not located within the Earthquake Fault Zone as defined by the Alquist-Priolo Earthquake Fault Zoning Act. See Section 8.11.2.4.
California Government Code, Section 53091	Exempts facilities for the generation and transmission of electrical energy by a local public agency such from obtaining applicable county building permits.	The KRCD will be exempt from applicable county permits. See Section 8.4, Land Use & Agriculture.
Health and Safety Element, Fresno County General Plan, 2000 Fresno County Community Health Department	Provides planning for growth and development for public safety issues including natural and manmade hazards and community health and safety issues.	To the extent that a project is not exempted by Section 53091 (above), the County shall require compliance with the safety elements of the general plan.

8.11.4.1 Federal

No Federal LORS have been identified.

8.11.4.2 State and Local

Applicable portions of the Uniform and California Building Codes set for rules and forth rules and regulations to control excavation, grading and earthwork construction. They establish basic policies to safeguard life, limb, property and public welfare and require acceptable design criteria for structures with respect to seismic design and load-bearing capacity. The individual agencies will be responsible for enforcing compliance with building standards.

8.11.5 INVOLVED AGENCIES AND CONTACTS

Agency contact information is listed below in Table 8.11-2.

Table 8.11-2
List of Geologic Resources and Hazards Contacts
KRCD CPP

Agency	Contact Person and Title	Phone Number
Fresno County Environmental Health Division 1221 Fulton Mall Fresno, CA 93721	Note 1	(559) 445-3271 dch@co.fresno.ca.us
Tulare County Health and Human Services Division 5957 South Mooney Boulevard Visalia, California 93277	Larry Dwoskin, Division Manager	(559) 733-6441 LDwoskin@co.tulare.ca.us
County of Fresno Department of Public Works & Planning 2220 Tulare Street, Suite A Fresno, California 93721	William M. Kettler Principal Staff Analyst	(559) 262-4242 wkettler@co.fresno.ca.us
County of Tulare Resource Management Agency 5961 South Mooney Boulevard Visalia, California 93277	William Hayter, Assistant Director	(559) 733-6291 BHayter@co.tulare.ca.us

Notes:
1. The Fresno Department of Community Health declined to provide individual contact information.

8.11.6 REQUIRED PERMITS AND SCHEDULES

As described above in Section 8.11.3.2, Mitigation Measures, a geotechnical investigation will be performed along the pipeline alignments where loose soil conditions are expected and along the transmission line alignment. Prior to conducting the investigation, a drilling permit(s) will be obtained to be drilled to below the water table. The permits will be obtained from either Fresno and/or Tulare counties depending on the drill locations.

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 obtained prior to that time. Table 8.11-3 identifies the required permits and permit schedule for the KRCD CPP.

Table 8.11-3
Permits Required and Permit Schedule
KRCD CPP

Permit/Approval Required	Due Date
Drilling permit/Fresno and/or Tulare counties	Prior to initiation of geotechnical investigation.
Excavation/Grading and Inspection permits/Fresno County	Prior to construction.

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