5.5 Geologic Hazards and Resources

This section discusses the BSEP's potential effects on geologic resources and the potential geologic hazards that may be encountered by the Project.

5.5.1 LORS Compliance

This section addresses the LORS applicable to geologic hazards and resources that are relevant to the BSEP. Table 5.5-1 summarizes the LORS that are expected to apply to the Project.

Table 5.5-1 LORS Applicable to Geological Resources and Hazards

LORS	Applicability	Where Discussed in AFC
Federal:		
Uniform Building Code	The Uniform Building Code specifies acceptable design criteria for structures and excavations with respect to seismic design and load bearing capacity.	Section 5.5.2
State:		
California Building Code	Specifies acceptable design criteria for structures and excavations with respect to seismic design and load bearing capacity.	Section 5.5.2
Alquist-Priolo Earthquake Fault Zoning Act	Identifies areas subject to surface rupture from active faults.	Sections 5.5.2 and 5.5.3
Local:		
Kern County Grading Code, (Ord. G-6914 § 9, 2002)	Kern County requires a grading permit for earth moving activities exceeding 50 cubic yards.	Section 5.5.1
Kern County Floodplain Management Ordinance, (Ord. G-6914 § 14, 2002)	Kern County requires a development permit prior to any construction or other development within any area of special flood hazards, areas of flood-related erosion hazards, or areas of mudslide (i.e., mudflow).	Section 5.5.1

5.5.1.1 Federal LORS

The Uniform Building Code specifies acceptable design criteria for structures with respect to seismic design and load bearing capacity. The State has adopted these provisions in the California Building Code (CBC).

5.5.1.2 State LORS

The Project is subject to the applicable sections of the CBC. The Kern County Building Department is responsible for implementing the CBC for the Project.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo (AP) Earthquake Fault Zoning Act was enacted by the State of California in 1972 to mitigate the hazard of surface faulting to structures planned for human occupancy and other critical structures. This law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. The State has established regulatory zones (known as Earthquake Fault Zones and often referred to as "AP zones") around the surface traces of active faults and issued "Earthquake Fault Zone Maps" to be used by government agencies in planning/reviewing new construction. In addition to residential projects, structures planned for human occupancy that are associated with industrial and commercial projects are of concern.

5.5.1.3 Local LORS

The Project is subject to the Kern County's Building Inspection Division requirements for building, grading, and flood development permits. The flood development permit is for development in areas with in special flood hazards.

The Kern County Floodplain Management Ordinance requires that if a watercourse is to be altered or relocated, adjacent communities and the California Department of Water Resources must be notified prior to such alteration or relocation of a watercourse, and evidence of such notification must be submitted to the Federal Insurance Administration and Federal Emergency Management Agency. The ordinance also requires that the flood carrying capacity of the altered or relocated portion of said watercourse be maintained (Ord. G-6914 § 14, 2002).

5.5.1.4 Involved Agencies

The agency and person(s) to contact for grading, building, NPDES, and floodplain development permits are identified in Table 5.5-2.

Table 5.5-2 Agencies and Agency Contacts

Agency Contact	Phone/E-mail	Permit/Issue
Kim Baldwin Kern County Engineering and Survey Services Department – Building Inspections Division 2700 "M" Street Bakersfield, CA 93301	(661) 862-8650 baldwink@co.kern.ca.us	Building permits, grading permit for earthmoving activities exceeding 50 cubic yards, and floodplain development permit for construction in a special flood hazard area

5.5.1.5 Required Permits and Permit Schedule

Building and grading permits are required by the Kern County Engineering and Survey Services Department, Building Inspections Division. Applications are required at least six weeks prior to construction.

Table 5.5-3 Permits Required and Permit Schedule

Permit/Approval	Schedule
Building permit	Application must be submitted six weeks prior to the start of construction.
Grading permit	Application must be submitted six weeks prior to the start of construction.
Floodplain development permit	Application must be submitted six weeks prior to the start of construction.

5.5.2 Affected Environment

This section discusses the existing geologic environment of the BESP site. Underlying geologic structures, seismicity, and geologic hazards are discussed.

5.5.2.1 Geological Setting

The BSEP site is located in the northwestern Mojave Desert, which is part of the greater Mojave Desert Geomorphic Province. The Mojave Desert Province is characterized by broad alluvial basins of Cenozoic-age sedimentary and volcanic materials overlying older plutonic and metamorphic rocks (Dibblee, 1980). This province lies between the northeast-trending Garlock fault on the north and the northwest-trending San Andreas fault on the south. One strand (East Strand) of the Garlock fault is adjacent to the Project site and the other (West Strand - also referred to as the Cantil or Cantil Valley fault) is present within the Project site. These two strands are an example of a classic left-stepping en echelon fault system (Kleinfelder, 2007 and 2008; see Appendices B.1 and B.2).

The Project is located in the alluvial-filled basin of the Fremont Valley. The geology of this area is shown on Figure 5.5-1, Regional Geology in the Koehn and California City sub-basins. This valley formed as a deep structural depression or a pull-apart basin formed between the two strands of the Garlock fault (Kleinfelder, 2007). The basin is bound by the southern Sierra Nevada Mountains and the El Paso Mountains on the northwest, and by the Rand Mountains on the east. Locally, the Project site is located southeast of the Tehachapi Mountain foothills and is underlain by Quaternary-age alluvium. Regionally, the ground surface slopes gently downward in a northwest direction at a gradient of less than two percent. Topography at the BSEP plant site is relatively flat with gentle slopes of one to three percent to the northeast, towards Koehn Lake. Ground surface elevations at the plant site range from 2,030 feet above mean sea level (msl) in the northeast to 2,260 feet above msl in the southwest (USGS, 1973a, 1973b, 1994a, and 1994b).

The BSEP plant site is underlain by recent alluvium, Holocene lacustrine and playa deposits near the surface, and older alluvium at depth. Alluvial deposits are comprised of sand, silt, and gravel and the lucustrine and playa deposits are comprised of finer-grained sands, silts and clays (Kleinfelder, 2007).

Artificial fill, Quaternary alluvium, Quaternary lake deposits, and Pleistocene older alluvium are all exposed at the surface (Kleinfelder, 2007). The minor fill on site is associated with existing developments such as roads and structures. The majority of the plant site is underlain by Cajon loamy sand and Rosamond clay loam with Arizo gravelly loamy sand and Cajon gravelly loamy sand occurring on small portions of the site (see "Soils", Section 5.12.2.2). The runoff potential of these soils is negligible to moderate, the water erosion hazard is moderate, and the wind erosion hazard is moderate to high. In contrast, the Cajon loamy land has rapid permeability whereas the Rosamond clay loam, located in the northeastern and northern portions of the plant site has a moderate to moderately slow permeability.

The plant site is bisected by the Pine Tree Creek dry wash which is a topographically well-defined drainage channel that trends in the north-northeast direction. This channel is the larger of the two drainages considered to be State jurisdictional waters (see Section 5.3, Biological Resources). The channel width ranges from approximately 25 to 70 feet and it has near vertical banks approximately two to four feet high (Kleinfelder, 2007). The western, southern, and northeast portions of the plant site are crossed by several other drainage channels. An eroded 15- to 25-foot high escarpment trends northeast through the middle of the Project site and coincides with the mapped trace of the Cantil Valley fault (Kleinfelder, 2007).

In the past, ground cracks have been observed in the Fremont Valley area following heavy rains. Some of the most extensive ground cracks were observed in the area of "Rancho Seco" which is located to the north of the northwest corner of the plant site (Kleinfelder, 2007). The cracks exhibited "normal-slip displacement with the west side down" (Kleinfelder, 2007). Several erosional features, ground cracks, and aligned depressions were mapped during Kleinfelder's (2007) site reconnaissance. In addition, formation of these types of ground cracks (erosional fissuring) were observed in September 2007 during a pumping test conducted for an onsite well (see Section 5.5.2.3).

Surface water in Fremont Valley drains to Koehn Lake; however, Koehn Lake is generally a dry lake bed. At the Project site, surface drainage is by sheetflow runoff toward the northeast. The channel near the middle of the site directs offsite drainage from the southwest from Pine Tree Creek onto the BSEP plant site.

There are no permanent bodies of water located on the plant site. Groundwater in the area of the site is contained within the Koehn subunit of the Fremont Valley Groundwater Basin. Groundwater levels at the site range between 270 to 313 feet below ground surface (DWR, 2007 and USGS, 2007); however, it is anticipated that depth to groundwater is on the order of 300 feet or deeper. A more detailed discussion of groundwater conditions at the BSEP plant site is provided in Section 5.17, Water Resources.

5.5.2.2 Seismicity

The BSEP site is located in seismically active Southern California, a region that has experienced numerous earthquakes in the past. A review of the Kern County Online Mapping System (2007) and the Alquist-Priolo Earthquake Fault maps (Division of Mines and Geology 2000) indicate that two AP fault zones are present within the Project boundaries. One AP fault zone crosses the BSEP plant site diagonally, from the southwest corner to the uppermost northeast corner (Figure 5.5-2). The available maps show the fault as buried beneath recent alluvial soils with its projected surface trace trending in a northeasterly direction. As shown on Figure 5.5-3, this AP zone crosses areas shown in the BSEP site plan for the solar array field and just to the south of the area planned for the power block. The other AP zone is located on the northwestern edges of the Project site and is a southeasterly trending splay of the Garlock East fault located just west of the Project. This AP zone is also shown on Figure 5.5-2.

The Interactive Fault Parameter Map of California (California Geological Survey, 2002) and Faults of Southern California Map (SCEC, 2007) indicate that the faults crossing the Project site are the active Garlock East and the Garlock West (also known as the Cantil or Cantil Valley fault). These faults are part of the overall Garlock fault system. Field observations indicate that the sense of displacement is northwest side down relative to the southeast side, which is consistent with literature reviewed (Kleinfelder, 2007). As also shown on Figure 5.5-2, the Garlock East fault runs southwest to northeast less than a mile west of the site, with a southeasterly trending splay of the fault zone extending into the northwestern edges of the site.

Regardless of whether or not they are located within an AP zone, all Project structures must be designed to comply with the California Building Code (CBC) and Uniform Building Code (UBC) Zone 4 requirements because the Project is located in a seismically active area. The CBC and UBC are considered to be standard safeguards against major structural failures and loss of life. The goals of the Codes are to provide structures that will: (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage but with some non-structural damage; and (3) resist major earthquakes without collapse but with some structural and non-structural damage. The CBC and UBC base seismic design on minimum lateral seismic forces ("ground shaking"). The CBC and UBC requirements operate on the principle that providing appropriate foundations, among other aspects, helps to protect buildings from failure during earthquakes.

Since the BSEP is in an area that includes mapped AP zones, a geotechnical/geologic constraints evaluation was conducted to identify and evaluate geologic and geotechnical constraints that could affect the Project, including an evaluation of whether fault rupture; moderate to severe seismic shaking; subsidence and ground failure related to groundwater withdrawal; local flooding; and/or expansive or collapsible alluvial soils exist within the BSEP plant site. The results of this evaluation are included in the Preliminary Geotechnical/Geologic Constraints Evaluation Report (Kleinfelder, 2007) which is provided as Appendix B.1, as well as throughout this section.

Site geotechnical work included a trenching program in the area of the power block and across some of the existing features in the north and northeast portion of the site. The purpose of the trenching was to evaluate the potential for ground fissures in the area of the proposed power block. The investigation included excavation and logging of five trenches ranging from approximately 40 to 970 feet in length, and approximately five feet deep. Additional trenching is expected in order to evaluate the extension and character of some of the previously mapped northwest trending features that project towards the power block.

5.5.2.3 Geologic Hazards

Seismic hazards related to ground shaking include ground rupture, slope stability, liquefaction, subsidence, tsunamis, and seiches. Due to the inland location of the Project site and the absence of nearby large bodies of water, hazards from tsunamis and seiches are not present.

Seismic Ground Shaking

The Project is located in a seismically active area and therefore will likely be subjected to ground shaking from movement along one or more of the sufficiently active or well-defined faults in the region. A "sufficiently active fault" (previously referred to as an "active fault") is defined as a fault that has broken the surface in the past 11,000 years (California Geological Survey, 2007). A "well-defined fault" (previously referred to as "potentially active fault") is defined as a fault whose trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface.

A search (Blake, 2000) was conducted that identified a total of 14 sufficiently active faults and well-defined faults within a 60-mile radius of the Project site (Kleinfelder, 2007). Table 5.5-4 highlights the five most proximal faults that have the potential to generate ground acceleration greater than 0.1 gravity (g). The 0.1g value is an industry standard for significance in terms of foundational design, and this potential acceleration can be managed with proper foundational design and site geotechnical investigation. The Cantil Valley and Garlock faults are located on or adjacent to the site and have the greatest ground acceleration potential; however, the Garlock fault – East Strand may be capable of generating a moment magnitude 7.5 earthquake, which would be considered the maximum credible event that could impact the Project (Kleinfelder, 2007). Studies suggest that the Garlock fault near the Project site has a slip rate of five to 11 millimeters per year with a recurrence interval for large earthquakes of 1,000 years (Kleinfelder, 2007). The maximum historical earthquake magnitude within a 62-mile (100-km) radius was 7.7 and occurred on July 21, 1952.

Based on available online Seismic Hazard Zone Maps by the California Geological Survey (2007), the plant site is located in an area that has not been mapped for seismic hazards. Based on the California Geological Survey's (2003), Probabilistic Seismic Hazards Mapping Ground Motion Page, there is a 10 percent probability of earthquake ground motion exceeding 0.37g at the BSEP plant site over a 50-year period.

Table 5.5-4 Active and Potentially Active Faults with Peak Site greater than 0.1 g

Fault Name	Approximate Distance from Site		Peak Site Acceleration (g)
	Miles	Kilometers	
Garlock (West) [Cantil Valley]	On site	On site	0.37
Garlock (East)	At Boundary	At Boundary	0.37
Lenwood-Lockhart-Old Woman Springs	14	23	0.14
Southern Sierra Nevada	18	29	0.13
White Wolf	22	35	0.12

Ground Rupture

The BSEP facilities are located within areas identified as subject to surface rupture from active faults; therefore, the Project is subject to the AP Earthquake Fault Zoning Act. An AP zone for the Project site, as mapped by the California Division of Mines and Geology (2000), is located on the Cinco, Cantil and Mojave NE quadrangles and coincides with the trace of the Cantil Valley fault. As shown on Figure 5.5-2, the Cantil Valley fault trace transects the center of the BSEP plant site. Surface expression of the Cantil Valley fault was observed on the site in the form of an eroded 15- to 25-foot high escarpment, classifying this fault as a significantly active fault. Portions of the site along the fault trace are defined as a special seismic study zone under the Alquist-Priolo Act; therefore, the risk of earthquake-induced ground rupture is considered to be significant.

Slope Stability

The BSEP is not considered to be an area with the potential for permanent ground displacement due to earthquake-induced landslides because surface topography at and near the site is relatively flat. However, the potential exists for ground displacement in the form of soil collapse due to precipitation events. A review of the Kern County General Plan (Kern County Online Mapping System, 2007) did not show any areas prone to landslides at or near the BSEP plant site. In addition, a site reconnaissance and review of aerial photographs did not identify any active or inactive landslides at the site or in the adjacent areas (Kleinfelder, 2007).

Erosion

Erosion is the displacement of solids (soil, mud, rock, and other particles) by wind, water, or ice and by downward or down-slope movement in response to gravity. Due to generally flat terrain, the Project site is not prone to significant mass wasting at present. Soil characteristics at the Project site allow for the potential for wind and water erosion. Soil erosion from wind and water during construction activities is further evaluated in Section 5.12, Soils. Under current conditions, the soil loss is estimated to be about one ton per year. Construction activities would increase the potential for soil loss to about 150 tons per year without implementation of Best Management Practices (BMPs). The implementation of BMPs is expected to reduce water and wind erosion of soils to less than significant levels.

Observations made during a pump test of an onsite well (Appendix J.3) indicate that when the Rosamond clay loam is thoroughly wetted, significant sloughing, erosion, and surface slumping occurs at existing fractures. In some cases “sink holes” may have formed upon wetting of the soil during the pumping test event which discharged water to the surface onto the lacustrine soils. Existing fractures have been mapped in previous studies (Kleinfelder, 2007); however, it should be noted that fractures, collapse structures, and “sink holes” may be concealed at the surface by a layer of lacustrine sediments, and may have significant impacts on the Project. This study concluded that damage due to collapsible soils is very low at the Project site provided that the recommended mitigation measures for sub-grade improvements are implemented (Kleinfelder, 2008). Recommended mitigation measures for collapsible soils are described in Section 5.5.4 below.

Further, investigation of the fissures and their apparent susceptibility to erosion indicate that:

- The fissures trend north-northeast, are not concentric around the water supply wells, and appear to be fault induced features; and
- A cluster of fissures northeast-southwest trending fissures is aligned toward the location of the BSEP power block (Figure 5.5-2). Trenching revealed that these features are not present below the power block. Further assessment in the areas of the power block is recommended as part of the design-level geotechnical investigation to investigate if these are deeper-seated structures. Additional trenching to depths of between about 25 and 30 feet is recommended (Kleinfelder, 2008).

Liquefaction

Liquefaction is a soil condition in which seismically induced ground motion causes an increase in soil water pressure in saturated, loose, sandy soils, resulting in loss of soil shear strength. Liquefaction can lead to near-surface ground failure, which may result in loss of foundation support and/or differential ground settlement. Sandy deposits deeper than 50 feet below ground surface usually are not prone to causing surface damage. In addition, soils above the groundwater table (soils that are not saturated) will not liquefy. As noted earlier, groundwater at the BSEP plant site is reported to be deeper than 270 feet, and thus, liquefaction is considered unlikely (See Section 5.17, Water Resources).

Subsidence

Subsidence due to groundwater withdrawal has been documented in various regions of the Mojave Desert. A detailed study of ground failure within the Fremont Valley, and more specifically in the area southwest of Koehn Lake, indicates that the substantial groundwater withdrawal from agricultural development during the 1960's to 1980's resulted in ground failure, mostly along pre-existing fault traces (Kleinfelder, 2007). During this period of significant groundwater pumping, water levels below the plant site dropped between 200 and 250 feet (See Section 5.17, Water Resources). Total consumptive use of groundwater during this period ranged from about 18,500 acre-feet in 1965 to 60,000 acre-feet in 1976, with estimates of about 20,000 acre-feet per year (AFY) being removed from storage. Between 1977 and 1985, subsidence rates were estimated at up to three feet in the area of the Project site (Kleinfelder, 2007). Regional subsidence has also been attributed to historical groundwater withdrawal. The current rate of subsidence in the valley is not known, though it is important to note that current groundwater pumping is a fraction of what was pumped during the period of agricultural development, and the proposed pumping by the BSEP of 1,600 AFY is less than 10 percent of the pumping reported in 1965 and three percent of what was pumped in 1976.

Seismically induced settlement can occur in areas where earthquake shaking causes densification of relatively loose sediments. Settlement can cause damage to surface and near-surface structures. However, with implementation of planned mitigation measures the potential for damage due to seismically induced settlement is considered to be low at the Project site. Additional geotechnical investigations will be completed to assess seismically induced settlement in the vicinity of the Project site as part of the detailed design process. Although the potential for damage due to seismically induced settlement is considered to be low, the results of the investigation will be used to support Project detailed design and construction.

Collapsible Soil Conditions

Alluvial soils in arid and semi-arid environments have the tendency to possess characteristics that make them prone to collapse with increase in moisture content and without increase in external loads. The Project is located in a geologic environment where the potential exists for collapsible soils. Collapsible soil conditions were observed in September 2007 (Appendix J.3) during a pump test for an onsite well. Low infiltration rates at this location caused the berm to fail and subsequently allowed water to flow into the dry wash that runs southwest to northeast across the BSEP plant site. The following conditions associated with wetted soils were observed:

- Substantial sloughing and erosion of materials was observed as water entered existing cracks and fractures (i.e., subsurface soil collapsing in the fractures), in some cases, the fractures were observed to be up to 15 to 20 feet in depth below ground surface;
- "Sink" holes were observed, some of which were pre-existing and some that may have formed upon being wetted; and,
- Erosion and surface slumping was noted along existing cracks and fractures that became wetted by the discharge.

Based on the pump test observations and the Project's preliminary geotechnical studies (Kleinfelder, 2007, 2008), the onsite soil alluvial deposits have a moderate to high potential for collapse. A more detailed investigation as part of the design level study is recommended to evaluate these soils including density and collapse tests. However, the potential for damage due to collapsible soils is considered to be very low provided that the mitigation measures for sub-grade improvements are implemented (Kleinfelder, 2008). Active mitigation measures will be implemented to minimize soil erosion and collapse including:

- Engineering berms and drainage to minimize wetting of these soils; and directing runoff away from the power block,
- Pre-watering the plant site to induce hydro-consolidation in advance of the grading program that will be part of Project construction. and
- Removing collapsible soils as part of the grading program.

Expansive Soil

Expansive soil consists of fine-grained clay which occurs naturally. It is generally found in areas that were historically a flood plain or lake area, but can occur in hillside areas also. Expansive soil is subject to swelling and shrinkage, varying in proportion to the amount of moisture present in the soil. As water is initially introduced into the soil (by rainfall or watering) expansion takes place. If dried out, the soil will contract, often leaving small fissures or cracks. Excessive drying and wetting of the soil can progressively deteriorate structures over the years because it can lead to differential settlement within buildings and other improvements.

Based on the Project's preliminary geotechnical investigation reports, the expansion potential of the onsite soils within the northern portion of the Project site is high. Soils present in other areas of the Project also may be expansive. A detailed geotechnical investigation is planned to support the Project's final design and this study will further evaluate and verify the expansion potential of the native soil deposits

5.5.2.4 Geologic Resources

Recreational and unique geologic resources and features typically include rock or mineral collecting, surface hydrothermal features, or surface expression of geologic features unique enough to generate recreational interests of the general public (natural bridges, caves, waterfalls, etc.). Based on a search of State recreation-related websites (California State Parks and Recreation.gov, 2007), there are no known recreational or unique geologic resources associated with the Project site. The Red Rock Canyon State Recreation Area is located approximately four miles north of the Project site.

Based on a review of Division of Oil, Gas, and Geothermal Resources oil and gas maps, there are no oil or gas resources beneath the Project site or in the adjacent areas.

5.5.3 Environmental Impacts

Environmental impacts associated with the construction and operations of the BSEP are discussed in the following sections.

5.5.3.1 Construction

Construction-related impacts to the geologic environment primarily are related to terrain modification (cuts, fills, and drainage diversion measures) and dust generation (excavation and grading). Dust generation and the potential for erosion related impacts associated with construction are further discussed in Section 5.12 Soils. No major unique geologic or physical features have been identified at the plant site. Based on the conceptual grading plan (WorleyParsons, 2007; see Appendix L) for the plant site, construction will require cut and fill activities on the site, but import/export of earthen materials to and from the site will not be required. Therefore, potential construction related impacts to the geologic environment would be confined to the plant site.

Evidence of ground subsidence has been reported in the Project area with studies indicating that regional subsidence is a result of past groundwater withdrawal. Historic pumping rates of between 18,500 and 60,000 AFY induced a significant water level decline of between 200 and 250 feet below the plant site (see Section 5.17, Water Resources). Proposed pumping rates in support of construction activities and grading are significantly lower than during the period of agricultural development. Groundwater modeling for the period of significant water usage of between five and 10 million gallons per day for the first five months of site development reveal only about 10 feet of drawdown below the plant site. It is anticipated that the moderate level of drawdown during this short period of pumping will not induce subsidence.

Fractures and collapsible soil conditions (when wetted) were observed at the Project site. In addition, subsurface soils show moderate to high potential for collapse. A preliminary geotechnical investigation (Kleinfelder, 2008; see Appendix B.2) of these fissures showed that they are probably fault induced and shallow and are not apparently present in the area of the power block. Additional investigation of these fissures is recommended as part of the design level geotechnical investigation that would include extending the investigation to depths of between 20 and 30 feet bgs to determine if the fissures are not deep-seated structures and to confirm their absence below the power block.

A potential geologic hazard exists during construction if soils are wetted. BMPs implemented during construction will reduce the potential for wetting of these soils, directing surface water to drainage channels and away from the expansive and collapsible soils. In addition, engineering measures such as wetting the soils in advance of grading to induce consolidation and removal of these soils and re-compaction may also be implemented.

The Project site is in the seismically active area southern California region; thus, the Project site is subject to ground shaking, and potentially subject to fault movement from earthquakes along faults in the region. The potential for earthquake-related impacts would begin during Project construction. However, seismic impacts would be of greater concern during long-term Project operation than during the limited duration of the Project construction phase and these impacts are discussed immediately below.

5.5.3.2 Operation

Regional and local geologic conditions will not be altered significantly by the long-term operation of the BSEP, including its linear facilities (transmission lines and gas pipeline). No major unique geologic or physical features have been identified at the Project site. The Project areas may be underlain by deposits of sand and gravel, and these resources could not be recovered and used during the active life of the Project. No other impacts to the geologic environment were identified.

The Project area is subject to ground shaking from nearby and distant earthquakes. Ground acceleration up to 0.37g may be experienced at the BSEP plant site, which represents the potential for moderate to severe shaking. The BSEP site is located in Seismic Zone 4, the zone with the highest potential for seismic ground shaking. The Garlock East (Cantil Valley fault) has been identified as having the potential for ground rupture at the Project site and thus, impacts resulting from fault rupture at the Project site may be anticipated. Project structures will be designed to meet the seismic design standards appropriate for Seismic Zone 4. While the solar array will be located in the AP zone, critical structures including the power block facilities and evaporation ponds will be located away from known active faults and State-recognized fault lines. The BSEP geotechnical investigation program will be expanded to address the recommendations from the Project's preliminary geotechnical studies and the potential for significant seismicity. Specifically, the BSEP will perform additional trenching in the area of the power block to confirm the presence or absence of faulting beneath the site. Due to the depth to groundwater (250 feet or more), liquefaction is not expected to occur.

Evidence of ground subsidence, such as fractures possibly caused by groundwater extraction has been noted at the BSEP site. The potential for local settlement due to groundwater withdrawal may be present at the Project site if the regional groundwater table were to be lowered significantly. As discussed in Section 5.17, Water Resources, groundwater pumping is expected to lower the water table below the plant site about 35 feet after 30 years of operation. Given that the water table was lowered between 200 and 250 feet during the period of agricultural development without significant subsidence, it is not anticipated that the Project pumping program will induce subsidence below the site. Project pumping of 1,600 AFY is between three and 10 percent of the pumping that occurred during the period of significant agricultural development.

As recommended by the Projects preliminary geotechnical studies, the BSEP will perform a more detailed study of the potential for subsidence-related ground failure. The study may include a review of previous groundwater records including drawdown rates, groundwater usage, and other groundwater and well records, as well as groundwater modeling to quantify the amount of anticipated future settlement. Additional geotechnical investigations also will be conducted to support the Project detailed design process.

Soils at the BSEP plant site and along the linear routes show a moderate to high collapse potential. To ensure that collapse potential is minimized, all foundations for plant facilities will be designed in accordance with the recommendations of the preliminary and planned future geotechnical investigations. Recommendations include overexcavation and recompaction where necessary.

In summary, the only identified potential geologic hazards for the BSEP are ground shaking and ground rupture from earthquakes and the potential for localized soil collapse. Construction of facilities in accordance with the mitigation measures identified below will ensure that earthquake-related impacts and impacts from potential soil collapse are minimized such that BSEP impacts are considered less than significant.

5.5.3.3 Cumulative Impacts

The BSEP will be designed and constructed to meet UBC/CBC requirements for industrial facilities located in Seismic Zone 4 and will adhere to sound professional practices and appropriate regulatory requirements related to geologic hazards (e.g., grading, slope stability). For these reasons, the Project is expected to have no significant impacts on geologic hazards or resources. Other projects in the same vicinity also would be expected to adhere to the appropriate professional standards and regulatory requirements. As such, the BSEP would not be expected to contribute to significant cumulative effects on geologic resources and hazards during either construction or operation.

5.5.4 Mitigation Measures

5.5.4.1 Construction

Geologic impacts associated with the construction of the BSEP are expected to be less than significant. Site-specific geotechnical, seismic, and collapsible soil conditions will be appropriately addressed during Project detailed design and during Project construction. The following mitigation measures are proposed to ensure that impacts are less than significant.

GEOL–1. Power plant structures and equipment as well as offsite linear facilities (natural gas, pipeline; transmission line) will be designed in accordance with Seismic Zone 4 requirements and the requirements of the Alquist-Priolo Earthquake Fault Zoning Act.

GEOL-2. Project foundations will be designed in accordance with recommendations (e.g., overexcavation and recompaction beneath project structures and paved areas) provided in the Preliminary Geotechnical/Geologic Constraints Evaluation Report and as amended by planned future geotechnical investigations.

5.5.4.2 Operations

Geologic impacts associated with the BSEP operations are expected to be less than significant. Thus, no geology-related mitigation measures are proposed.

5.5.5 References

Blake, T.F., 2000. EQFAULT, A Computer Program for the Deterministic Prediction of Peak Horizontal Acceleration from Digitized California Faults, A User's Manual.

California Department of Conservation, Division of Mines and Geology. 2000. Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Central Coastal Region, DMG CD 200-004.

California Geological Survey, 2003. Seismic Hazard Shaking in California; accessed at http://www.consrv.ca.gov/cgs/rghm/pshamap/pshamain.html, May 8, 2007.

California Geological Survey, 2007. Seismic Hazard Zonation Program, accessed at www.conservation.ca.gov/cgs/shzp, May 11, 2007.

California State Parks, 2007. Accessed at http://www.parks.ca.gov, on May 15, 2007.

Dibblee, T.W., Jr., 1980. Cenozoic Rock Units of the Mojave Desert in Geology and Mineral Wealth of the California Desert, D.L. Fione and A.R. Brown, ed. South Coast Geological Society.

Division of Land Resource Protection, 2004. Williamson Act Program 2004; accessed at www.consrv.ca.gov/DLRP/lca/index.htm

Division of Oil, Gas, and Geothermal Resources, 2007. Oil and Gas Maps, District Maps 1 and 4. http://www.conservation.ca.gov/dog/maps/Pages/index_map.aspx

Department of Water Resources, 2007. Groundwater Level Data and Water Quality Data. http://well.water.ca.gov

Federal Emergency Management Agency, 1986. Flood Insurance Rate Map, Kern County California (Unincorporated Areas), Panel 1380 of 2075, Community-Panel Number 060075 1380 B, September 29.

Kleinfelder, 2007. Preliminary Geotechnical/Geologic Constraints Evaluation, Project Beacon, Kern County, Califorina, September 21 (see Appendix B.1).

Kleinfelder, 2008. Preliminary Geotechnical Investigation Report, February 26 (see Appendix B.2).

United States Geological Survey (USGS), 2007. Water Quality, Groundwater Levels and Stream Flow Data - USGS Water Resources Links for Station 18090206 - Antelope-Fremont Valleys. http://mojave.usgs.gov/climate-history/Mojave.html

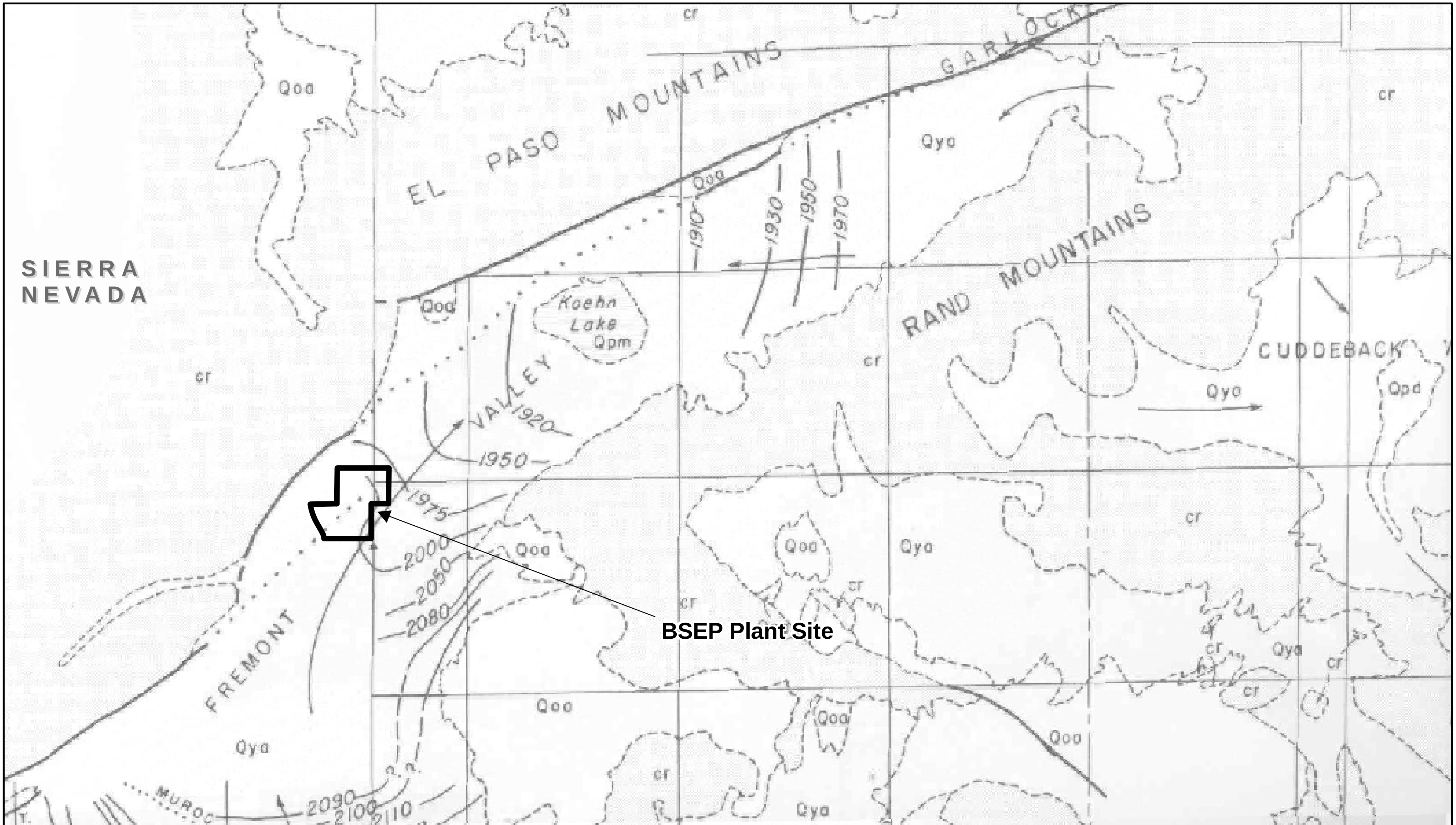
USGS, 1973a. California City North California, 7.5-Minute Quadrangle, 1:24,000.

USGS, 1973b. Cantil, California, 7.5-Minute Quadrangle, 1:24,000.

USGS, 1994a. Cinco, Califorina, 7.5-Minute Quadrangle, 1:24,000.

USGS, 1994b. Mojave NE, California, 7.5-Minute Quadrangle, 1:24,000.

WorleyParsons, 2007. Conceptual Grading Plan, Sheet No. C1, Scale: 1 inch = 600 feet, October 31.



Map Location

Legend

BSEP Plant Site Boundary

N
W E
S

Source: Kunkel, U.S.G.S, 1962

0 2 4 6 8 Miles

1:253,440

BSEP

Figure 5.5-1
Regional Geology in the Area of the Project Site

Beacon Solar

ENSR | AECOM

Project: 10056-014
Date: March 2008

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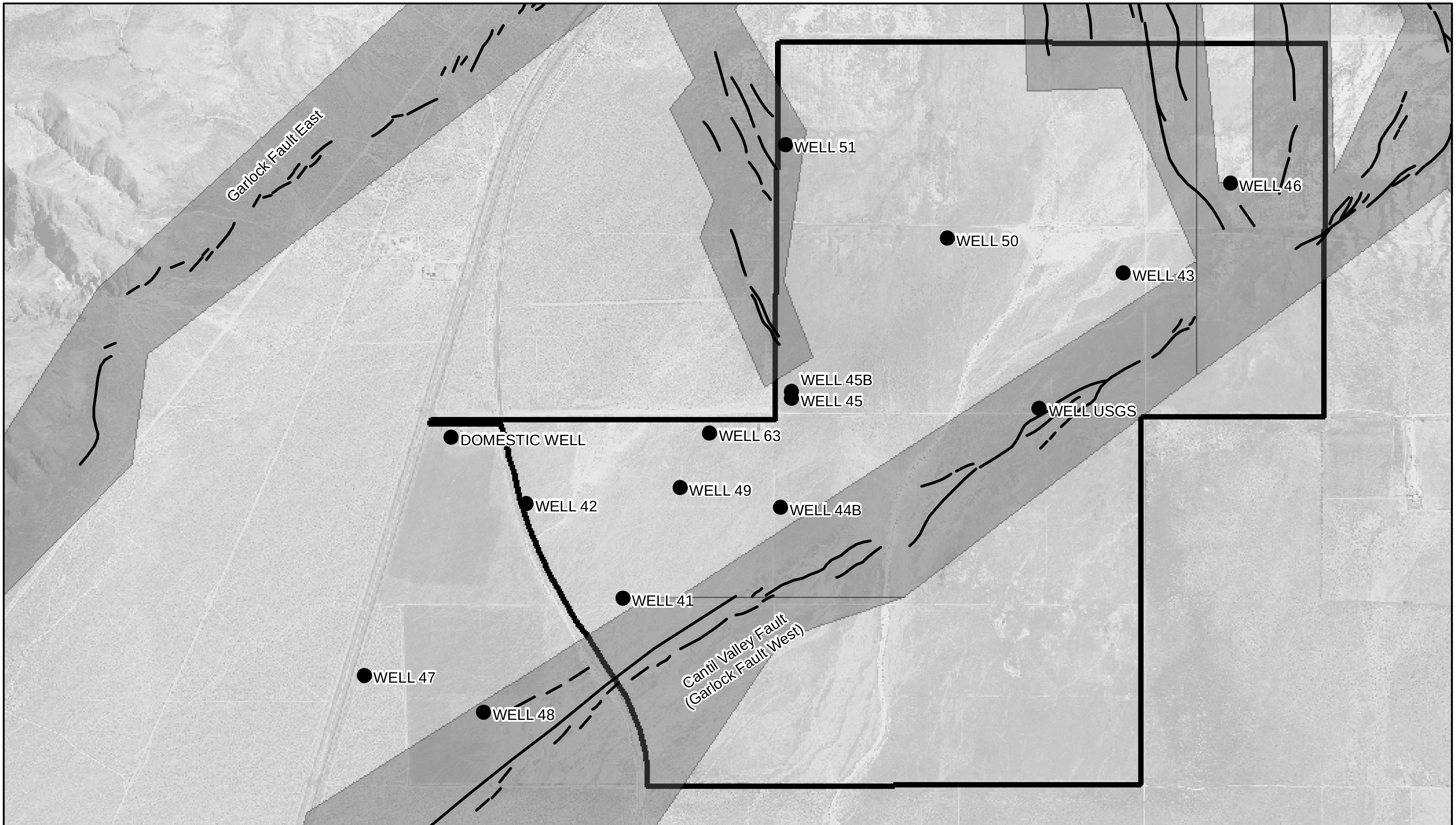

Map Location

Legend

- Water Supply Well Location
- BSEP Plant Site Boundary
- Fault
- Alquist-Priolo Fault Zone

Note: Fault locations are approximate

0 1,000 2,000 3,000 4,000 Feet

1:24,000

N W E S

BSEP

Figure 5.5-2
Plant Site Plan vs.
Alquist-Priolo Fault Zones

Beacon Solar

ENSR | AECOM

Project: 10056-014
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Map Location

Legend

- Fault
- Alquist-Priolo Fault Zone
- BSEP Plant Site Boundary
- Plant_Features

N W E S

Note: Fault locations are approximate

0 1,000 2,000 3,000 4,000 Feet

1:24,000

BSEP

Figure 5.5-3
Plant Site Layout vs.
Alquist-Priolo Fault Zones

Beacon Solar

ENSR | AECOM

Project: 10056-014
Date: March 2008

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