RIDGECREST SOLAR POWER PROJECT (09-AFC-9)
DATA ADEQUACY SUPPLEMENT

Technical Area: Soil **Response Date: October 26, 2009**

Following are additional information and/or clarifications in response to the specific issues raised in the CEC staff Data Adequacy review. For each specific area where the questions were raised by CEC staff, the applicable section of the CEC Siting Regulations is identified, followed by the "Information Required to Make AFC Conform with Regulations," followed by the supplemental/clarifying information.

DA-SOIL-1. Appendix B (g) (15) (A) (iii)

Information Required:

Please provide the location of any proposed fill disposal or fill procurement (borrow) sites.

Response:

There are no proposed fill disposal or fill procurement sites. The earthwork on-site is balanced.

DA-SOIL-2. Appendix B (g) (15) (B) (i)

Information Required:

The AFC did not provide supporting information and calculations for all potential soil loss scenarios. For all soil loss estimates (annual loss of soil due to wind and water erosion under a no-project scenario, during construction, and during operation), please provide supporting information and calculations. The volume of soil loss due to accelerated wind and water erosion must be numerically quantified using the Revised Universal Soil Loss Equation (RUSLE2 model) and the Wind Erosion Prediction System (WEPS model) or similarly accepted methods.

Response:

Water and wind erosion calculations for the no-project and construction scenarios are provided in Appendix B Preliminary Geotechnical Investigation Report- Attachment C Ridgecrest Soils Report, Water and Wind Erosion Modeling, Field Reconnaissance Soil Survey, Section C 4.0 - Modeling Results of the AFC. RUSLE2 and WEPS models were used to calculate erosion from water and wind at the Project site.

As requested, water and wind erosion calculations were run for the operational scenario, provided as Attachment SOIL-A. Water erosion was modeled for the Cajon and Wasco soil units using Universal Soil Loss Equation (USLE). Based on soil properties and the assumption that these soils will undergo compaction during the construction phase, water erosion for the Cajon soil unit is estimated at 0.46 tons/acre/year (t/ac/yr) and for the Wasco soil unit 0.73 t/ac/yr. Soil loss values for water erosion are estimated to be low due to the low rainfall and flat or nearly level slopes at and near the Project site.

The USLE model was used to calculate soil loss due to water erosion instead of the RUSLE2 model because the USLE program allowed for more specific site data to be used for the calculation. USLE is a linear model that is well researched and suitable for estimating gross erosion, especially where there is insufficient data for developing more complex models.

In 1997, the USLE was modified and released as the RUSLE2. The revision seeks to better model erosion processes under frozen soil conditions in the West and to account for below-ground root mass. RUSLE2 requires the use of site-specific parameters files. The current Windows implementation of RUSLE2 is supplied with state databases containing parameters for soils, vegetation, and conservation practices; however, there are limited input files for non-cropland areas. The Project site is located in a non-cropland area.

The difference in the two programs is primarily in the slope calculation inputs, RUSLE2 does not allow slope length inputs greater than 1,000 feet, whereas in the USLE model, a slope lengths greater than 1,000 feet or greater can be inputted to represent the final grade of a site. Other input parameter differences include the climate calculation. The RUSLE2 model uses the supplied climate data for the general area, whereas in the USLE model, local climate data from a weather station can be imputed. In addition, comparisons between the outputs of the two programs for the same soil type showed statistically insignificant differences between the two programs; therefore, USLE was determined to be the more appropriate program to model water erosion at the Project site. The Applicant would be happy to discuss this decision with CEC staff. If, as a result of these discussions, CEC staff prefers the analysis be performed with RUSLE2, the Applicant will revise the analysis using RUSLE2.

Wind erosion values were estimated using the WEPS model. Again, soils are assumed to experience compaction during the construction phase. During operations, water will be applied to the site for dust control and mirror washing. It is assumed that approximately 4 inches of water per month would be applied to the site during these activities. Thus, wind erosion is estimated to be 388 t/ac/yr for the Cajon soil unit, and 64 t/ac/yr for the Wasco soil unit. The wind erosion estimates for these two soil units are high and may pose a potential impact to the Project; however, with the implementation of Best Management Practices (see Section 5.12.3.1 of the AFC and Appendix L Drainage Erosion Sediment Control Plan), impacts from wind erosion can be mitigated.

Supplemental Information

As promised in the original AFC filing on September 1, 2009, AFC Appendix C.4 Geologic and Foundation Design Criteria, is provided in Attachment SOIL-B at the end of this section.

Supplemental Information

A revised site soil map, Figure 2-12a and Figure 2-12b, is provided at the end of this section (Attachment SOIL-C) at the requested scale of 1:24,000.

Attachment SOIL-A

Operational Phase Erosion Estimates

MEMORANDUM

TO: Eric Phillips

FROM: Stephen Caruana

DATE: 10/21/09

SUBJECT: Ridgecrest Erosion Estimates

CC: Carmen Caceres-Schnell

Here are estimates for the Ridgecrest Solar Power site operational phase erosion estimates.

Water Erosion

The following estimates were made of the potential for sheet and rill erosion at the RSPP utilizing the USLE model.

Input values are listed for each sample soil. Compaction of the soils affects the K factor. The K factor used for the undisturbed calculations is based on the published values for the whole, whereas for the compacted calculations the published value for the fines component is used as this represents the most erodible portion. The T values for the representative soils are not exceeded during any phase of construction or operations. Values during the operational phase are less because the slope gradient is flatter.

Modeling estimates of water erosion utilizing the Universal Soil Loss Equation requires that assumptions be made regarding input parameters. These assumptions include a determination that there is minimal vegetative cover in the undisturbed state and bare soil in the construction and operational phases. Soil loss values for water erosion are estimated to be low due in large measure to the low rainfall and flat or nearly level slopes.

During the construction phase, soils will undergo changes to the bulk density due to compaction from heavy equipment. Increases in bulk density due to compaction may decrease the soil's infiltration rates and potentially lead to greater runoff, especially from high intensity, short duration rainfall events. It is expected that the sandy loam soils similar to the Wasco soils will experience compaction as they have silt and clay contents up to 16.8%.

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Wind Erosion

Wind erosion estimates for the Ridgecrest site were made utilizing the Wind Erosion Prediction System (WEPS) developed by the USDA – Agricultural Research Service. The model is a process model which is based on input values for climate, soil, management (land treatment), and the application of best management practices. Climate parameters are based upon the nearest climate station records to the site. Input values for the soil parameters are based upon published values for the soil series that most closely matches the soil conditions observed in the field and as measured in laboratory tests. Soil input parameters were modified to reflect potential changes in soil conditions as a result of construction or operational conditions. In addition to climate and soil inputs, the WEPS model requires the input of a management parameter file. The management file describes what is done with vegetation, land treatment, or tillage. Management input files for developing the predicted wind erosion levels at the Ridgecrest site are based on WEPS management templates for rangeland. The undisturbed state is assumed to be similar to lightly grazed rangeland whereas the construction and operational phases when the surface is devoid of vegetation are assumed to be the equivalent to overgrazed condition consisting of bare earth.

Estimates were made for potential wind erosion at the Ridgecrest site during the construction phase and the operational phase. Due to the presence of highly erosive fine sands at the Ridgecrest site, the estimates of soil loss under disturbed conditions is predicted to be approximately 141 tons/ac/yr for the Wasco sandy loam. Values during the construction phase wind erosion soil loss is potentially as high, however continuous wetting of the soil will reduce the potential for dust mobilization. During the operational phase the input parameters for the soil component were changed for increasing bulk density due to the moderate levels of silts and clays. Reductions in wind erosion losses during the operational phase of the project are predicted based upon the application of water to control dust and wash the mirror arrays. At the current design stage, wind erosion losses were calculated based upon the application of 4 inches of water per month throughout the year. At that level of water application, wind erosion was reduced to 64 tons/ac/yr for the Wasco soil.

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USLE Worksheet Erosion Calculation Record
Wasco sandy loam

Inputs:

Tract #: General Calculation
Owner name: Solar Millennium
Field name: Ridgecrest Solar Power Project

Location: Riverside county average (Ridgecrest)
Soil: Wasco sandy loam
T factor: 5
Slope length (undisturbed): 1,000 ft
Slope length (operational): 2,300 ft
Average slope steepness undisturbed and construction phase: 3.0 %
Average slope steepness operational phase: 0.52%
2-yr, 6-hr rainfall: 0.7 in
R factor: 12.6
K factor: 0.32
K factor (compacted): 0.32
LS factor (undisturbed): 0.57
LS factor (Operational): 0.18
C factor (vegetated): 0.45
C factor (bare soil): 1.0
P factor: 1.0

Outputs:

Management	*Soil Loss Tons/acre/year*
Operational phase – Bare earth, soils compacted	0.73

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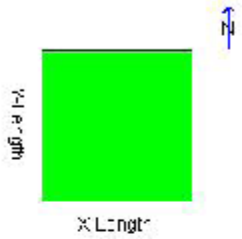
Run Summary: Ridgecrest Entire Site 1_45

NRCS Natural Resources Conservation Service

Run Date: Monday 19 October 2009 04:38 PM
Client Name: Solar Millenium
Farm No: Ridgecrest **Tract No:** SIngle Power **Field No:** ---
Run Location: WEPS_Runs
Management: Graze_Stubble 90_continuous.man
Soil: Wasco_243_85_SL.ifc

Simulation & Site Information



X-Length: 5600.07 ft
Y-Length: 5600.07 ft

Area: 719.94 ac
Elevation: 2758.99 ft
Orientation: 0.00 °

Mode: NRCS
Soil Loss T: 5.0 tn/ac/yr

State: California
County: Kern
Location: 35.564092° N, 117.727533°

Cligen: INYOKERN
Windgen: CHINA LAKE (NAF)

Erosion

Period	Crop/Residue	Gross Loss tn/ac	Net Soil Loss From Field (tn/ac) Total	Creep/Salt.	Suspension	PM10
Rot. year: 1		141.47	141.47	23.668	117.800	8.281
Ave. Annual		141.47	141.47	23.668	117.800	8.281

SCI Summary

Soil Conditioning Index -10.9430
Energy Calculator 0.0000 gal diesel/ac
Average Annual STIR 0.4900

Wind Erosion Soil Loss 141.4889 tn/ac
Water Erosion Soil Loss 0.0000 tn/ac

SCI Subfactors

OM	FO	ER
-1.0000	0.9951	-54.7046

Rotation Stir Energy

Date	Operation	Crop	Stir	Energy gal diesel/ac
Jan 01, 01	Graze, continuous overgrazing 90 pct removal		0.49	0.00

Notes

Operational phase - No treatment

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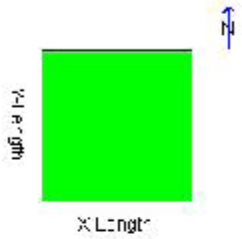
Run Summary: Ridgecrest Entire Site 1_47

NRCS Natural Resources Conservation Service

Run Date: Monday 19 October 2009 04:45 PM
Client Name: Solar Millenium
Farm No: Ridgecrest **Tract No:** SIngle Power **Field No:** ---
Run Location: WEPS_Runs
Management: Graze_Stubble 90_continuous_1yr_irr.man
Soil: Wasco_243_85_SL_blk.ifc

Simulation & Site Information



X-Length:	5600.07 ft	**Mode:**	NRCS
Y-Length:	5600.07 ft	**Soil Loss T:**	5.0 tn/ac/yr
Area:	719.94 ac	**State:**	California
Elevation:	2758.99 ft	**County:**	Kern
Orientation:	0.00 °	**Location:**	35.564092° N, 117.727533°
		Cligen:	INYOKERN
		Windgen:	CHINA LAKE (NAF)

Erosion

Period	Crop/Residue	Gross Loss tn/ac	Net Soil Loss From Field (tn/ac) Total	Creep/Salt.	Suspension	PM10
Rot. year: 1		64.29	64.29	11.132	53.154	3.724
Ave. Annual		64.29	64.29	11.132	53.154	3.724

SCI Summary

Soil Conditioning Index	-4.8650		**Wind Erosion Soil Loss**	64.2944	tn/ac
Energy Calculator	0.0000	gal diesel/ac	**Water Erosion Soil Loss**	0.0000	tn/ac
Average Annual STIR	0.4900				

SCI Subfactors

OM	FO	ER
-1.0000	0.9951	-24.3129

Rotation Stir Energy

Date	Operation	Crop	Stir	Energy gal diesel/ac
Jan 01, 01	Graze, continuous overgrazing 90 pct removal		0.49	0.00
Jan 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Feb 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Mar 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00

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Run Summary: Ridgecrest Entire Site 1_47

NRCS Natural Resources Conservation Service

Rotation Stir Energy

Date	Operation	Crop	Stir	Energy gal diesel/ac
Apr 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
May 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Jun 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Jul 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Aug 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Sep 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Oct 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Nov 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00
Dec 01, 01	Irrigation (4 inch, Pivot, Linear, Wheelline)		0.00	0.00

Notes

Operational phase - Bulk density of soil increased by 40%, 4 inches of water applied per month

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Attachment SOIL-B

C4 Geologic and Foundation Design Criteria

Appendix C.4 Geologic and Foundation Design Criteria

C.4.1 Introduction

This appendix contains a description of the site conditions and preliminary foundation-related subsurface conditions. Geological evaluations were performed at the site by Kleinfelder West, Inc.; the results are provided in "Preliminary Geotechnical Investigation Report, Solar Millennium Concentrating Solar Power Project, Ridgecrest, Kern County, California," dated August 26, 2009 (Kleinfelder), and provided as Appendix B of this AFC.

The information presented in this appendix is based on the results of the Kleinfelder evaluation and reflects the codes, standards, criteria, and practices that will be used in the design and construction of site and foundation engineering systems for the facility. More specific project information will be developed prior to construction of the project to support detailed design, engineering, material procurement specification, and construction specifications.

C.4.2 Scope of Work

The scope of services for the preparation of this appendix included an assessment of soils-related hazards, a summary of preliminary foundation and earthwork considerations, and preliminary guidelines for inspection and monitoring of geotechnical aspects of construction based on available published data, as evaluated by Kleinfelder (Appendix B).

C.4.3 Site Conditions

The proposed project is located north and south of Brown Road just west of US Highway 395, in Kern County, California. The site is divided into two primary areas, one north and one south of asphalt-paved Brown Road. The entire site is undeveloped with desert vegetation, natural drainage swales and channels, jeep trails, and rock outcroppings with elevation up to 2,892 feet at the east portion of the site. The entire site has an overall topographic relief of about 200 feet, with generally level areas and some mildly undulating terrain. The entire Project site is located within Sections 14, 23, 24, 25, 26, 27, 34 and 35 of Township 27 South and Range 39 East of the Mount Diablo Meridian.

C.4.4 Site Subsurface Conditions

C.4.4.1 Stratigraphy

The near surface soils in this area of the Mojave Desert are underlain by laterally discontinuous layers of silty sand with gravel, gravelly sand, and sandy gravel with some cobbles to the depth of exploration. Some fine to coarse gravel, and cobbles up to 4 inches, were encountered in some of the borings. The granular soils generally have a relative density of medium dense to very dense. For a detailed description of the site soil stratigraphy, please refer to Section 4 of the Kleinfelder report (Appendix B).

C.4.4.2 Seismicity/Ground-Shaking

The Project site is located in an area with moderate to high seismic activity. The site is within the influence of several fault systems, which are considered to be active or potentially active. These sufficiently active and well-defined faults are capable of producing seismic shaking at the site that could potentially be damaging to buildings and appurtenant structures. It is anticipated that the Project site will periodically experience ground acceleration as the result of moderate to large magnitude earthquakes.

C.4.4.3 Ground Rupture

The subject site is not located within, nor is it adjacent to, a state-designated Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 2007). Based on the reviewed geologic/seismologic reports and maps, no known active or potentially active faults cross or project toward the site.

C.4.4.4 Liquefaction Potential

Liquefaction is a phenomenon that may occur because of earthquake shaking at locations where loose sandy soils are present and groundwater levels are shallow. Groundwater is anticipated at a depth of approximately 100 feet below ground surface. Considering this depth and geologic age of the soils, liquefaction at the site is typically not considered likely. Based on this, the potential for liquefaction-induced settlement to occur at the site is anticipated to be low.

Lateral spreading is a potential hazard commonly associated with liquefaction where extensional ground cracking and settlement occur as a response to lateral migration of subsurface liquefiable material. These phenomena typically occur adjacent to slopes or channels. Due to anticipated grading and depth to groundwater at approximately 100 feet deep, the potential for lateral spreading is considered low.

Another type of seismically-induced ground failure, which can occur as a result of seismic shaking, is dynamic compaction. Such phenomena typically occur in loose unsaturated granular material or uncompacted fill soils. The potential for dynamic compaction to occur during the design basis earthquake is considered low. This potential should be verified during the design geotechnical investigation.

C.4.4.5 Groundwater

At the time of the investigation, groundwater was not encountered within the exploratory borings, which ranged in depth from 17 feet to 43 feet below the existing ground surface. Based on available Department of Water Resources (DWR) records, the depth to groundwater is greater than 100 feet (1959). Kern County Water Agency records (Water Supply Reports, recent editions) indicate that groundwater in the vicinity has remained below 100 feet in more recent time.

C.4.5 Assessment of Soil-Related Hazards

C.4.5.1 Liquefaction

Refer to C.4.4.4, above.

C.4.5.2 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 surface soils encountered in the borings and test pits during the geotechnical exploration consist primarily of granular soil. The potential for soil swell is generally low to none.

C.4.5.3 Collapsible Soils

Collapsible soil deposits can exist in arid regions adjacent to mountains and/or drainage courses. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content, even without increase in external loads. Soils susceptible to collapse include loess, weakly-cemented sands and silts where the cementing agent is soluble (e.g. soluble gypsum, halite), valley alluvial deposits within semi-arid to arid climate, and certain granite residual soils. Based on the geotechnical data and observation of the soil profile exposed in the test pits, the potential for collapsible soil present on the site is considered low. These conditions should be verified during the design level geotechnical investigation.

C.4.6 Preliminary Foundation Considerations

C.4.6.1 General Foundation Design Criteria

For satisfactory performance, the foundation of any structure must satisfy two independent design criteria. First, it must have an acceptable factor of safety against bearing failure in the foundation soils under maximum design load. Second, settlements during the life of the structure must not be of a magnitude that will cause structural damage, endanger piping connections or impair the operational efficiency of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base area of the structure and the settlement tolerances. Where more than one foundation type satisfies these criteria, then cost, scheduling, material availability and local practice will probably influence or determine the final selection of the type of foundation.

Based on the information presented in the Kleinfelder report (Appendix B), construction of the foundations for the project is feasible using shallow spread foundations, mat foundations and pier foundations for the various structures.

C.4.6.2 Shallow Foundations

Shallow foundations are considered feasible for use at the site following earth work recommendations noted in the Kleinfelder report. Allowable bearing pressures will include a safety factor of at least three against bearing failures. Settlements of footings are expected to be limited to allowable settlements for the foundations (typically one inch maximum); tanks can usually undergo somewhat larger allowable settlements.

Minimum footing sizes and depths will use building code minimums. Refer to the Kleinfelder report (Appendix B) for more details.

C.4.6.3 Deep Foundations

Compressible soils are not expected based on information in the Kleinfelder report (Appendix B). However, if compressible soils are present at the project site, which would preclude use of shallow foundations mentioned above, deep foundations could be needed. This foundation selection would come later in final design.

Drilled piers may be used for support of the solar arrays due to ease of construction. Most likely, drilled piers on the order of 24 inches and 72 inches could be used for support of most pipe racks and solar panels. Larger diameter piers may be needed for some structures with higher loads. Refer to the Kleinfelder report (Appendix B) for more details.

C.4.6.4 Corrosion Potential and Ground Aggressiveness

Corrosivity tests were conducted as part of the preliminary geotechnical evaluations. Detailed results are presented in the Kleinfelder report (Appendix B).

C.4.7 Preliminary Earthwork Considerations

C.4.7.1 Site Preparation and Grading

At the time of the field exploration, light to moderately heavy growth of desert vegetation occupied the site. The density of surface vegetation varies significantly and could change substantially prior to the time of grading. All surface vegetation and any miscellaneous surface obstructions should be removed from the project area, prior to any site grading. It is anticipated stripping of brush and seasonal vegetation could involve the upper 2 to 3 inches. Grubbing should include removal of bush root-balls and isolated

roots greater than 0.5 inch in diameter. Surface strippings should not be incorporated into fill unless they can be sufficiently blended to result in an organic content less 3 percent by weight (ASTM D2974).

Following site stripping, grubbing and/or any required over-excavation, some working of soils will be required. In most areas this will entail moisture conditioning and compaction.

C.4.7.2 Temporary Excavations

All excavations should be sloped in accordance with Occupational Safety and Health Act (OSHA) requirements. Near-surface soils encountered during the field investigation consisted predominantly of sandy silt and silty sand with some interbeds of poorly graded sand. These soils would be considered as a Type C soil with regard to OSHA regulations. According to OSHA regulations, the maximum allowable slopes for Type C soil is 1.5:1 (horizonal:vertical) for excavations less than 20 feet deep. Use of higher or steeper cut slopes for temporary excavations will require specific evaluation of strength, moisture content, and homogeneity of the soils and associated stability analysis.

A braced or cantilevered shoring system may be used. The need for internal supports in the excavation will be determined based on the final depth of the excavation.

C.4.7.3 Permanent Slopes

Cut and fill slopes shall be 2:1 (horizontal to vertical) maximum unless otherwise engineered.

C.4.7.4 Backfill Requirements

All engineered fill soils should be nearly free of organic or other deleterious debris and less than three inches in maximum dimension. The native soil materials, exclusive of debris, may be used as engineered fill provided they contain less than three percent organics by weight (ASTM D2974).

Recommended requirements for any imported soil to be used as engineered fill, as well as applicable test procedures to verify material suitability are provided in the Kleinfelder report (Appendix B).

Soils used for engineered fill should be uniformly moisture conditioned to, at, or above, optimum moisture, placed in horizontal lifts of 6 to 8 inches in thickness generally, and compacted to at least 90 percent relative compaction. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill**.** Lift thicknesses should be compatible with the compaction equipment to produce uniform compaction throughout the lift.

C.4.8 Inspection and Monitoring

A California-registered Geotechnical Engineer or Engineering Geologist, or their representative, will monitor geotechnical aspects of foundation construction and/or installation and fill placement. At a minimum the Geotechnical Engineer/Engineering Geologist will supervise inspection of the following activities:

- Surfaces to receive fill will be inspected prior to fill placement to verify that no pockets of loose/soft or otherwise unsuitable material were left in place and that the subgrade is suitable for structural fill placement.
- Fill placement operations will be monitored by an independent testing agency. Field compaction control testing will be performed regularly and in accordance with the project specifications.
- The Geotechnical Engineer will supervise inspection of drilled shaft installation as required.

C.4.9 Site Design Criteria

C.4.9.1 General

The project plans to generate approximately 250 megawatts (MW) of power with a single power plant utilizing two solar fields.

The power block solar array fields will be distributed over approximately 1,440 acres within the 3,920 acre Project site. The power block is anticipated to include associated structures and equipment such as a switchyard, retention/detention basin(s), cooling tower(s), steam turbines, and numerous lightly loaded structures. Building construction will include a single-story warehouse facility (approximately 30 feet tall) and a single-story administrative building.

The currently effective FEMA Flood Insurance Rate Maps for the site are numbers 06029C 1575E and 1600E, dated September 26, 2008. These maps indicate most of the areas are zone X with local areas adjacent to larger drainage channels being zone A. Zone X areas are outside the 0.2% annual chance of flooding. Zone A areas have no base flood elevation determined but are areas within the 1% annual chance flood (100-year flood).

C.4.9.2 Datum

The site elevation ranges from approximately 2,692 to 2,892 feet (msl), based on the U.S. Geological Survey (USGS) Quad Map information. Final site grade elevation will be determined during detail design.

C.4.10 Foundation Design Criteria

C.4.10.1 General

Reinforced concrete structures (spread footings, mats, and deep foundations) will be designed consistent with Appendix C.5, Structural Engineering Design Criteria.

Allowable soil bearing pressures for foundation design will be in accordance with this appendix and the detailed geotechnical investigation for the site.

C.4.10.2 Groundwater Pressures

Hydrostatic pressures due to groundwater or temporary water loads will be considered.

C.4.10.3 Factors of Safety

The factor of safety for structures, tanks and equipment supports with respect to overturning, sliding, and uplift due to wind and buoyancy will be as defined in Appendix C.5, Structural Engineering Design Criteria.

C.4.10.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the load factors and load combinations will be in accordance with Appendix C.5, Structural Engineering Design Criteria.

C.4.11 References

Kleinfelder (2009), “Preliminary Geotechnical Investigation Report, Solar Millennium Concentrating Solar Power Project, Ridgecrest, Kern County, California,” dated August 26, 2009

California Building Code, (2007), California Building Standards Commission.

California Department of Water Resources (www.water.ca.gov/waterdatalibrary)

Carman, P.C. (1938). “The determination of the specific surface of powders.” *J. Soc. Chem. Ind. Trans*., 57, 225.

Carman P.C. (1956). *Flow of gases through poruous media*, Butterworths Scientific Publications, London

California Geological Survey (CGS), (1986), Guidelines for Preparing Engineering Geologic Reports: CGS Note 44.

Chiou, B.S, and R.R. Youngs. (2008), An NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra", Earthquake Spectra, February 2008, Volume 24, Issue 1, pp. 173-215.

Dibblee, T. W., (2008), Geologic Map of the Inyokern and Ridgecrest 15 Minute Quadrangles: Dibblee Geology Center Map DF-410, scale 1:62,500.

Federal Emergency Management Agency (2008), Flood Insurance Rate Maps, Kern County, California: No. 06029C 1575E and 1600E, dated September 26, 2008.

Hart, E.W. and W. A. Bryant. (1997), Fault-Rupture Hazard Zones in California: CGS, Special Publication 42, 2007 revised edition.

Hazen, A. (1892). “Some physical properties of sands and gravels, with special reference to their use in filtration.” *24th Annual Rep., Massachusetts State Board of Health*, Pub. Doc. No. 34, 539-556.

Hazen, A. (1911). “Discussion of Dams on sand foundations’ by A.C. Koenig.” *Trans. Am. Soc. Civ. Eng*., 73, 199-203

Howard, A. (1996), “Pipeline Installation”

International Building Code (2006), International Code Council

Jennings, C.W. (1994), Fault Activity Map of California and Adjacent Areas with Locations and Ages of Recent Volcanic Eruptions, CGS.

Kern County Water Agency, Water Supply Report, (2002-2004)

Kozeny, J. (1927). “Ueber kapillare Leitung des Wassers im Boden.” *Wien, Akad. Wiss.*, 136(2a), 271

Reese, L.C., Ph.D., P.E and M.W. O’Neil, Ph.D., P.E. (1988) Drilled Shafts: Construction Procedures and Design Methods, Publication No. FHWA-HI-88-042, Publication No. ADSC-TL-4, August 1988

Risk Engineering (2009), EZ-FRISK, Version 7.32.001.

Sadigh, K., C.-Y. Chang, J.A. Egan, F. Makdisi, and R.R. Youngs. (1997), Attenuation Relationships for Shallow Crustal Earthquakes Based on California Strong Motion Data, *Seismological Research Letters*, Vol. 68, No. 1, January/February.

Schmidt, C.J., SCS and W. C. Boyle, RSE (October 1980), U.S. Environmental Protection Agency. Office of Research and Development, Onsite Wastewater Treatment and Disposal Systems,

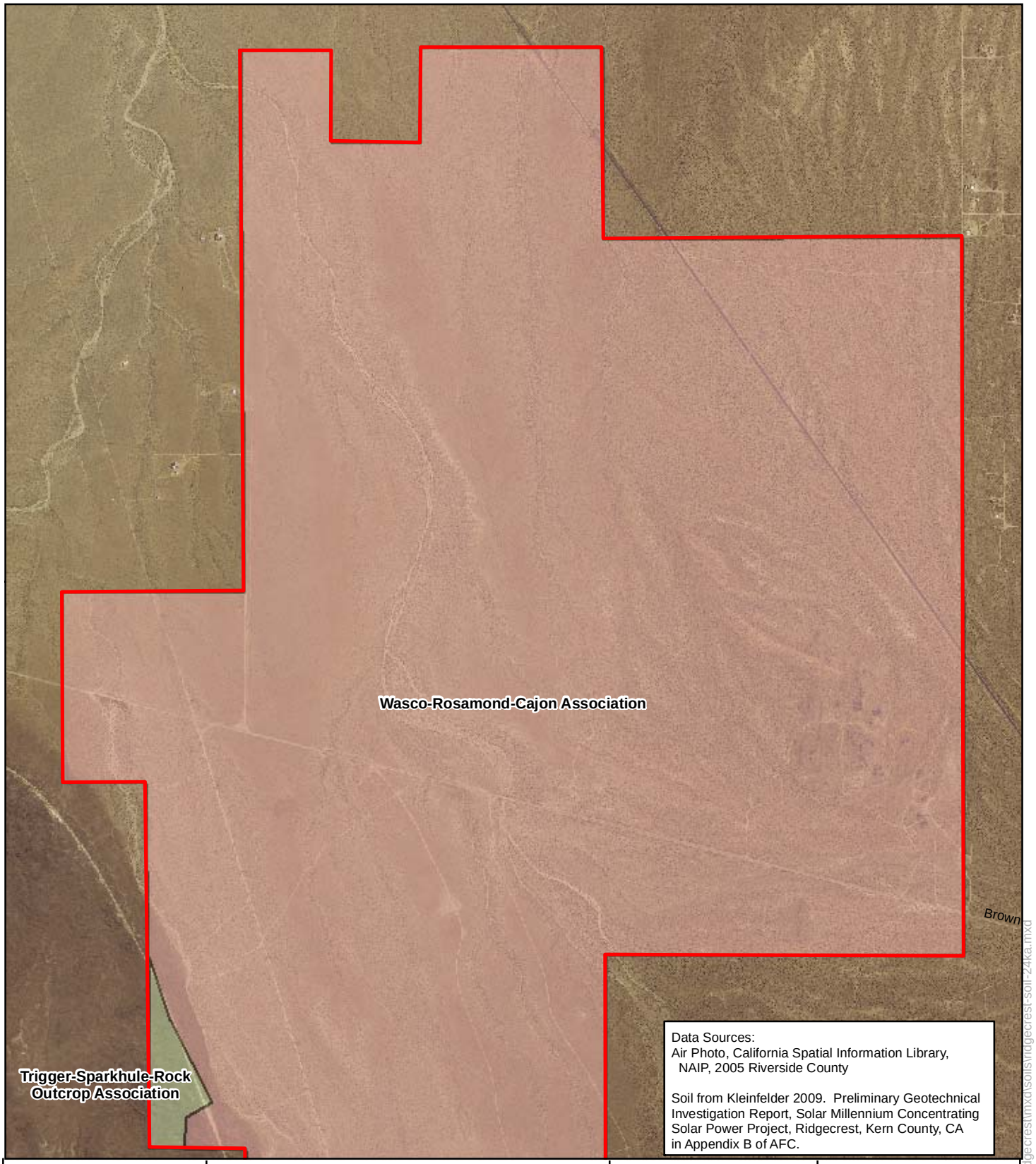
United States Environmental Protection Agency, (1980). “Onsite Wastewater Treatment and Disposal Systems.” Design Manual, Office of Water Program Operations**,** Office of Research and Development, Municipal Environmental Research Laboratory, October 1980

Working Group on California Earthquake Probabilities (2003), Understanding Earthquake Hazards in the San Francisco Bay Region: Is a Powerful Quake Likely to Strike in the Next 30 Years?, U.S. Geological Survey, Fact Sheet 039-03.

Youd, T.L., I.M. Idriss, R.D. Andrus, I. Arango, G. Castro, J.T. Christian, R. Dobry, W.D.L. Finn, L.F. Harder, Jr., M.E. Hynes, K. Ishihara, J.P. Koester, S.S.C. Liao, W.F. Marcuson III, G.R. Martin, J.K. Mitchell, Y. Moriwaki, M.S. Power, P.K. Robertson, R.B. Seed, and K.H. Stokoe II. (2001) Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils: Journal of Geotechnical and Environmental Engineering, Vol. 127, No. 10, October 2001

Attachment SOIL-C

Revised AFC Soils Figure



Data Sources:
Air Photo, California Spatial Information Library, NAIP, 2005 Riverside County

Soil from Kleinfelder 2009. Preliminary Geotechnical Investigation Report, Solar Millennium Concentrating Solar Power Project, Ridgecrest, Kern County, CA in Appendix B of AFC.

Map Location

Legend

Project Right-of-Way

Soil Types

Wasco-Rosamond-Cajon Association

Trigger-Sparkhule-Rock Outcrop Association

0 2,000 4,000 Feet

N W E S

Ridgecrest Solar Power Plant

Figure 5.12-1a
Site Soil Map

Solar Millennium

AECOM

Project: 12944-003
Date: September 2009

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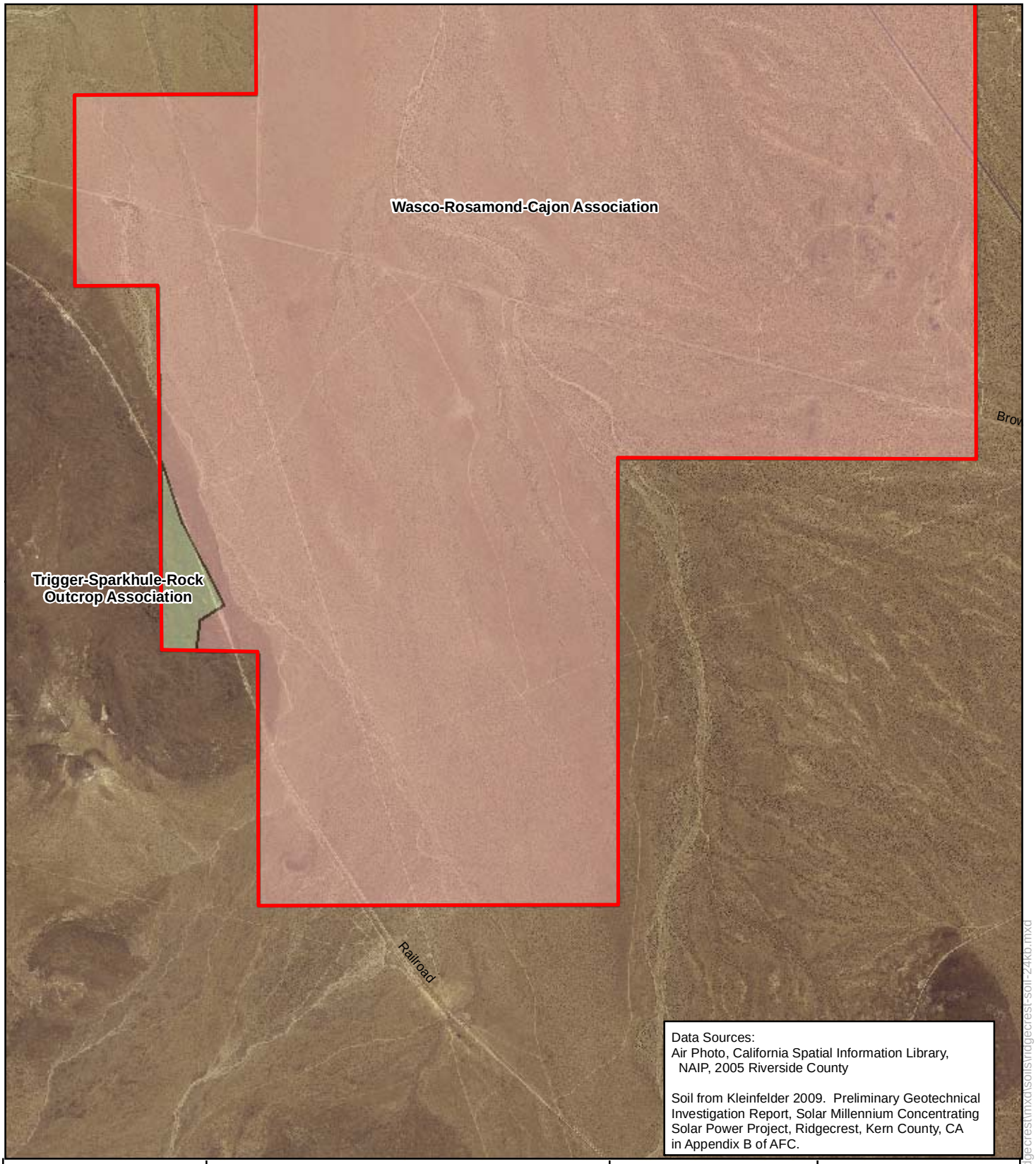

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N W E S

Ridgecrest Solar Power Plant

Figure 5.12-1b
Site Soil Map

Solar Millennium

AECOM

Project: 12944-003
Date: September 2009

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