State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Engineering

SOUTHERN FIELD DIVISION
PEARBLOSSOM SOLAR PROJECT
GEOTECHNICAL REPORT

State Water Facilities
Los Angeles County
California

PROJECT GEOLOGY REPORT 57-31-25

MARCH 2015

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STATE WATER FACILITIES
SOUTHERN FIELD DIVISION
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GEOTECHNICAL REPORT

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STATE OF CALIFORNIA
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Engineering

ENGINEERING AND GEOLOGIC CERTIFICATION

This report has been prepared under my direction as the professional engineer in direct responsible charge of the work, in accordance with the provisions of the Professional Engineers Act of the State of California.

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Date: 3/19/2015

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INTRODUCTION

PROJECT SCOPE

The Division of Engineering's (DOE), Dams and Canals Section (Dams and Canals) and Project Geology Section (Project Geology) were tasked by the State Water Project (SWP) Power and Risk Office with preparing a Geotechnical Report for the Pearblossom Solar Project site. This report is a joint effort between Dams and Canals and Project Geology since the primary tasks as outlined by the Resources Agreement between the SWP Power and Risk Office and the Geotechnical Services Branch (GSB) overlapped between the two sections.

This report presents the engineering and geologic analysis of the results of the subsurface exploration and laboratory testing for the proposed Pearblossom Solar Project site. In addition, a geologic hazards evaluation and design and construction recommendations for the solar array are provided.

The geotechnical engineering scope of work for this project included the following items:

- Field exploration
- Laboratory testing
- Engineering and Geologic Analysis
    - Description of field exploration, including boring and test pit logs;
    - Laboratory testing, including interpretation of the results;
    - Interpretation of surface and subsurface conditions, geologic setting, groundwater;
    - Geologic hazards evaluation, including seismic design parameters, faulting, liquefaction potential, seismic settlement, lateral spreading and other related hazards; and slope stability, erosion, settlement, expansive or collapsible soils, soil corrosivity, and other related hazards;
    - Design and construction recommendations, including general earthwork and over-excavation and re-compaction requirements, design criteria for shallow and deep foundations – including lateral load analysis using LPile software, allowable bearing pressures, active and passive pressure, friction coefficient, and other related soil parameters.

A more detailed description of the scope of work can be found in Dams and Canals' proposal memo dated October 10, 2014 (Appendix A) which also references Project Geology's proposal memo dated October 9, 2014.

PROJECT LOCATION AND DESCRIPTION

The proposed Pearblossom Solar Project site is located on a vacant parcel (Parcel 1A) within the Pearblossom Operations and Maintenance (O&M) Center site at 34534 116th Street East, Pearblossom, California (Figure 1). Parcel 1A is located due east of the existing pumping plant and O&M center buildings, and is composed entirely of spoil material generated during excavation of the adjacent canal and Pearblossom Pumping

Plant facilities. The parcel has approximately 36 acres of useable area at the top of the spoil embankment, which is at an elevation ranging from 25 to 30 feet above surrounding grades. Parcel 1A is bordered by undeveloped land on the south and east, and by power line easements on the north. An additional vacant parcel (Parcel 5A) is located south of the existing switchyard, and consists of approximately 6 acres of useable land bordered by Highway 138 on the south and undeveloped land on the east. Parcel 5A may or may not be used as part of the proposed solar project, but will be included as part of our study. Photographs of both Parcels 1A and 5A can be found in Appendix B.

The project will consist of a ground-mounted solar array likely supported on many small, lightly loaded foundations (concrete pedestals, driven steel or cast-in-drilled hole piles); a substation and other electrical equipment supported on shallow foundations; maintenance roads (unpaved); and underground utilities.

Figure 1 - Vicinity Map

PHYSICAL SETTING

The climate of the area is arid, with large variations in daily and seasonal temperatures. Diurnal temperatures range from near 32 to 66 degrees Fahrenheit in the winter, and commonly approach 100 degrees Fahrenheit in the summer. Average annual precipitation for this area of northeastern Los Angeles County is less than seven inches, most of which falls during the winter months (NOAA, 1992). Occasionally summer thunderstorms produce high intensity showers. Wind is generally from the southwest and often blows strongly enough to transport sand and silt (DWR, 1969b).

Parcel 1A consists of approximately 36 acres of useable surface area atop the East Spoil Area that is sparsely vegetated and has previously been used as an equipment and materials "boneyard," and even as an airstrip (Figure 2). Debris, such as concrete, is scattered throughout the surface. Overhead high-tension power lines are located on the northern edge of the parcel, outside of the useable surface area.

Parcel 5A is approximately 6 acres in area located north of State Highway 138 and south of the Pearblossom Pumping Plant switchyard. It is a sparsely vegetated parcel on an undeveloped portion of the property. The parcel is accessed through a locked swing gate on the northeast side of the property. A dirt road surrounds the perimeter of the parcel. The Pearblossom Pumping Plant discharge lines, and other possible associated underground utilities, are located on the western edge of the parcel.

TOPOGRAPHY AND HYDROLOGY

In Parcel 1A the elevation varies from about 3,050 feet at the southwest corner to 2,990 feet at the northeast corner (Figure 2). The site gradient in general is 100 feet: 4 feet (horizontal to vertical) or 0.04, and surface runoff appears to follow a designed drainage swale along the eastern portion of the parcel that drains in a northeasterly direction across the top of the spoil pile. The parcel is entirely comprised of fill approximately 25 to 30 feet above the adjacent native ground.

In Parcel 5A the elevation varies from about 3,065 feet at the southwest corner to 3,045 feet at the northeast corner (Figure 2). The parcel gradient in general is 100:5 or 0.05, and surface runoff appears to flow across the parcel in a northeasterly direction.

GEOLOGY

Regional Geologic Setting

The Pearblossom facility is located on the southwestern edge of the broad, alluvium-filled Antelope Valley, which at this location coincides with the southern margin of the Mojave Desert geomorphic province. The Mojave Desert consists of isolated mountain

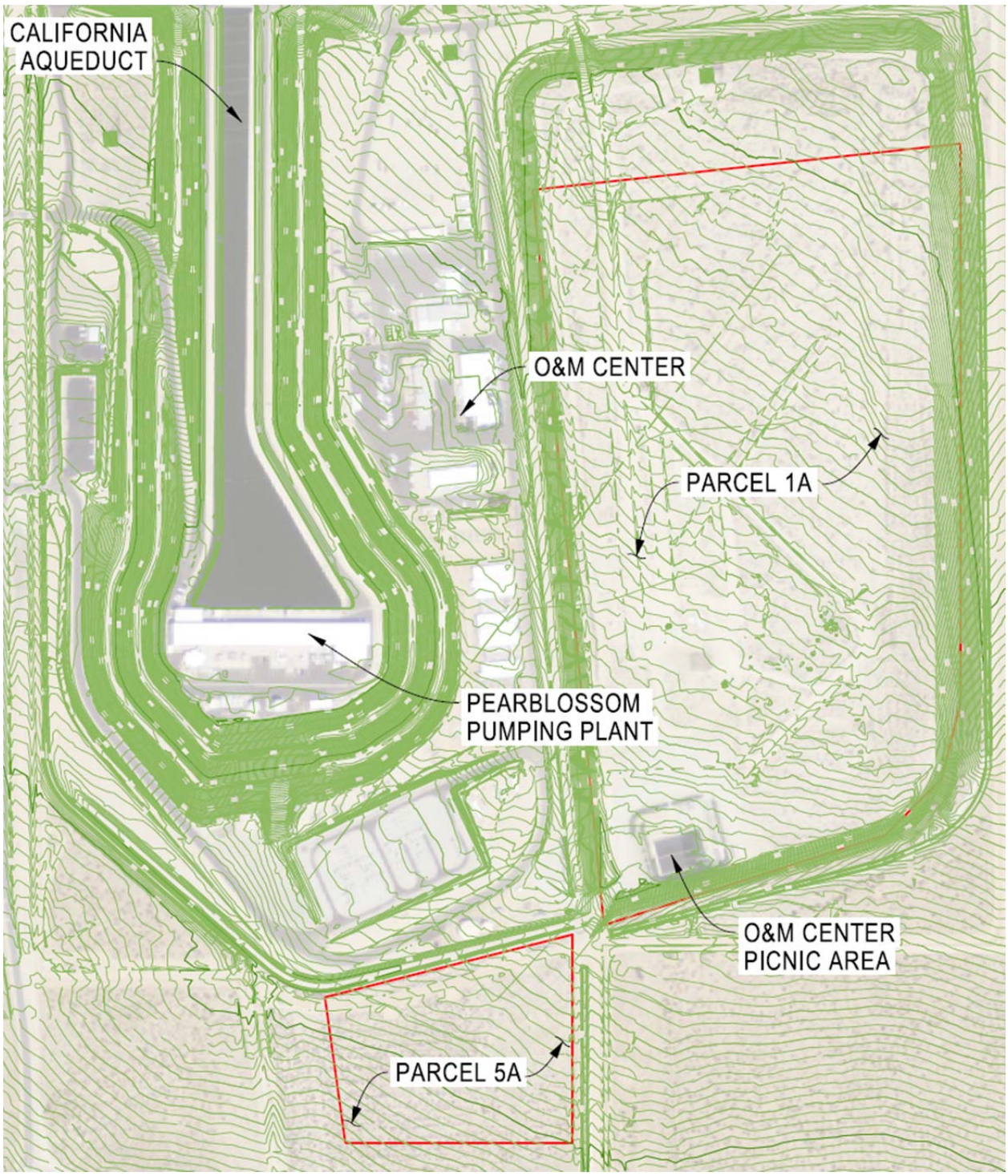

Figure 2 - Topographic Map

ranges separated by vast expanses of desert plains. Major fault systems trend northwest-southeast parallel to the San Andreas Fault Zone, and secondary fault systems trend east-west parallel to the Transverse Ranges geomorphic province. Major bounding faults include the San Andreas fault (SAF) located about 2 miles to the southwest, and the Garlock Fault Zone located about 45 miles to the northwest. A summary of faulting and seismicity is included in the Faulting and Estimated Ground Motions Section of this report. The regional geologic setting for the project area is depicted on Plate 1.

Local Geologic Setting

Previous DWR subsurface geologic investigations show that native materials on site consist of alluvial fan sediments derived from the San Gabriel Mountains located about 4 miles to the south of the site. Sediments are thinnest near the southern edge of the site closest to Parcel 5A and thicken with distance away from the mountains. Recent Alluvium (Qal) ranges from about 4 to 50 feet thick, and is underlain by Older Alluvium (Qoal) ranging from 17 to 158 feet thick. Underlying the alluvial sediments is quartz monzonite bedrock ranging from as shallow as approximately 21 feet below grade (Parcel 5A) to as deep as 240 feet below ground surface (bgs) beneath Parcel 1A. A summary of findings from previous geologic investigations at the site can be found in Appendix C.

Faulting and Estimated Ground Motions

The Pearblossom O&M Center is located within a seismically active area of southern California, with the San Andreas fault (SAF), Mojave segment, located only about two miles to the south. The SAF is a right-lateral strike-slip vertically dipping fault with a total length of about 800 miles; the Mojave segment of the SAF is approximately 96 miles long.

Evaluation of the seismicity and estimated ground motions included using a probabilistic earthquake recurrence interval of 10 percent chance of exceedance in 50 years, which is a return period of approximately 475 years. The SAF was used as the predominant deterministic fault, and as a single-source probabilistic fault primarily based on a review of the current US Geological Survey Probabilistic Seismic Hazard Assessment Interactive Deaggregation web site (2008 deaggregation model). In the 2008 deaggregation model only the SAF carries weight in ground motions for the Pearblossom Parcel 1A site, so it is the only fault that was evaluated for ground motion and seismicity.

Using the UCERF3 database (Field, et al., 2014), a magnitude M8.0 earthquake on the San Andreas fault with a return period of 447 years was derived, which is close to the desired 10 percent in 50 years exceedance of 475 years. Using the Next Generation Ground Motion Attenuation Relationships, version West2 (NGA-W2) equations (Bozorgnia et al., 2014), a M8.0 earthquake on the SAF results in a median (50th percentile) peak ground acceleration (PGA) ground motion of about 0.63g, and an 84th percentile PGA ground motion of about 1.09g. A PGA of 1.09g occurs about every

2,475 years, or a 2 percent chance of recurrence in 50 years. For design purposes a PGA of 0.63g is recommended.

Faulting and ground motion estimates are discussed in more detail in Project Geology Report No. 57-31-26, Pearblossom Solar Array Project, Faulting and Seismicity Report, dated March 9, 2015, and can be found in Appendix D.

SEISMIC HAZARDS

Fault Rupture

Based on our review, the proposed solar array sites at Parcel 1A and Parcel 5A are not located within an Alquist-Priolo Earthquake Fault Zone. However, there are several mapped fault segments within a special studies zone west of Parcel 5A that abuts the Pearblossom Pumping Plant discharge lines (CGS, 1974).

As mentioned earlier, the San Andreas Fault (Mojave Segment) is a right-lateral strike slip fault approximately 96 miles long with a slip rate of about 39 to 40 millimeters per year according to the UCERF3 database (Field et al., 2014). This segment of the San Andreas last ruptured in 1857 (Fort Tejon earthquake) with an estimated magnitude Mw 7.9 earthquake along 225 miles; the greatest surface offset was about 30 feet in the Carrizo Plain area of eastern San Luis Obispo and western Kern counties.

Based on this information, it is our opinion that the potential for fault rupture at the site is considered to be “low to moderate” during an earthquake event.

Liquefaction

Liquefaction is the phenomenon where saturated soils develop elevated pore water pressures during seismic shaking and lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or hydraulic fill soils are present.

Groundwater depths vary significantly between the two parcels. At Parcel 1A groundwater is estimated to be between 180 and 240 feet bgs, while at Parcel 5A groundwater could be as shallow as 30 feet bgs. The California Geological Survey (CGS) has mapped the Littlerock Quadrangle for seismic hazards as part of the California Seismic Hazards Mapping Act. No zones of liquefaction have been mapped at either parcel (CGS, 2003). Based on the historical exploration data, the relative densities of the soils encountered in our borings, depth of historical groundwater (greater than 50 feet bgs at Parcel 1A), depth to bedrock in Parcel 5A and seismic hazard zone mapping (CGS, 2003), liquefaction potential of site soils is considered to be low, as is the probability of lateral spread.

Seismically Induced Landslides

As mentioned in the Liquefaction section, above, the California Geological Survey has mapped the quadrangle containing both parcels of interest for seismic hazards. One of the hazards mapped as part of the California Hazards Mapping Act is the potential for earthquake-induced landslides. The Littlerock Quadrangle Seismic Hazard Zone Map (CGS, 2003) shows no areas of earthquake-induced landslides on either Parcel 1A or Parcel 5A. The parcels are not adjacent to any steeply sloping native ground, and as such, the potential for seismically induced landslides is low.

USDA SURFACE SOILS INFORMATION

Based on a review of the United States Department of Agriculture (USDA), Natural Resources Conservation Service, online soil survey maps (USDA, 2014) it appears that the project area parcels being considered are characterized by three soil types:

Hanford (HbC)

Hanford soils are characterized as a well-drained, coarse sandy loam (alluvial fan) that is derived from granite parent rock.

Cajon (CaC)

Cajon soils are characterized as excessively drained, sandy loam (alluvial fan) that is derived from granite parent rock.

Adelanto (AaB)

Adelanto soils are characterized as well-drained, loamy sand (alluvial fan, terraces) that is derived from granite parent rock.

While Parcel 1A is comprised entirely of fill, all three of the USDA soil types identified for the Pearblossom site underlie the parcel. Most of Parcel 1A is underlain by Hanford coarse sandy loam, while the southeast corner has Adelanto loamy sand beneath it, and Cajon loamy sand underlies a narrow belt beneath the parcel from the southwest corner to about midway along the eastern edge. Parcel 5A consists mostly of Hanford coarse sandy loam, except for southeast corner, which is comprised of Cajon loamy sand. Plate 2 depicts the USDA soil types within the project area.

GEOLOGIC EXPLORATION

Geologic exploration for the Pearblossom Solar Project was conducted December 15 through 18, 2014 by Teresa Butler and Dave Perry, Engineering Geologists (Range D) in the Project Geology Section. Several exploration methods were performed, including borings, test pits, and surface geophysical methods. Prior to the commencement of exploration activities, an environmental and cultural clearance (DWR Form 77) was secured through the Southern Field Division Environmental Support Unit. Underground utility clearance was accomplished through Underground Service Alert (USA) South, along with Southern Field Division.

The exploration consisted primarily of borings and test pits, but also included soil electrical resistivity measurements and thermal resistivity measurements. Originally, 14 borings and 8 test pits were proposed to characterize the two project sites (Plate 3). The number of borings was reduced to 11 in order to complete the exploration within the one week allotted before Christmas and the subsequent site holiday shutdown. Borings B6, B10, and B13 were not drilled. All eight of the proposed test pits were completed, as was three pairs of soil electrical resistivity survey transects. Soil samples collected from the test pits and borings were transported to DWR's Bryte Soils Laboratory for geotechnical and chemical testing. The results of the testing can be found in Appendix E. Following is a summary of each exploration method employed.

DRILL HOLES

Under the supervision of a DWR Project Geology engineering geologist, Gregg Drilling and Testing, Inc., of Signal Hill, California drilled 11 borings to total depths between 21.5 and 51.5 feet bgs (Plate 3). Parcel 1A was characterized with 8 borings with depths ranging between 40.5 and 51.5 feet bgs, while Parcel 5A was characterized with 3 borings advanced between 21.5 and 30.5 feet bgs. The borings were advanced using an 8.25-inch outside diameter hollow-stem auger utilizing a CME dry-core system. Geotechnical samples were collected using a Standard Penetration Test (SPT) sampler with N rod and a Modified California Sampler (MCAL); SPT blow count data was collected per ASTM D1586 and D6066. MCAL samples were collected at 7- to 17-foot or 12- to 22-foot intervals in alternate borings. SPT samples were collected at 5-foot intervals offset between the MCAL sampling intervals. Dry soil cores were collected in borings B2 and B8 in Parcel 1A and boring B12 in Parcel 5A. Each boring was logged by a DWR engineering geologist using the Unified Soil Classification System (USCS) per ASTM D2488. At the completion of drilling, the drill holes were backfilled to the surface with hydrated bentonite chips, and the drill cuttings were spread on site. Drill hole logs can be found in Appendix F.

TEST PITS

Under the direction of a DWR Project Geology Section engineering geologist, 8 exploration test pits (Plate 3) with maximum depths of 8 to 14 feet bgs were excavated employing a Southern Field Division, Civil Maintenance Branch, backhoe and operator on December 16, 2014. A total of 6 test pits were excavated in Parcel 1A (8-14 feet

bgs), and 2 test pits were excavated in Parcel 5A (10-14 feet bgs). As with the drill holes, each test pit was sampled and logged by a DWR engineering geologist using the USCS per ASTM D2488. A composite bulk soil sample was collected in each test pit from 1 to 5 feet bgs (1-4 feet bgs in TP6) and was containerized in a sealed 5-gallon bucket. At the completion of logging and sampling, each test pit was backfilled with the excavation spoil that was compacted by wheel-rolling or driving over the backfilled excavation. Test pit logs are contained in Appendix F.

GEOPHYSICAL TESTING

Limited geophysical testing was conducted to measure electrical and thermal properties of soils from both Parcels 1A and 5A. The intent of measuring these geophysical properties was to utilize the data in designing protective measures against corrosion of metal support structures and degradation of electrical cables from high ambient temperatures.

Soil electrical resistivity was measured along six 60-foot transect arrays using the Wenner 4-electrode method per ASTM G57. The arrays were laid out in pairs perpendicular to each other; one pair was located in the center of Parcel 5A, and one pair each at the north and south ends of Parcel 1A. Three sets of soil electrical resistivity measurements were collected at each array pair, each utilizing a different resistivity meter. The first array measurements were made using a MC Miller model 400D Digital Resistance Meter, while the second and third sets of measurements were collected utilizing two separate Nilsson Model 400 Soil Resistance Meters. The variations between the three sets of data were magnitudes apart, so it was decided that none of the data would be incorporated into this report.

Soil thermal resistivity testing was conducted in selected test pits using a Decagon Devices KD2 Pro thermal properties analyzer. The in-situ thermal resistivity measurements were completed in TP3, TP4, TP6, and TP8 at about 4 feet bgs per IEEE Standard 442-1981 and ASTM D5334. Test pit thermal resistivity data can be found on the exploration test pit logs in Appendix F.

SUBSURFACE CONDITIONS

TYPICAL PROFILE

As previously mentioned in the Local Geologic Setting section, the general geology of the Pearblossom facility consists of Recent Alluvium (Qal) overlying Older Alluvium (Qoal) underlain by granite bedrock of the Holcomb Ridge Quartz Monzonite – Quartz Diorite; localized fill is also present within the project area. The exploration conducted as part of the Pearblossom Solar Project was limited in scope to the two parcels under consideration for construction of a photovoltaic array. A detailed summary of previous geologic findings at the Pearblossom facility can be found in Appendix C.

Parcel 1A

Parcel 1A consists of a large spoil pile comprised of materials excavated from the California Aqueduct alignment and the Pearblossom Pumping Plant bowl (East Spoil Area). The foundation conditions of Parcel 1A were characterized with 8 borings and 6 test pits (Plate 3). The maximum depth of the borings was 51.5 feet bgs. Exploration test pits and borings encountered two soil units, Fill and Recent Alluvium. Both soil units were logged in the field as predominantly silty sand (SM). The fill was logged as a dense to very dense, light brown to brown, dry to moist, 65 to 80 percent fine to coarse angular sand with 20 to 35 percent non-plastic fines, and occasional angular gravel. Corrected SPT blow counts (N_{60}) within the fill ranged from 17 to 115, and averaged 47.9. Debris including concrete, pieces of PVC pipe, angular cobbles, and gravel layers were encountered in the test pits. A variety of soil coloration was also observed from white to reddish brown.

Underlying the fill that makes up Parcel 1A is Recent Alluvium that was logged in the field as predominantly silty sand; a lens of well-graded sand was also encountered in boring B3 between 33.5 and 38 feet bgs. The silty sand Recent Alluvium was described as medium dense to very dense, light brown to dark reddish brown, dry to moist, 60 to 80 percent fine to coarse angular sand and 20 to 40 percent nonplastic fines with a trace of angular gravel and trace of cobbles. There were two exceptions to all of the Recent Alluvium being silty sand. In boring B3, 4.5 feet of dense, dry, light brown, well-graded sand was described as about 90 percent subrounded fine to coarse sand and 10 percent nonplastic fines; boring B7 contained a 5-foot thick layer of silty sand with gravel ((SM)g). Corrected blow count data for the Recent Alluvium ranged from N_{60} = 11 to 111, and averaged 41.6.

Surface expression of the East Spoil Area indicates that the spoil is approximately 25 to 30 feet higher than the surrounding grade. However, drill hole logs (Appendix F) indicate that the fill is approximately 20 to 24 feet thick. The contact between the overlying fill soils of Parcel 1A with underlying native soils was determined to be approximately 20 to 24 feet bgs. The distinction between the two units was characterized by a color change and a change in density from SPT and MCAL blow counts in the field. The density would switch from either very dense to medium dense or from medium dense to very dense. Also, the native soils were typically darker in

color, with some exhibiting a red coloration. Geologic cross sections A-A and B-B (Plate 4) depict the approximate contact between the fill and underlying Recent Alluvium.

Parcel 5A

The 6-acre Parcel 5A is comprised of Recent Alluvium. Three borings and two test pits at Parcel 5A were logged entirely as silty sand. The silty sand was described as medium dense to very dense, light brown to brown to reddish brown, dry to moist, 60 to 80 percent fine to coarse sand and 20 to 40 percent nonplastic fines with gypsum veinlets. Corrected SPT blow counts within the parcel ranged from N_{60} = 7 to 127, and averaged 50. Geologic cross section C-C (Plate 4) depicts the subsurface of Parcel 5A.

While none of the most recent exploration encountered Older Alluvium or bedrock, previous geologic investigations (Appendix C) indicate that granitic bedrock may be as shallow as 21 feet bgs somewhere within the parcel (likely near the southwest corner).

GROUNDWATER

The borings and test pits were monitored for groundwater during and immediately after completing the bore hole or test pit. Groundwater was not encountered in any of the bore holes or test pits. The results of the subsurface exploration and the USDA soils information indicate the sediments are highly permeable. However, groundwater is estimated to be between 180 to 240 feet bgs in Parcel 1A and possibly at least 30 feet deep on the southern edge of Parcel 5A. From previous exploration at the site it appears that the depth to groundwater increases to the north and east (Appendix C).

RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

GEOTECHNICAL CONSIDERATIONS

The site appears to be suitable for the proposed construction based upon geotechnical conditions encountered at the test boring and test pit locations. Based on the geotechnical engineering analyses, subsurface exploration and laboratory test results, the proposed structures may be supported on shallow foundations or deep foundations, as applicable and provided the recommendations in this report are adhered to during design and construction.

It appears that the majority of the on-site soils will be suitable for use as engineered fill for support of concrete slabs, shallow foundations, and unpaved roads. There should be sufficient material on site, however, if imported soils are required, they should be non plastic or low plasticity and similar in composition to the on site soils (i.e. SM or SC per USCS Classification). It should be noted that the design criteria for shallow foundations contained in this report are based on laboratory results from remolded, re-compacted samples. Thus, on-site soils should be re-compacted as recommended in the Earthwork section of this report prior to placing foundations and other facilities.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in Appendices F and E, respectively), engineering analyses, and our current understanding of the proposed project.

EARTHWORK

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth-supported elements for foundations are contingent upon following the recommendations outlined in this section. All grading for each structure should extend a minimum of 5 feet beyond the footprint of the proposed structure.

Earthwork on the project should be observed and evaluated by representatives of a licensed engineer practicing in the field of geotechnical engineering. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation excavations, and other geotechnical conditions exposed during the construction of the project.

Strip and remove any existing vegetation, scattered trash and debris, and other deleterious materials from proposed structural and pavement areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

Subsequent to the surface clearing, grubbing, and unsuitable material removal efforts, the exposed subgrade soils beneath proposed structures, exterior slabs, and roadways

should be prepared to a minimum depth of 10 inches. Subgrade preparation should include scarification (or removal in the case of building foundations), moisture conditioning, and compaction. The moisture content and compaction of subgrade soils should be maintained until foundation or slab construction.

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than six inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

On-site soils less than six inches in maximum particle size or approved imported materials may be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slab areas
- exterior slab areas
- roadway areas
- foundation backfill

Imported soils for use as fill material within proposed structure areas should conform to the following specifications:

Gradation	**Percent Finer by Weight (ASTM C 136)**
6"	100
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	30 (max)
• Liquid Limit (LL)	25 (max)
• Plasticity Index (PI)	15 (max)
• Maximum Expansion Index	20

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed ten inches loose thickness.

Building Subgrade

Substation equipment, control building, and other building structures supported by shallow foundations will require over-excavation and re-compaction as follows: (1) excavation a minimum of 4 feet below the footing bottom, and (2) excavation a minimum of 5 feet beyond the footprint for building structures. For lightly loaded equipment pads and ground mounted solar array foundations, no over-excavation is required, however the surface soil should be prepared as recommended above and compacted to engineered fill specifications as outlined below.

Compaction Requirements

All engineered fill and surface soil supporting structures should be compacted to not less than 95% of the material's maximum dry density (ASTM D 1557). In addition, the

material should be within minus 3% or plus 3% of optimum water content (ASTM D-1557).

Corrosion Potential

Results of soluble sulfate testing indicate that ASTM Type I/II Portland cement is suitable for all concrete on and below grade. Foundation concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Laboratory test results indicate the on-site soils have pH values ranging from 7.3 to 8.2 and minimum resistivity values ranging from 2,960 to 11,700 ohm-cm per ASTM G57. Based on these resistivity values, the soils at the site may be moderately to mildly corrosive to buried metals and reinforced concrete structures. In addition, the results of the pH testing indicate that the soil is generally slightly alkaline. Water soluble sulfate contents were observed to range from 15 to 94 ppm per Caltrans Test Method 417. Based on the testing performed, the concentration of sulfates in the samples may be considered to have a negligible risk with respect to sulfate attack on concrete. The laboratory test results can be found in Appendix E. Consideration should be given to consulting with a corrosion engineer for a more detailed evaluation and attendant recommendations.

Surface Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Surface features which could retain water in areas adjacent to the retaining walls should be sealed or eliminated. Backfill against footings, walls, and in utility trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Construction Considerations

It is anticipated that shallow excavations for the proposed construction can be accomplished with conventional earthmoving equipment. However, instability in the form of slope raveling, caving, and sloughing should be expected in all excavations and trenches at the site which extend into granular materials with little to no cohesion.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of the excavation sides and the excavation bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current Cal-OSHA and federal OSHA excavation and trench safety standards. The Department of Water Resources' Code of Safe Work Practices should also be followed.

Earthwork during wet site conditions may result in the disturbance of the site soils. The ability to use native soils from site excavations as structural fill will depend on their moisture content at the time of earthwork and the prevailing weather conditions when

site grading activities take place. Construction traffic should be restricted to dedicated driveway and laydown areas to prevent excessive disturbance of the building pad, parking area and driveway subgrades. Even intermittent wet weather could delay earthwork if soil moisture conditions are elevated above the optimum moisture content. Performing site grading operations during the warmer and drier months would aid in reducing potential need for subgrade stabilization.

During or shortly after periods of rainfall, earthwork operations may have to be temporarily halted should the moisture content of the proposed fill materials and areas planned to receive fill become elevated to levels well above optimum. When excessive moisture contents are created as a result of rainfall, the soil materials may have to be blended/mixed/aerated to reduce moisture contents to within compactible ranges.

During earthwork operations, the source of water required for moisture conditioning and dust control should be identified. There is the potential for a large amount of water being required for these earthwork operations.

FOUNDATION RECOMMENDATIONS

Where applicable, structures can be supported by concrete pedestal footings (ground mounted foundation), shallow spread footings, drilled shafts, driven piles, or screw piles. Design and construction recommendations for foundations for the proposed structures and related structural elements are presented in the following paragraphs.

Ground Mounted Foundation Design Recommendations

Ground surface materials below ground mounted foundations should be recompacted as recommended in the Earthwork section of this report. If undesirable (e.g., soft, loose, water softened, low density) materials are encountered, the undesirable bearing materials should be removed and replaced with compacted (engineered) fill.

Driven Pile Design Recommendations

Driven pile foundations (pipe piles, H-piles, or other steel piles) are considered applicable for support of solar arrays provided sufficient lateral load capacity can be generated between the pile and soil interaction. Recommended soil parameters for design of axial capacity and lateral load analysis would be the same as those provided for drilled shaft foundations (see Table 2).

Helical Pier Design and Construction Recommendations

Helical piers are an acceptable form of support for the foundation provided sufficient lateral load capacity can be generated between the pile and soil interaction. Recommended soil parameters for lateral load analysis would be the same as those provided for drilled shaft foundations.

Installation of the helical piers should be with a rotary type motor with equal forward and reverse torque capabilities. The equipment should be capable of continual adjustment of the torque drive unit's revolutions per minutes (RPM's) during installation. Percussion drilling equipment should not be used during installation of the helical piers. It is recommended that the installer use a torque monitoring device that is either part of the installing unit or an independent device in-line with the installing unit throughout the installation.

Spread Footing Design Recommendations

Table 1 - Shallow Continuous Spread Footing Design Recommendations

Item Description	Recommendation
Foundation Type	Conventional Shallow Spread Footing
Bearing Material	Recompacted Soils
Allowable Bearing Capacity	2,000 psf
Factor of Safety Applied to Ultimate Bearing Capacity	3.0
Minimum Width/Diameter of Footing	1 foot
Minimum Embedment Depth Below Finished Grade	1 foot
Total Estimated Settlement	< 1 inch
Estimated Differential Settlement*	< ½ inch

* The horizontal distance upon which the vertical differential settlement is measured is 20 feet. (The typical allowable differential settlement is 0.002L)

The allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

The general bearing capacity equation developed by Terzaghi was used to obtain the ultimate bearing capacity for the value provided above. The friction angle that was used in the calculation was based on a database of lab results from previous Department projects for similar materials (dense, silty sands). The soil unit weight was based on the lab results from the geologic exploration for this site (see Appendix E). A factor of safety of 3.0 was applied to the ultimate value to obtain the allowable bearing capacity. The final value was rounded down to the nearest 500 psf.

If a footing other than a 1-foot width and 1-foot depth is desired, the following equation can be used to calculate the allowable bearing capacity, Q:

$$Q_{all}(psf) = 1200D_f + 800B;$$

where D_f is the desired depth of footing and B is the width (or diameter) of footing. The allowable bearing capacity determined by the above equation should not exceed 10,000 psf without consulting a qualified soils engineer.

Footings should be proportioned to reduce differential foundation movement. Proportioning on the basis of equal total settlement is recommended; however, proportioning to relative constant dead-load pressure will also reduce differential settlement between adjacent footings. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction.

Spread Footing Construction Recommendations

The foundation excavations must be observed by a geotechnical engineer or a qualified representative to evaluate the bearing conditions prior to the placement of reinforcing steel and concrete. If undesirable (e.g., soft, loose, water softened, low density) materials are encountered in the foundation excavations, the excavations should be deepened to extend completely through the undesirable bearing materials. A lean concrete (slurry ABC with a minimum cement content of 2 sacks per cubic yard) material may be used as backfill to obtain a shallow, uniform footing depth for those foundation excavations that have been deepened. Alternatively, for the case where only a minor amount (i.e., less than six inches in thickness) of soft, loose, or disturbed soil is encountered at the base of a foundation excavation, the bottom could be mechanically compacted (hand tamped) to densify and improve this limited thickness of unsuitable soil, with the approval of the geotechnical engineer.

Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

Drilled Shaft Design Recommendations

Drilled shaft foundations—drilled a minimum of 10 feet or greater into suitable soils—are considered appropriate for support of proposed pole mounted equipment on the project. Allowable vertical axial load capacities of drilled shaft foundations for various diameters are shown on Figure 3. Uplift loads on drilled shafts can be resisted through the side shear developed between the walls of the shaft and the surrounding soils. Allowable shaft uplift load capacities (allowable load capacities in tension) for various diameters are shown on Figure 4. A factor of safety of 3 was applied to the ultimate load for both load capacity calculations.

A minimum practical horizontal spacing between shafts of at least three diameters should be maintained, and adjacent shafts should bear at the same elevation.

Recommended soil parameters for lateral load analysis of drilled shaft foundations have been developed for use in LPILE or COM624 computer programs based on data collected from the Standard Penetration Tests that were performed at the site (see Appendix F). Engineering properties have been estimated as outlined below:

Table 2 - Drilled (or Driven) Pier Design Criteria

Soil Properties	Recommendation
Unit Weight, γ	120 pcf
USCS Soil Type	SM
Internal Friction, ϕ	36°
Cohesion, c	0 psf
Modulus of Subgrade Reaction, k[1]	150 pci[2]

[1] Note: These values are based upon parameters for LPILE or COM624P analyses
[2] Note: This value increases linearly with depth an amount equal to the modulus and is independent of shaft diameter.

Lateral load design parameters are valid within the elastic range of the soil. The coefficient of subgrade reaction is an ultimate value; therefore, appropriate factors of safety should be applied in the shaft design or deflection limits should be applied to the design.

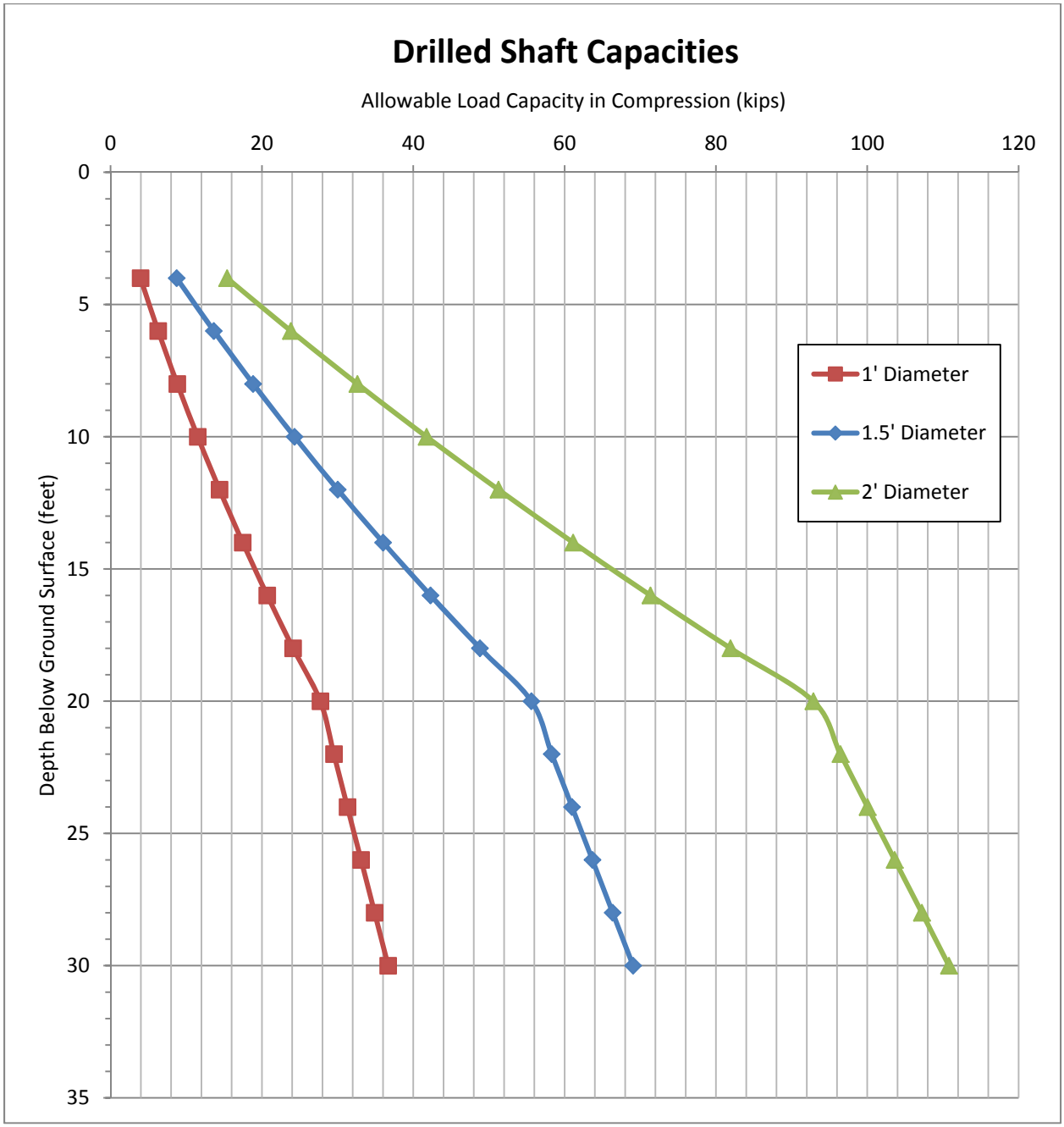

Figure 3 - Drilled Shaft Capacities – Allowable Load Capacity in Compression

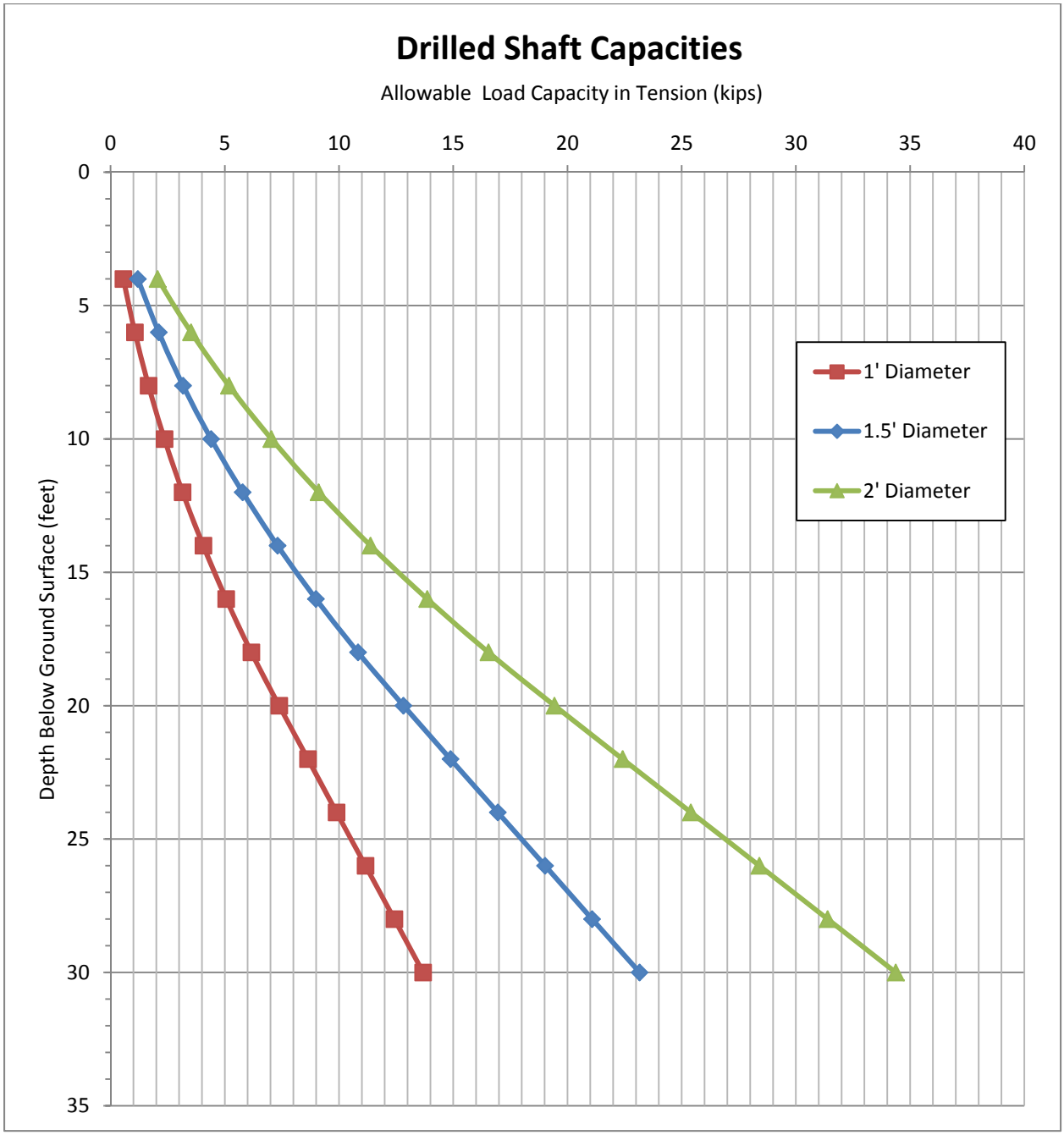

Figure 4 - Drilled Shaft Capacities – Allowable Load Capacity in Tension

Drilled Shaft Construction Recommendations

Drilling to design depth should be possible with conventional single flight power augers. Shafts will probably remain open without stabilizing measures. However, pier concrete should be placed soon after completion of drilling and cleaning. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes. Pier concrete with slump in the range of 4 to 6 inches is recommended.

If casing is used for pier construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or the creation of voids in pier concrete.

Shaft bearing surfaces must be cleaned prior to concrete placement. A representative of the design engineer or a qualified geotechnical engineer should inspect the bearing surface and shaft configuration prior to the placement of reinforcing steel and concrete. A sewer camera can be used to aid in the inspection.

Slab Mounted Equipment Support

If a concrete slab-on-grade with turn down edges is used as support for ancillary equipment pads the turn down edges should extend to a minimum of 12-inches below the lowest adjacent grade.

The footings may be designed for a maximum allowable bearing pressure of 1,000 psf when bearing on soils prepared as recommended in the Earthwork section. The design bearing pressure applies to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions.

Total and differential settlements on the order of 1 inch and ½ inch, respectively are estimated. Foundations and slabs should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

SEISMIC CONSIDERATIONS

The following site specific seismic design parameters are recommended in accordance with the 2013 California Building Code (CBC).

Table 3 - Seismic Design Parameters

Description – CBC (2013) Seismic Design Coefficients	Value
2012 International Building Code Site Classification (IBC)	D
Mapped Spectral Responses Acceleration Parameter, S_s (Figure 1613.3.1(1) for 0.2 second)	2.209 g
Mapped Spectral Response Acceleration Parameter, S_1 (Figure 1613.3.1(2) for 1.0 second)	1.038 g
Site Coefficient, F_a (Table 1613.3.3(1) for short period)	1.0
Site Coefficient, F_v (Table 1613.3.3(2) for 1-second period)	1.5
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{MS} (eq. 16-37)	2.209 g
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{M1} (eq. 16-38)	1.556 g
Design Spectral Response Acceleration Parameter, S_{DS} (Figure 16.39)	1.473 g
Design Spectral Response Acceleration Parameter, S_{D1} (Figure 16.40)	1.038 g

Reference: CBC (2013) Chapter 16, Section 1613 – Earthquake Loads

LATERAL EARTH PRESSURES

Table 4 - Lateral Earth Pressures

Item Description	Recommendation
Active Case	40 psf/ft
Passive Case	400 psf/ft
At-Rest Case	60 psf/ft
Friction Factor*	0.45

*The friction factor should be reduced when used in conjunction with passive pressure for resistance to lateral loads.

The lateral earth pressures recommended here do not include a factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.

Fill against foundation and retaining walls should be compacted to densities specified in the Earthwork section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors.

CONCLUSION

The analyses and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations (Appendix F) and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, the Division of Engineering should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report has been prepared for the exclusive use of the Department of Water Resources, Power and Risk Office for the specific application to the project described herein and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. The Department shall not be held liable for any discrepancies in the site conditions as described in this report.

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APPENDICES

APPENDIX A

Dams and Canals Proposal Memo
(Project Geology Proposal Memo Attached)

OFFICE MEMO

TO: George Baldini Senior Engineer, SWP Power and Risk Office	**DATE:** October 10, 2014
FROM: Robert Black RB Senior Engineer, Dams & Canals	**SUBJECT:** Pearblossom Solar Project Scope of Work and Cost Estimate Geotechnical Report

Introduction

As requested, this memo presents Geotechnical Services Branch's proposed scope of work and cost estimate to prepare a Geotechnical Report for the Pearblossom Solar Project site. The scope of work is a modified version of the "Scope of Work for Geotechnical Survey Services" prepared by Sunpower Corporation and provided by you, and will include the following work items:

1. Subsurface Exploration
2. Laboratory Testing
3. Engineering and Geologic Analysis and Report Preparation

The above items are described in greater detail below, and in Project Geology's proposal dated October 9, 2014 (attached).

Project and Site Description

The project will consist of a ground-mounted solar array supported on many small, lightly loaded foundations (driven steel or cast-in-drilled hole piles); a substation and other electrical equipment supported on shallow foundations; maintenance roads (unpaved); and underground utilties.

The solar array is to be located on a vacant parcel (Parcel 1A) within the Pearblossom Pumping Plant site at 34534 116th Street East, Pearblossom, California. Parcel 1A is located due east of the existing pumping plant and office buildings, and is composed entirely of spoil material generated during excavation of the adjacent canal and pumping facilities. The parcel has approximately 36 acres of useable area at the top of the spoil embankment, which is at an elevation ranging from 25 to 30 feet above surrounding grades. Parcel 1A is bordered by undeveloped land on the south and east, and by power line easements on the north. An additional vacant parcel (Parcel 5A) is located south of the existing switchyard, and consists of approximately 6 acres of useable land bordered by Highway 138 on the south and undeveloped land on the east. Parcel 5A may or may not be used as part of the proposed solar project, but will be included as part of our study.

Scope of Work

Field Exploration: The subsurface exploration will consist of 14 hollow stem auger borings spaced evenly within the two parcels, with at least one located at the proposed substation. The depth of the borings will range from 30 to 40 feet. The borings will be performed under the supervision of Project Geology by their drilling subcontractor with a truck mounted drilling rig. Soil samples (2.5" ring and SPT) will be obtained at regular intervals and transported to Bryte Laboratory for testing. Up to 10 exploratory test pits will also be excavated for purposes of collecting bulk samples and to log the near surface soils. The test pits will be excavated by a backhoe operated by SFD personnel. Environmental clearance will be obtained prior to drilling and excavation, as well as Underground

Service Alert and coordination with Southern Field Division (SFD) personnel to clear the drilling and test pit locations for underground utilities.

Field Electrical Resistivity Testing will be performed in accordance with ASTM G 57 along a minimum of 4 lines. A more detailed description of the subsurface exploration is provided in Project Geology's Proposal.

Laboratory Testing: Bulk and tube samples obtained during the subsurface exploration will be transported to the Bryte Laboratory for testing. The testing will consist of Gradation (ASTM D 422), Atterberg Limits (ASTM D 4318), maximum density (ASTM D 1557), moisture content and density (ASTM D2937), classification (ASTM D2487), direct shear (ASTM D3080), sulfate (California Test Method [CTM] 417), chloride (CTM 422), electrical resistivity (ASTM G 187-12a), and pH (ASTM G 51), and Thermal Resistivity (ASTM D 5334).

Engineering and Geologic Analysis & Report Preparation: An engineering and geologic analysis of the results of the subsurface exploration, laboratory testing, and review of existing site information will be performed. A geotechnical report will be prepared including the following items:

- Description of field explorations, including boring and test pit logs;
- Laboratory testing, including interpretation of the results;
- Interpretation of surface and subsurface conditions, geologic setting, groundwater;
- Geologic hazards evaluation, including seismic design parameters, faulting, liquefaction potential, seismic settlement, lateral spreading and other related hazards; and slope stability, erosion, settlement, expansive or collapsible soils, corrosivity, and other related hazards;
- Design and construction recommendations, including general earthwork and over-excavation and re-compaction requirements, design criteria for shallow and deep foundations – including lateral load analysis using LPile software, allowable bearing pressures, active and passive pressure, friction coefficient, and other related soil parameters.

Schedule

After all appropriate environmental permits and clearances are obtained, we anticipate the field exploration can be completed in approximately 1 to 2 weeks (includes marking the borings and test pit locations and clearing the site for USA), laboratory testing approximately 4 to 5 weeks after completion of field work, and report preparation approximately 2 to 3 weeks after completion of the laboratory testing.

Costs have been deleted

[redacted]

Attachments: Project Geology Proposal dated October 9, 2014
Resources Agreement

OFFICE MEMO

TO: Robert Black Dams and Canals Section	**DATE:** October 9, 2014
FROM: Brent Lamkin Project Geology Section	**SUBJECT:** Pearblossom Solar Project Proposed Geologic Exploration

INTRODUCTION

At the request of George Baldini, of the State Water Project Power and Risk Office, the Division of Engineering's Project Geology Section (Project Geology) has prepared this proposal and cost estimate for geologic exploration of the proposed solar power project at the Pearblossom Operations and Maintenance (O&M) Center and Pumping Plant. The proposed project will consist of multiple solar arrays and appurtenant structures to be located on one of two vacant parcels within the Pearblossom Pumping Plant (Pumping Plant) and O&M Center site at 34534 116th Street East, Pearblossom, California (Figure 1). The solar power generation project will likely consist of ground-mounted solar panels supported on small foundations of driven steel piles, or alternatively cast in drilled-hole piles. Appurtenant construction will consist of reinforced concrete equipment pads, a substation, an operations and maintenance building, underground utilities, and maintenance roads (unpaved). The final configuration and layout for the proposed development is not available at this time. This proposal and cost estimate was prepared by David Perry of the Project Geology Section.

SITE DESCRIPTION

The Pumping Plant is located on the southwest corner of the site, and consists of an inlet forebay, the pumping plant structure which houses pump turbines and equipment, and three discharge lines extending from the south side of the structure. The Pumping Plant footprint has been excavated approximately 100 feet below the surrounding grade.

The Pearblossom O&M Center proper consists of several buildings which house operations and maintenance shops and office facilities located northeast of the Pumping Plant. There is also a switchyard located south of the Pumping Plant and O&M Center. Two vacant parcels (1A and 5A) occupy the southeast corner of the site, and are being considered for solar development (Figure 1); other parcels were also considered for solar power development, but were not considered feasible. Descriptions of the two parcels are as follows:

<u>Parcel 1A:</u> This parcel is located due east of the Pumping Plant and O&M Center buildings, and is composed entirely of spoil material from the adjacent plant and canal excavations. The parcel has approximately 36 acres of useable area at the top of the spoil embankment, which is at an elevation ranging from 25 to 30 feet above the

surrounding grade. The parcel is bordered by undeveloped land on the south and east, and by power line easements on the north.

Parcel 5A: This parcel is located south of the switchyard, and consists of approximately 6 acres of useable area bordered by Highway 138 on the south and undeveloped land on the east. Existing and future discharge lines from the Pumping Plant are located along the west side of the parcel.

Project Geology proposes to conduct geologic exploration for the purpose of design and construction of a solar power generation facility. The exploration program proposed is designed to determine subsurface soil conditions for the potential solar arrays and appurtenant structures. The proposed exploration program includes hollow stem auger (HSA) drilling, backhoe test pits, geotechnical properties lab testing, project meetings, and preparing a report. The report will include exploration findings, a geologic profile, drill hole and test pit soil logs, laboratory results, and design recommendations.

GEOLOGICAL EXPLORATION PROGRAM

Hollow Stem Auger Drilling and Backhoe Test Pits

A total of about 14 HSA borings are proposed (roughly 620 feet total). The HSA borings will be drilled evenly across Parcels 1A and 5A. Ten borings will be drilled at Parcel 1A and four at Parcel 5A (Figure 2). Eight to ten backhoe test pits will also be excavated across both parcels. The purpose of these borings and test pits is to assess the subsurface conditions of the fill and underlying native materials in the vicinity of the proposed solar array and to gather samples for field logging and index testing of soils encountered. Borings will be advanced to approximately 40 feet deep to extend through the existing fill and into the native soils below; the borings on Parcel 5A will be shallower (20 to 30 feet deep), as there is little or no fill. The boring depths will allow us to characterize the foundation soils and to collect undisturbed soil samples for index and strength testing. Test pits will be excavated by SFD personnel and will extend to a depth of about 10 to 15 feet below existing site grade, depending on the capability of the equipment available. The test pits will not be shored and will be logged from the ground surface. In-place density measurements (nuclear gauge and sand cone) will not be collected.

The drilling equipment for this work will be a CME 75 or similar drill rig. Drilling will be conducted using 8.25-inch outside diameter HSA equipped with a continuous coring system. The recovered cores will be saved in polycore boxes and stored at Bryte Soils Lab for additional review. A Standard Penetration Test (SPT) split spoon sampler will be utilized to collect soil samples every 5 feet. The sampler types used will

be determined in the field based on the soil conditions encountered, but will likely include SPTs and Modified California Samplers. SPT blow counts will be collected at each soil sample interval; this will help the design engineer select soil samples for testing. The soils from both borings and test pits will be geologically logged by a Project Geology Engineering Geologist using the Unified Soil Classification System as outlined in ASTM D2488. All of the work will be conducted under the supervision of a California Certified Engineering Geologist.

Surface Mapping

A Project Geology Engineering Geologist will inspect and map the surface of the two parcels noting the general soil types encountered. This will be a cursory examination, and will not involve the collection of samples or laboratory testing unless unanticipated conditions are encountered.

Borehole Abandonment and Test Pit Abandonment

All HSA holes will be backfilled with cement-bentonite grout through a tremie pipe, unless otherwise dictated by environmental requirements. All test pits will be backfilled with excavated soil materials and compacted with a backhoe sheeps-foot compaction wheel.

Geotechnical Properties Laboratory Testing

Soil samples will be collected for geotechnical properties testing during HSA drilling and from test pit excavations. The design engineer will assist in selecting samples to submit for testing, which will be conducted by the Bryte Soils Laboratory in West Sacramento. Laboratory testing is anticipated to include Atterberg limits (ASTM D4318), gradation testing (ASTM D422), moisture content (ASTM D2216), density (ASTM D6938), classification (ASTM D2487), direct shear (ASTM D3080), compaction (ASTM D1557), electrical resistivity (ASTM G187-12a or California Test Method [CTM] 643), sulfate content (CTM 417), chloride content (CTM 422), and pH (ASTM G 51 or CTM 643). Soil electrical resistivity will also be measured in the field (ASTM G57-06), and thermal resistivity (ASTM D5334 or IEEE 442-1981) can be measured in the lab and in the field. Actual soil testing will depend on soils and soil conditions encountered in the field.

Logistics

An Engineering Geologist from Project Geology will direct all field activities including inspecting the site, marking the proposed exploration locations with white paint (as required by law for underground utility clearance), and directing the field work.

HSA borings will be drilled using Project Geology's Southern California Drilling Contract with Gregg Drilling (Contract No. 4600010436. The equipment anticipated for this work will be a truck-mounted HSA drill rig, such as a CME 75 or Mobile B-53.

The backhoe test pits will be excavated by personnel and equipment from Southern Field Division's Civil Maintenance Branch.

Permits and Clearances

Based on Project Geology's understanding of the site location, a variety of permits may be required in order to complete this work, including environmental clearance. This effort will be coordinated between Project Geology, and DOE and O&M environmental staff; we may also require the assistance of Environmental Scientists from the Division of Integrated Regional Water Management's Southern Region Office (SRO). Underground Service Alert South (USA) will be contacted by Project Geology to locate underground utilities prior to the subsurface exploration work. If needed, Project Geology will request Gregg Drilling to subcontract with a utility locator where underground utilities are poorly marked or locations are uncertain.

No excavation or drilling will take place until all environmental, cultural, right-of-way, and utility clearances and permits have been secured.

Schedule and Costs

It is anticipated that field work can begin a couple of weeks after all the appropriate permits and clearances are obtained. HSA drilling is anticipated to take four to six working days to complete. Backhoe test pits will take one to two days to complete. A geologic report will be provided within six to eight weeks of completion of any lab work required, as long as there are no unforeseen delays, and will include a site geology map, geologic cross section(s), final boring and test pit logs, geologic summaries, all field and lab testing data, a discussion of the findings, and recommendations for design and construction.

Costs have been deleted

[redacted]

[redacted]

Thank you for the opportunity to assist you with this project. If you have any questions or need additional information, please contact me at 376-9881.

Attachments

cc: Joe Royer, Acting GSB Chief, 538
Rob Barry, West Sacramento

Figure 1

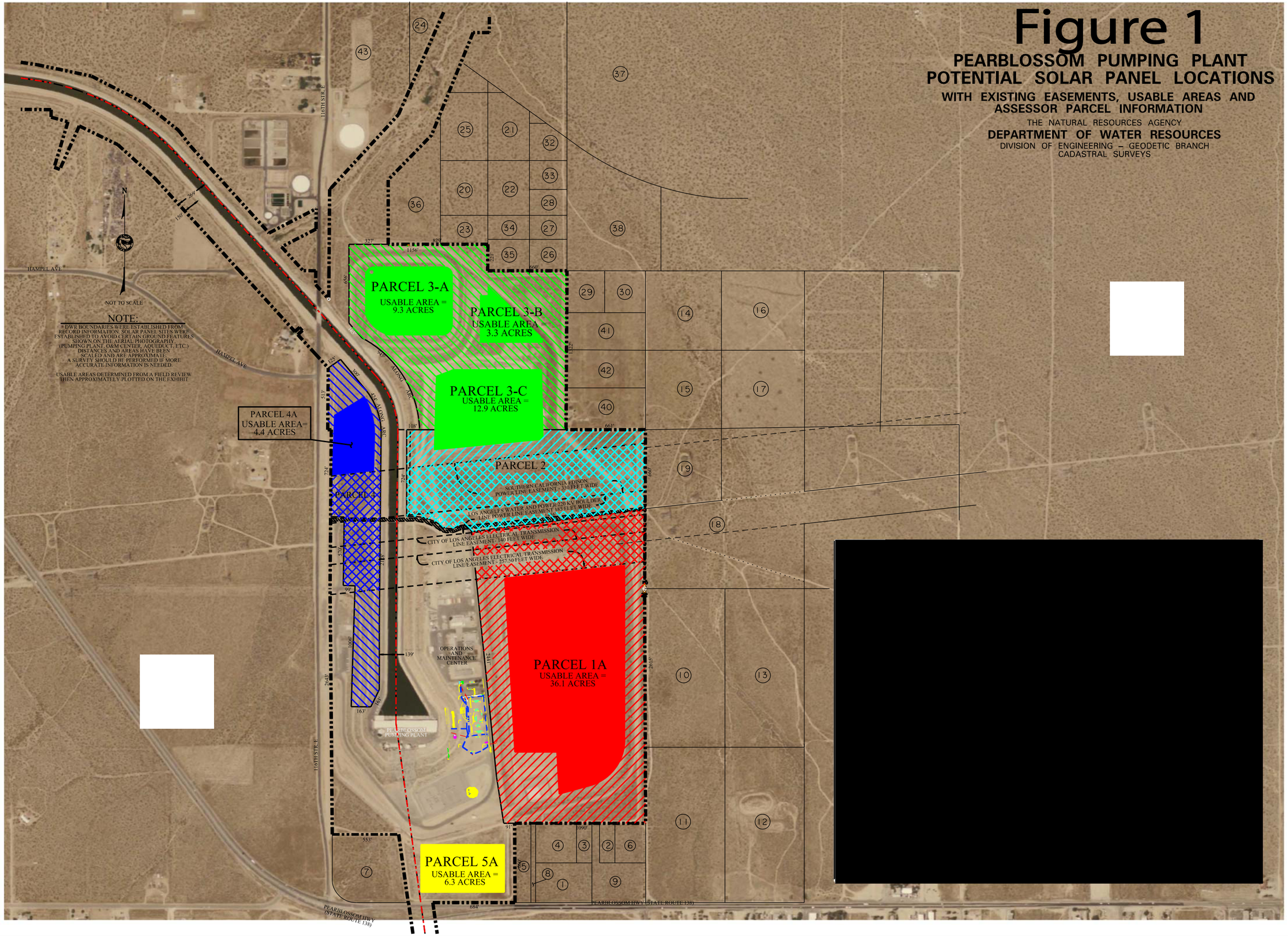
PEARBLOSSOM PUMPING PLANT POTENTIAL SOLAR PANEL LOCATIONS

WITH EXISTING EASEMENTS, USABLE AREAS AND ASSESSOR PARCEL INFORMATION

THE NATURAL RESOURCES AGENCY

DEPARTMENT OF WATER RESOURCES

DIVISION OF ENGINEERING – GEODETIC BRANCH
CADASTRAL SURVEYS



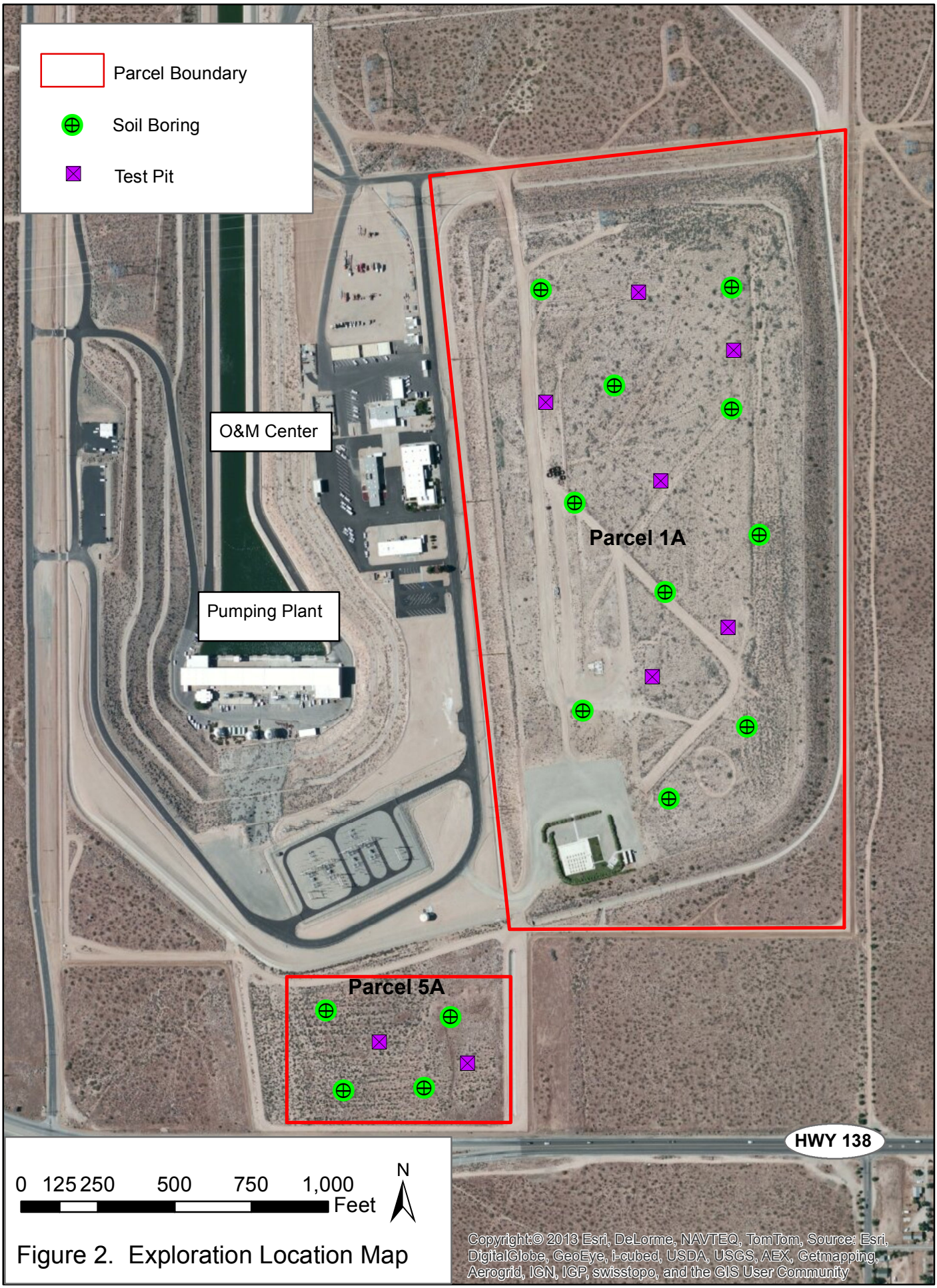


Figure 2. Exploration Location Map

APPENDIX B
Photographs

Photo 1 – View of Parcel 1A from the North-South midpoint, looking north

Photo 2 – View of Parcel 1A from the northeast corner of the parcel, looking south

Photo 3 – Concrete lined embankment at the northeast corner of Parcel 1A

Photo 4 – 24" CMP at the northeast corner of Parcel 1A for drainage collection

Photo 5 - View of Parcel 5A from the south end of the parcel, looking north

Photo 6 - View of Parcel 5A looking southeast with Hwy 138 bordering the south end of the parcel

APPENDIX C

Summary of Geologic Findings from Previous DWR Geologic Conditions (Office Memo from Brent Lamkin to Robert Black dated 6/19/14)

OFFICE MEMO

TO: Robert Black Dams and Canals Section	**DATE:** June 19, 2014
FROM: Brent Lamkin Project Geology Section	**SUBJECT:** Pearblossom Solar Project Summary of Geologic Conditions

Pursuant to your April 24, 2014 request for geologic information regarding the proposed Pearblossom Solar Project, the Project Geology Section has prepared this Office Memo summarizing the geologic conditions at the general site, and at each of the individual sites under consideration. The geologic summary has been compiled from existing reports and documents; no new exploration or field work was conducted for this report. It is my understanding that additional geologic data may be needed in the future to supplement the preliminary engineering considerations you are developing.

A detailed proposal and cost estimate for a subsurface investigation and geotechnical report will be provided separately once the facility location and layout is finalized.

PROPOSED PROJECT

The proposed project will consist of one or more solar arrays at the Pearblossom Operations and Maintenance (O&M) Center, in Pearblossom, Calfiornia (Figure 1). The arrays will be located on one of two vacant parcels out of a total of eight originally considered. The solar arrays will likely consist of ground-mounted solar panels, concrete equipment pads, underground utilities, and unpaved maintenance roads.

The first parcel being considered for a solar array is Parcel 1A, located immediately east of the main portion of the Pearblossom O&M Center and south of the Southern California Edison power transmission corridor. This parcel consists of approximately 36 acres of usable land, and is completely contained within the East Borrow Area. The East Borrow Area is one of two excavation spoil areas from construction of the Pearblossom Pumping Plant and the East Branch of the California Aqueduct. Parcel 1A is located on approximately 25 to 30 feet of spoil material.

The second parcel under consideration is Parcel 5A, located at the south end of the Pearblossom facility, between State Highway 138 and the Pearblossom Pumping Plant switchyard, with the Pearblossom Pumping Plant discharge lines bordering to the west. There is approximately 6 acres of useable land within this parcel, and it appears to be covered by native soils.

PREVIOUS INVESTIGATIONS

Numerous geologic investigations have been conducted at the Pearblossom facility; however, none have been undertaken for this project. For the most part, the previous investigations have concentrated on the following facilities: 1) Pearblossom Pumping Plant, 2) Pearblossom Pumping Plant discharge lines, 3) the East Branch of the California Aqueduct, and 4) the Pearblossom O&M Center.

A list of reports that contain information relevant to the overall site geology, and/or the individual parcels being considered for the solar array(s) can be found in Appendix A.

SITE DESCRIPTION

The Pearblossom O&M Center serves as a support center for the operation and maintenance of the adjacent Pearblossom Pumping Plant and the California Aqueduct, East Branch. It is located approximately 12 miles east of Palmdale, and approximately one-half mile north of State Highway 138, within the city limits of Pearblossom, Los Angeles County, California. The site lies about two and one-half to three miles north of the San Andreas Fault Zone and the foothills of the San Gabriel Mountains, at the southern edge of the Mojave Desert. Average annual precipitation for this area is less than seven inches, most of which falls during the winter months. Vegetation is sparse, consisting of mostly low shrubs and brush.

GEOLOGIC SETTING AND SITE CONDITIONS

The Pearblossom facility is located on the southwestern edge of the broad, alluvium-filled Antelope Valley, which at this location coincides with the southern margin of the Mojave Desert geomorphic province.

Geologic exploration and construction of the pumping plant facilities has shown three distinct geologic units at the margin of the valley: one granitic bedrock unit and two overlying alluvial units. Geologic references for the site can be found in Appendix A.

The nearby San Gabriel Mountains consist of Cretaceous to Jurassic age granitic bedrock which varies in composition from granite to quartz diorite, but is predominantly quartz monzonite. The granitic bedrock surface dips to the north beneath the sediments of Antelope Valley. Locally, the granitic bedrock is intensely to moderately weathered and intensely to moderately fractured, with prominent joint sets (DWR, 1969). About ten feet of reddish-orange arkosic sand overlies the granitic bedrock on the southern edge of the Valley and comprises a Quaternary Older Alluvium geologic unit (Qoal) at the site. The Qoal is a dense, cohesive, reddish-brown, arkosic sand (SP) that contains about ten percent angular granitic pebbles and cobbles. Recent Alluvium (Qal) overlies the Qoal and covers the unimproved areas of the site. Recent Alluvium is light gray to tan, bedded, silty sands, well-graded sands, gravelly sands (g(SP)) and g(SW)), interbedded with reddish-brown gravelly silty sand (g(SM)). Gravel and cobbles in the sands are of granitic and metamorphic origin, ranging from five to 25 percent content and rarely exceeding six inches in diameter.

The Quaternary Older Alluvium and Recent Alluvium units are composed of permeable sands and gravels, but do not exhibit continuously saturated conditions. Based on previous exploration at the site (DWR, 1965b and DWR, 1968b), groundwater is primarily transmitted through fractures along the surface and shallow depths of the weathered granitic bedrock underlying the site from at least 156 to 226 feet below ground surface (bgs). One boring from early 1965 immediately west of the Pearblossom Pumping Plant (Boring 18) did not encounter groundwater at the maximum drilling depth of 226 feet bgs, while encountering bedrock at 112 feet bgs; another boring further east (Boring 12) reached bedrock at 156 feet bgs, but

groundwater depth could not be determined in the 223-foot drill hole because of the rotary wash drilling method employed (DWR, 1965b). Groundwater was encountered at 107 feet bgs during exploration of the pumping plant bowl (DWR, 1965b) located about 600 feet west of the new administration building site. Depth to bedrock and groundwater is less at the pumping plant location as the granitic bedrock surface appears to dip to the east and north.

The direction of groundwater flow beneath the site appears to be mainly to the north, toward the interior of Antelope Valley and away from the San Gabriel Mountains. Groundwater was encountered in the Pearblossom Pumping Plant excavation at 108 feet below original ground surface during construction.

The active San Andreas fault zone lies about 3 miles south of the Pearblossom O&M Center, paralleling the San Gabriel Mountain front. The active fault zone is manifested through the area in a number of individual faults, however, no evidence of recent fault displacement is known from the surface of the quaternary alluvium within the site.

Parcel 1A

The soils and geologic conditions within Parcel 1A have been characterized using several exploration methods. Several borings drilled in the 1960s were located within the confines of what is now the East Spoil Area prior to placement of the 25 to 30 feet of construction spoil now covering the site. More recent shallow test pits were excavated in the spoil of the parcel as part of a foundation and septic disposal study of alternative sites for the Pearblossom O&M Center Administration Building.

Seven shallow test pits were excavated, logged, and sampled in 2008. All of the test pits are near the western boundary of Parcel 1A, and range from 6.3 to 7.2 feet deep. The spoil in the test pits was logged as poorly graded sand with gravel (SP)g, poorly graded sand with silts and gravel (SP-SM)g, poorly graded sand (SP), silty sand (SM), poorly graded sand with clay (SP-SC), and poorly graded sand and gravel (SP-SC). Many of the test pits encountered zones of layered gravel from the fill placement. The spoil material below the maximum test pit depths are very likely to be the same as described here, with the exception that it is possible that larger cobbles and even boulders from the pumping plant bowl excavation may be found.

Two borings (11 and 12) from 1964 depict the preconstruction subsurface beneath the parcel. Loose to compact silty sand (SM), well graded sand (SW), sandy gravel (GW) and gravelly sand (SW) Recent Alluvium underlies the spoil material to a depth below original ground surface of 31 to 50 feet. From 31-50 feet to 156-208 feet below original ground surface is composed of a compact to dense arkosic silty sand (SM). Quartz monzonite bedrock with granite pegmatite intrusions was encountered at depths of 156 and 208 feet below original grade. The depth to groundwater was not determined in the borings, but was encountered at 108 feet below grade in the Pearblossom Pumping Plant excavation, about 900 feet west of the site; given that previous studies have shown that groundwater is generally transmitted along and near the surface of the granitic bedrock, it is estimated to occur at about 156 to 208 feet below original ground beneath the parcel.

In December 2009 and a subsurface investigation was conducted at the site of the new Pearblossom O&M Center Administration Building to determine the feasibility of constructing a geothermal ground-loop heating/cooling system for the new building located approximately 350 feet west of Parcel 5A. Well-graded sand Recent Alluvium was logged in the test boring from the ground surface to 29 feet bgs. Older Alluvium was logged between 29 and 161 feet bgs, and comprised of silty sand, with lesser sequences of clayey sand, well-graded gravel, and thin layer of cobbles and boulders overlying lean clay with sand atop granitic bedrock encountered at 161 feet bgs. Thermal conductivity testing was conducted in the 405-foot boring. Thermal diffusivity was estimated from the calculated thermal conductivity data and estimated heat capacity; the formation temperature was also measured during the January 2010 testing. Thermal conductivity for the formation was calculated to be 1.16 Btu/hr-ft-F^{o}, the formation thermal diffusivity was estimated to be 0.82ft^{2}/day, and the undisturbed formation temperature was measured at 69 to 72°F. Keep in mind that this data was from a vertical boring over 400 deep, and likely does not represent conditions at and near the surface.

Parcel 5A

The Parcel 5A geologic conditions that follow have been summarized from several exploration borings, geophysical surveys, construction mapping, and test pits. Most of the exploration conducted within or adjacent to the parcel is associated with the Pearblossom Pumping Plant discharge lines at the western edge, while the test pits are associated with an alternative site for the Pearblossom O&M Center Administration Building at the eastern boundary.

Bucket auger and rotary borings along the discharge line alignment showed silty sand, poorly graded sand, and well graded sand Recent Alluvium (Qal) ranging from 4 to 20 feet thick, and thinning toward the south. Beneath the Qal is 17 to 21 feet of Older Alluvium (Qoal) consisting of arkosic silty sand, well graded sand, and clayey sand. Underlying the alluvial soils is quartz monzonite bedrock 21 to 38 feet below original ground surface. Groundwater was measured at 34.4 feet below grade in a boring located 112 feet west of the discharge lines alignment.

Two test pits were excavated and logged at the eastern edge of Parcel 5A as part of a foundation and septic field evaluation. Both test pits were excavated seven feet bgs and sampled. The excavations were confined to Recent Alluvium, with the upper 1.4 to 3.0 feet consisting of silty sand, and the remainder (between 1.4 – 3.0 feet bgs and 7.0 feet bgs) comprised of poorly graded sand with silt (SP-SM) with 10 percent gravel.

Geologic mapping of excavations for the Pearblossom Pumping Plant discharge lines (1st, 2nd, and 3rd barrels) show that silty sand, well graded sand, well graded gravel, and sandy gravel were encountered during construction. No groundwater was encountered during construction, but was reported in previous exploration approximately 100 feet south of Highway 138.

Electrical resistivity surveys were conducted for the Pearblossom Pumping Plant discharge line, third barrel in 1988. One survey transect fall along the southern edge of Parcel 5A, at

Station 9+70. A Resistivity value of 8,040 ohm-cm was measured for an electrode spacing of 5-feet, while a value of 3,450 ohm-cm was measured for a 20-foot spacing.

FINDINGS AND CONCLUSIONS

In general, the overall site, and both of the alternative solar array parcels, consist of coarse-grained soils overlying granitic bedrock to depths between 25 and 208 feet bgs. Groundwater is typically encountered along the alluvial soil – bedrock contact, and has not been encountered in any excavations above 108 feet bgs. An exploration boring for the first discharge line encountered groundwater at a minimum depth of 30 feet south of the parcel, but no groundwater was encountered during construction of any of the Pearblossom Pumping Plant discharge lines within the areas of consideration. Likewise, groundwater was not encountered in any of the foundation and septic field exploration test pits for the various Pearblossom O&M Center Administration Building alternative locations.

Parcel 1A

As outlined above, previous geologic exploration has shown that the parcel is covered with 25 to 30 feet of silty sand and poorly graded sand with various percentages of gravel excavation spoil. Underlying the spoil are alluvial soils consisting of silty sand, well graded sand, gravely sand, and sandy gravel. Groundwater is estimated to be between 156 and 208 feet below the original ground surface, or approximately 180 to 240 feet below the current land surface.

The loose to slightly compact, dry to moist, cohesionless sandy spoil covering the parcel is expected to have a presumptive bearing capacity of 1,500 to 6,000 pounds per square foot (1.5 to 6 kips/ft^2) according to Sowers (1979), and 2,000 to 8,000 pounds per square foot (1.0 to 4.0 tsf) per NAVFAC (1986); in all likelihood, though, the foundation is probably on the lower side of Sower's and the NAVFAC soil types with 1,500 to 3,000 lbs/ft^2 (1.5 to 3 kips/ft^2 – Sowers), or 2,000 to 6,000 lbs/ft^2 (1.0 to 3.0 tsf – NAVFAC) expected as a typical presumptive bearing capacity because the material is uncompacted fill.

Presumptive bearing capacities from the loose to compact silty sand, well graded sand, sandy gravel, and gravelly sand Recent Alluvium underlying the spoil of Parcel 1A is expected to range from about 1,500 to 6,000 pounds per square foot (1.5 to 6.0 kips/ft^2) per Sowers, and 1.5 to 3.0 tsf for the silty sand and well graded sand, and 3.0 to 5.0 tsf for the sandy gravel and gravelly sands. The overall bearing capacities for the Recent Alluvium are likely on the lower side of the values listed above, as the gravel lenses are discontinuous and the soils are predominantly sandy.

The dense, arkosic silty sand Older Alluvium between approximately 31-50 and 156-208 feet below the original ground surface (about 55-80 to 180-240 feet below the spoil pile surface) is expected to exhibit a presumptive bearing capacity of 3,000 to 12,000 pounds per square foot (3.0 to 12 kips/ft^2) according to Sowers (1979), and 4,000 to 10,000 pounds per square foot (2.0 to 5.0 tsf) per NAVFAC (1986). The presumptive bearing capacities are likely to be on the higher side of the ranges given as the Older Alluvium is generally dense to very dense.

The depth to groundwater beneath the parcel is estimated to be at least 180 feet below the ground surface, and will not be encountered in any excavation, or drill hole for a footing or pile that can be reasonably expected.

While the site is close to the San Andreas fault, liquefaction is not anticipated. The likely foundation soils are well above any groundwater that might be encountered beneath the parcel, minimizing the probability of liquefaction. However, ground shaking and surface rupture are possible given the proximity of the San Andreas fault zone.

Parcel 5A

As previously described, the Recent Alluvium covering Parcel 5A is from 4 to 20 feet thick, thins to the south, and is composed primarily of loose to slightly compact silty sand with lesser quantities of poorly graded sand and clayey sand. Presumptive bearing capacities for these soil types range between 1,500 to 4,500 pounds per square foot (1.5 to 4.5 kips/ft^2) per Sowers (1979), and 2,000 to 12,000 pounds per square foot (1.0 to 6.0 tsf) according to NAVFAC (1986).

Older Alluvium within the area of Parcel 5A, and underlying the Recent Alluvium, is between 4-58 feet and 21-65 feet below the original ground surface, and thins to the south. The Older Alluvium is composed of arkosic silty sand, clayey sand, and well graded sand. Presumptive bearing capacities of the Older Alluvium range from 2,000 to 7,500 pounds per square foot (2.0 to 7.5 kips/ft^2) according to Sowers (1979), and 4,000 to 8,000 pounds per square foot (2.0 to 4.0 tsf) per NAVFAC 1986).

Quartz monzonite granitic bedrock is much shallower in Parcel 5A than in Parcel 1A, so it has been included in the discussion of possible foundation materials. The surface of the granitic bedrock is between 21 and 38 feet below original ground surface. During pre-construction exploration the upper portion of the bedrock was described as decomposed, severely weathered, friable, very soft, sheared, and crushed to very badly fractured. A zone of less weathered granitic bedrock was encountered in a boring west of the discharge lines alignment at 108 feet below original grade; the deeper bedrock was described as moderately decomposed, moderately hard, and sheared. Presumptive bearing capacities for the bedrock are 16,000 to 50,000 pounds per square foot (8.0 to 25.0 tsf) according to NAVFAC (1986), and 10,000 to 25,000 pounds per square foot (10 to 25 kips/ft^2) per Sowers (1979).

The depth to groundwater beneath Parcel 5A is not known with certainty, as it was not encountered during the preconstruction discharge line exploration or the later test pits excavated for the new Southern Field Division Headquarters. However, stable groundwater was measured on October 4, 1960 at 34.4 feet bgs (elevation 3,016.6') in drill hole 3, located 112 feet west of the parcel. Groundwater was also measured at 30.3 feet bgs (elevation 3,034 feet) in a boring about 100 feet south of the Parcel 5A southern boundary. Depending upon the type of foundation selected, groundwater may be encountered during construction, but only if it excavated/drilled into bedrock.

While the site is close to the San Andreas fault, liquefaction is not anticipated. The likely foundation soils are above any groundwater that might be encountered beneath the parcel. Surface rupture and strong motion may be expected given the proximity to the San Andreas fault.

RECOMMENDATIONS

Both Parcel 1A and Parcel 5A appear to be acceptable for construction of a large photovoltaic array. Parcel 1A is larger, with approximately 36 usable acres, while Parcel 5A contains only 6.3 useable acres. Furthermore, the useable acreage of Parcel 5A might be less if a western buffer is maintained for the Pearblossom Pumping Plant discharge lines. From an available/usable area standpoint, Parcel 1A appears to be the preferred choice.

Parcel 1A consists of approximately 25 to 30 feet of uncompacted sandy fill overlying native sandy soils, while Parcel 5A contains loose alluvial sand soils. Both the fill and shallow alluvium are of relatively low strength and will likely require excavation and recompaction at locations where structures will be located.

As the existing data for both parcels was not specific to this proposed project, and is up to 54 years old, it is imperative that any further considerations for the project include additional geologic and geotechnical exploration and testing. This can be carried by the Project Geology Section, but it must be based on a proposed project configuration. We would be happy to scope out the additional exploration that may be required once a project description and layout has been developed.

Thank you for giving us the opportunity to comment on the proposed project. Please let me know if you have any questions on the content of this memo, or if you need more information.

APPENDIX A – REFERENCES

DWR References

Project Geology Report 57-31-03, “Engineering Geology, Pearblossom Pumping Plant and Intake Channel,” dated December 1965.

Project Geology Report 57-31-05, “Office Report, Geophysical Survey of Pearblossom Pumping Plant Discharge Lines,” dated November 1967.

Project Geology Report C-30, “Final Geologic Report of Pearblossom Pumping Plant Site Development,” dated November 1967.

Project Geology Report 57-31-07, “Office Report, Geologic Exploration, Pearblossom Pumping Plant, dated July 1968.

Project Geology Report C-48, “Final Geologic Report of Pearblossom Pumping Plant,” dated April 1969.

Project Geology Report 57-31-09, “Office Report, Engineering Geology of Pearblossom Pumping Plant Discharge Line,” dated August 1969.

Project Geology Report D-110, “Geologic Data, Pearblossom Pumping Plant Discharge Line,” dated August 1969.

Project Geology Report C-71, “Final Geologic Report, Pearblossom Pumping Plant Discharge Line,” dated May 1973.

Project Geology Report C-89, “Final Geologic Report, Pearblossom Pumping Plant Discharge Line, Second Barrel,” dated January 1976.

Project Geology Report 57-31-17, “Pearblossom Pumping Plant Discharge Line, Resistivity Survey,” dated December 6, 1988.

Project Geology Report 57-31-21, “Pearblossom Operations and Maintenance Center, Geologic Foundation and Percolation Test Investigation Results for Proposed Structures,” dated November 5, 2010.

Project Geology Report 57-31-22, “Pearblossom Operations and Maintenance Subcenter, Proposed Administration Building and Leach Field; Results of Supplemental Geologic Exploration,” dated November 5, 2010.

Project Geology Report 57-31-23, “Pearblossom Operations and Maintenance Subcenter, Proposed Administration Building; Geologic Investigation for a Geothermal Heat Exchange System,” dated July 15, 2010.

Project Geology Report D-201, “Geologic Data Report, Southern Field Division Headquarters Project, Southern Filed Division,” dated November 2010.

Non-DWR References

Sowers, George F., 1979, Introductory Soil Mechanics and Foundations: Geotechnical Engineering (4th ed.): Macmillan Publishing Co., Inc., New York.

United States Navy, 1986, Foundations and Earth Structures: Naval Facilities Command (NAVFAC) Design Manual DM-7.02, Washington D.C.

APPENDIX D

Project Geology Report No. 57-31-26

State of California | California Natural Resources Agency

Memorandum

Date: March 9, 2015

Project Geology
Report No. 57-31-26

To: Tim Wehling, Chief
Dams and Canals Section

From: G. Robert Barry, Chief
Project Geology Section
Department of Water Resources

Subject: Pearblossom Solar Array, Faulting and Seismicity Report

PURPOSE

At the request of the Division of Engineering's (DOE) Dams and Canals Section (D&C), DOE's Project Geology Section (Project Geology) has estimated deterministically and probabilistically derived horizontal ground motions from earthquakes expected near the proposed solar array project located adjacent to and to the east of the Pearblossom Pumping Plant.

The estimated ground motions will be used in the design of the proposed solar array. The location of the solar array is identified as parcel 1A, as shown on Figure 1. Project Geology has used available information supplied in previous reports to set site condition parameters of our seismic hazard evaluation (DWR, 1965; DWR, 2015). The approximate geographic coordinate centroid of the proposed solar array located on parcel 1A is: latitude 34.512°, longitude -117.916°; NAD 83.

This report only addresses the proposed Pearblossom Solar Array, Parcel 1A, area (PBSA-1A) and should not be used for evaluating ground motions located outside of the parcel 1A area due to significant changes in site conditions located outside of the footprint of this project.

GROUND MOTION SOURCES

The PBSA-1A is located about 3.6 kilometers (km) northeast of the seismically active San Andreas fault, Mojave sections (SAF), a right-lateral strike-slip fault system. The SAF may be capable of generating a magnitude (M) 8.5+ earthquake. An earthquake of this size is very infrequent with a recurrence interval of about 600,000 years or more (UCERF3, 2014).

Currently, the U.S. Geological Survey (USGS) is updating the 2008 National Seismic Hazard Mapping Program's Probabilistic Seismic Hazard Assessment Interactive Deaggregation web site (2008 deaggregation model) that will utilize the 2014 Uniform California Earthquake Rupture Forecast version 3 database (UCERF3), and the Next Generation Ground Motion Attenuation Relationships, version West 2

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equations (NGA-W2). UCERF3 is the current peer reviewed California fault model database and NGA-W2 is the current peer reviewed ground motion prediction equations calculator. The latest version of the USGS deaggregation model is the 2008 web based calculator that uses the 2008 UCERF2 database and some of the 2008 NGA-W1 model equations (2008 USGS deaggregation model and 2008 NGA-W1 models). Significant changes in both UCERF3 from UCERF2 and NGA-W2 from NGA-W1 require current ground motion analysis to use the most up-to-date models and calculators available.

Project Geology was asked by D&C to consider the probabilistic earthquake recurrence interval of 10% chance of recurrence in 50 years (10% in 50 years). This interval has a return period of approximately 475 years. Since the USGS web based deaggregation model is not yet available, Project Geology approached the 475 year return interval using the SAF as the predominant deterministic fault and as a single source probabilistic fault. This decision to only use the SAF as the probabilistic fault was based on reviewing all the faults that weighed in the 2008 web based probabilistic deaggregation model for this same location (PBSA-1A). In the 2008 deaggregation model, only the SAF carries weight in the ground motions at PBSA-1A. Using the UCERF3 "EventRates" spreadsheet we back-calculated to determine what magnitude earthquake from the SAF would have a return period of 475 years. The 475 year return period event on the SAF is approximately a M8.0 earthquake.

METHODOLOGY

Project Geology used the M8.0 earthquake on the SAF to determine the 50th and 84th percentile ground motions at PBSA-1A. The recurrence interval of a M8.0 earthquake on the SAF is roughly about 447 years. As mentioned above, a 10% in 50 years is 475 years (Figure 2 and Figure 3). The 447 year return period was determined by extrapolating the binned value of a M7.95 and a M8.05 from the UCERF3 "EventRates" spreadsheet and then taking the median between the two return periods. The result is about 447 years for an approximate M8.0 earthquake on the SAF.

In order to determine the resultant spectral accelerations at PBSA-1A from a M8.0 event of the SAF Project Geology applied several input parameters into the NGA-W2 calculator. The magnitude earthquake is selected (M8.0) and three distance parameters; Rrup, Rjb, and Rx. For evaluating ground motions at PBSA-1A the SAF is considered a vertically dipping strike-slip fault so all three input distance parameters are equal (3.62 km).

The site condition is based on the soil profile type and is typically estimated using the shear wave velocity in the upper 30 meters of surface (Vs30), or 30 meters below the base of the structure's foundation. Other methods of determining the soil profile type are by testing the undrained shear strength of the soil, or using the standard penetration test (SPT) for cohesionless soil layers (blows/foot). Since no recorded shear wave velocity data is available for the site, Project Geology approximated the Vs30 value using existing drill hole data.

Recent SPT blow count data from Project Geology Report No. 57-31-25, dated March 2015, was used to correlate the shear wave velocity at depth. None of the recent drill holes went deeper than about 50 feet (15 meters) below ground surface so additional data was needed to approximate the remaining 50 feet to reach a total depth of 100 feet (30 meters) below ground surface to satisfy the Vs30 input parameter. Most of the drill holes were drilled to about 40 feet below ground surface. To supplement the recent SPT data we used drill hole log data collected during the pre-construction phase of the Pearblossom Pumping Plant in 1965 (DWR, 1965). The data from the 1965 report did not include SPT data so an approximation of the soil condition was made based on the geologic log information.

Project Geology used Pearblossom Solar Array, Parcel 1A, Bore Hole No. B-8, completed December 16, 2014, as the representative location to estimate the average shear wave velocity value for the upper 40 feet of surface in PBSA-1A (DWR, 2015). The average shear wave velocity in the upper 40 feet in PBSA-1A is about 248 meters per second (m/s). For estimating the shear wave velocity in the lower 60 feet below ground surface, Project Geology used drill log data from Pearblossom Pumping Plant, Drill Hole No. 11, completed November 23, 1964 (DWR, 1965). An approximate value of 400 m/s from 40 feet below ground surface to 100 feet below ground surface was used for generalizing the Vs value in the lower 60 feet. The final Vs30 value used in the NGA-W2 calculator is 324 m/s, or Vs30 = 324 m/s.

RESULTS

Project Geology was asked by D&C to evaluate the expected ground motions at PBSA-1A from earthquakes generated by area faults. The predominant fault in the area is the San Andreas fault, specifically the Mojave section.

D&C specifically requested Project Geology to address the level of ground motion at PBSA-1A with a 10% chance of recurrence in 50 years, or a return period of about 475 years. Using the USGS 2008 deaggregation model, the 10% in 50 years PGA is about 0.59g (USGS, 2008) (Table 1). A M7.65 earthquake on the SAF would generate a PGA of about 0.59g about every 220 years. To better approximate the

475 year recurrence PGA ground motion we need to increase the earthquake magnitude on the SAF to a M8.0 event. The recurrence interval of a M8.0 earthquake on the SAF is about every 447 years, which is close to the desired 475 years (UCERF3). A M8.0 earthquake on the SAF results in a median (50th%ile) PGA ground motion of about 0.63g and an 84th%ile PGA ground motion of about 1.09g (Table 2). Using the USGS 2008 deaggregation model, a PGA of 1.09g occurs about every 2,475 years, or about a 2% chance of recurrence in 50 years (2% in 50 years) (Table 1).

Table 1 lists probabilistically derived earthquake ground motions for peak horizontal ground accelerations (PGA) using the USGS 2008 deaggregation model. Table 2 lists the deterministically derived spectral accelerations from a M8.0 earthquake located about 3.6 km from PBSA-1A. Table 2 includes the 50th and 84th percentile ground motion estimates at various periods with 5 percent damping. Figure 4 is the graphic representation of the spectral accelerations expected at PBSA-1A from a M8.0 earthquake on the SAF.

RECOMMENDATION

Project Geology recommends that a PGA of 0.63g be considered for design purposes at PBSA-1A, but not outside of the footprint of PBSA-1A due to varying site conditions. Site conditions specifically at the Pearblossom Pumping Plant facility are significantly different than at PBSA-1A. The 0.63g PGA value is based on a modified probabilistically derived estimate as described above.

REFERENCES

DWR, 1965, Project Geology Report No. 57-31-03, dated December 1965, Engineering Geology Pearblossom Pumping Plant and Intake Channel.

DWR, 2015, Project Geology Report No. 57-31-25, dated March 2015, Southern Field Division Pearblossom Solar Project Geotechnical Report.

WEBSITES

NGA-W1, 2008, Ground Motion Prediction Equations: http://peer.berkeley.edu/ngawest/

NGA-W2, 2014, Ground Motion Prediction Equations: http://peer.berkeley.edu/ngawest2/final-products/

UCERF3, 2014, Fault database: http://pubs.usgs.gov/of/2013/1165/

USGS, 2008, Interactive Deaggregation Website Model, National Seismic Hazard Mapping Program Interactive Deaggregation website: https://geohazards.usgs.gov/deaggint/2008/

FIGURES

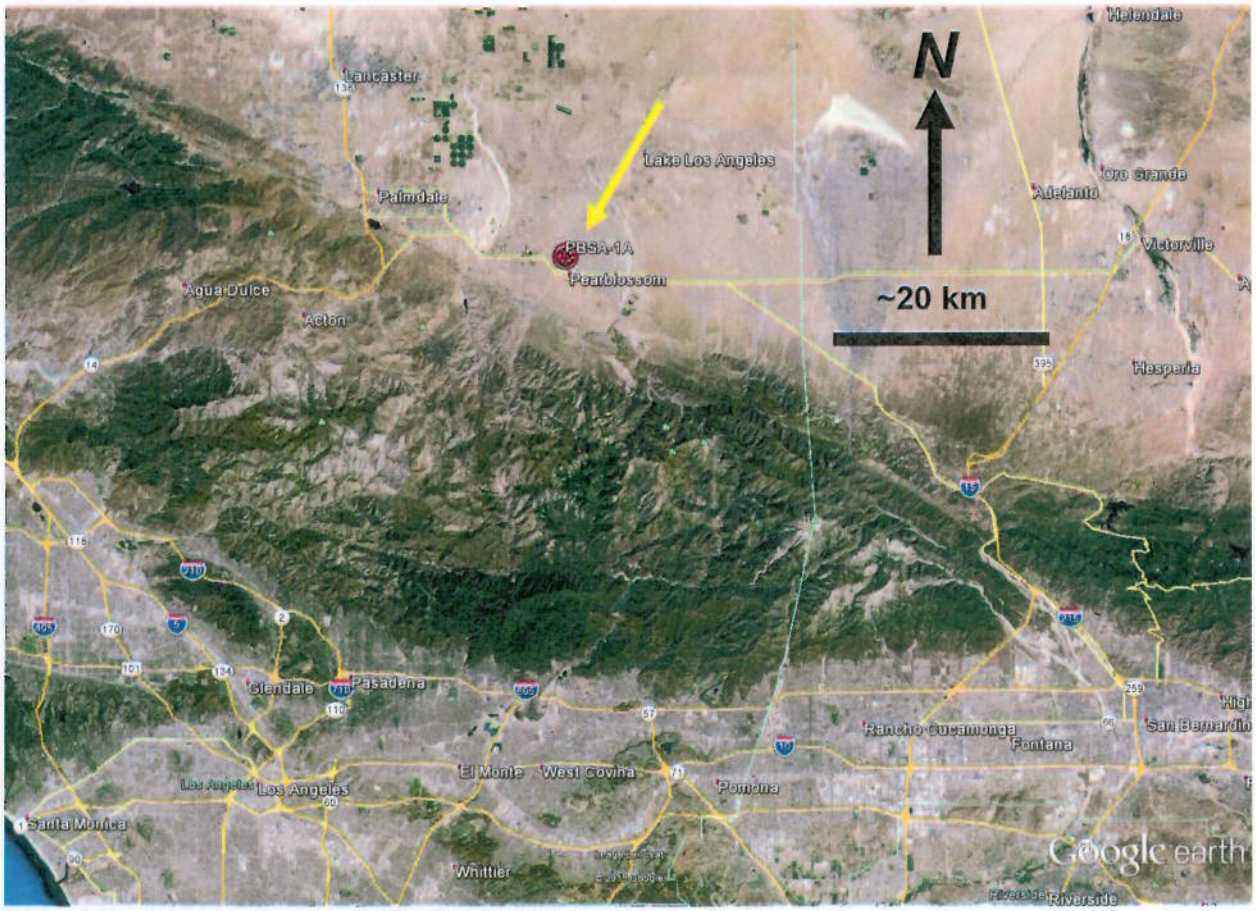


Figure 1. Location map of PBSA-1A (yellow arrow), Los Angeles County, California.

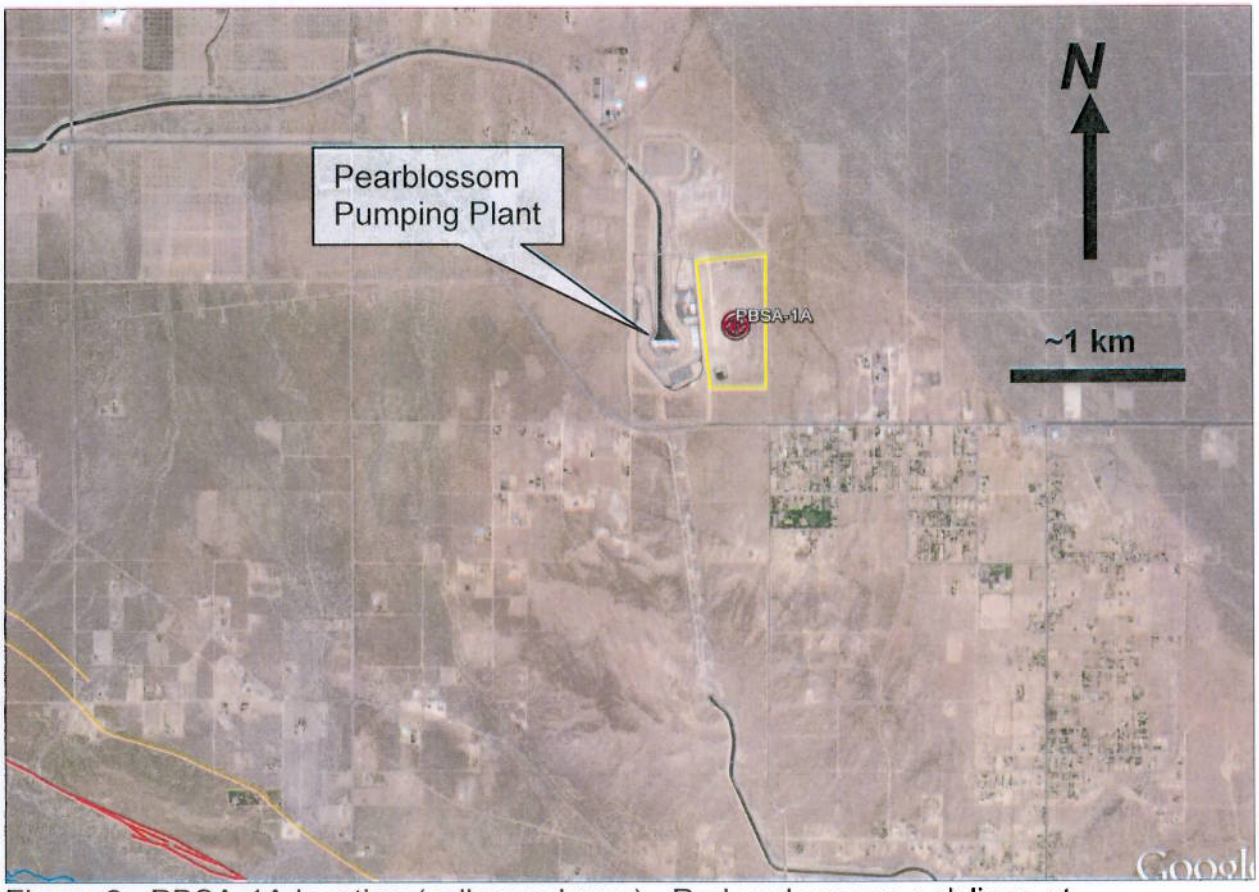


Figure 2. PBSA-1A location (yellow polygon). Red and orange polylines at southwestern potion of map are strands of the SAF.

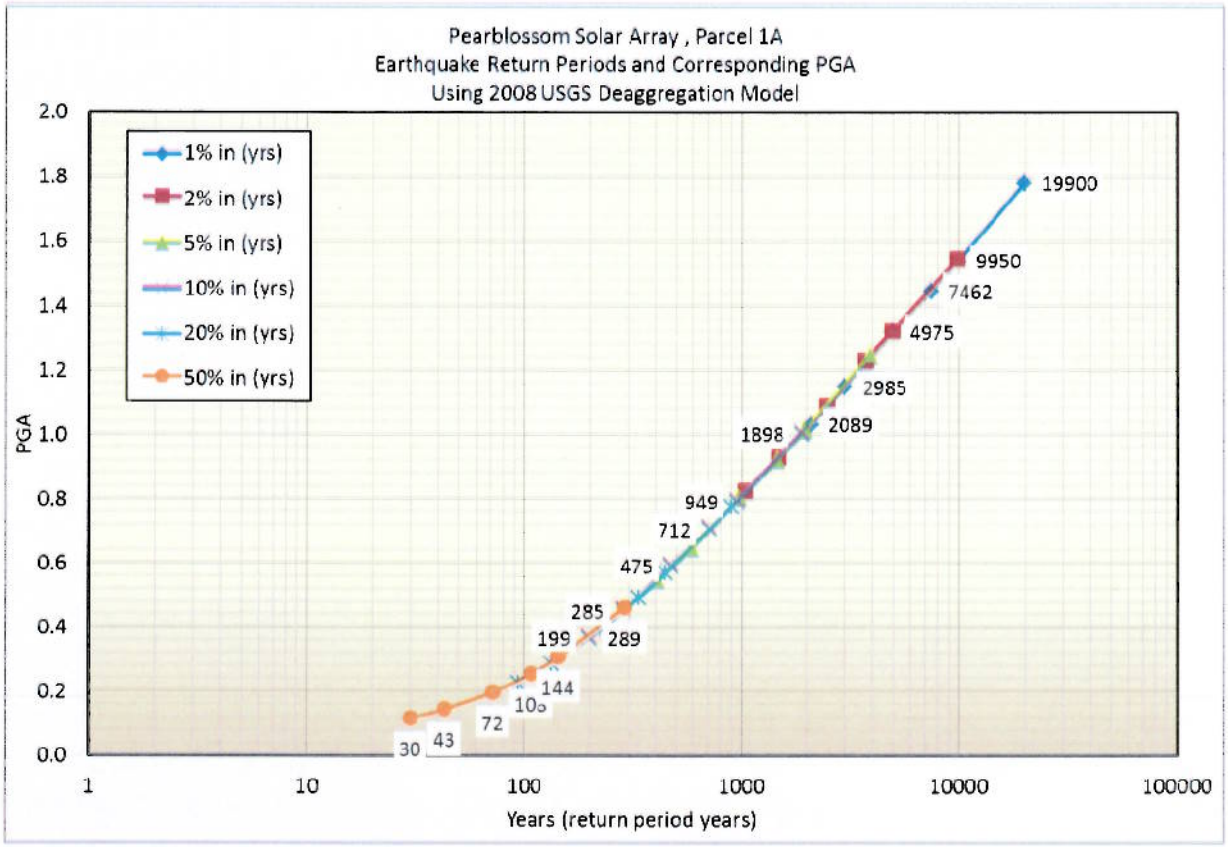


Figure 2. Continuous return period curve for PBSA-1A.

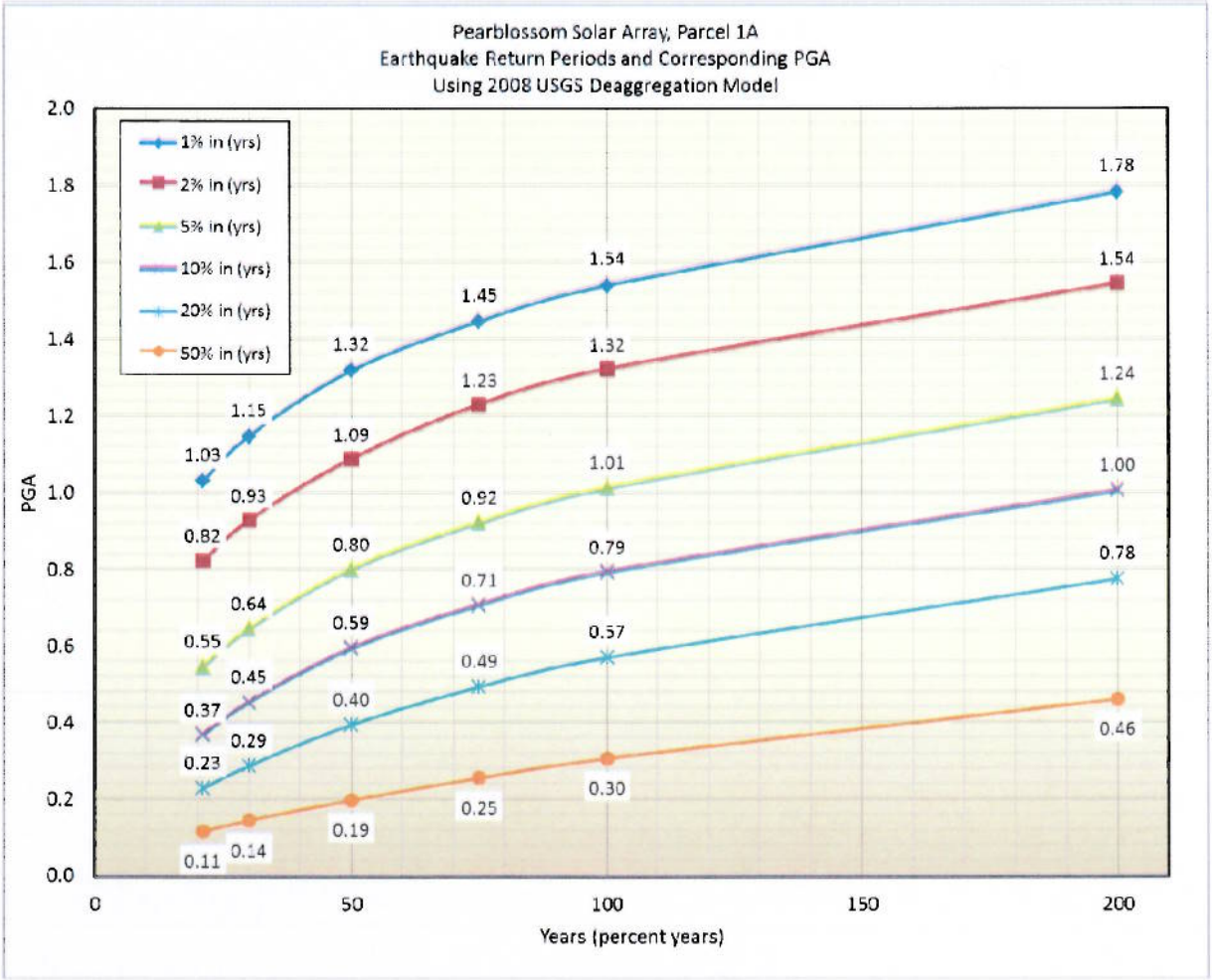


Figure 3. Isolated return period curves for PBSA-1A.

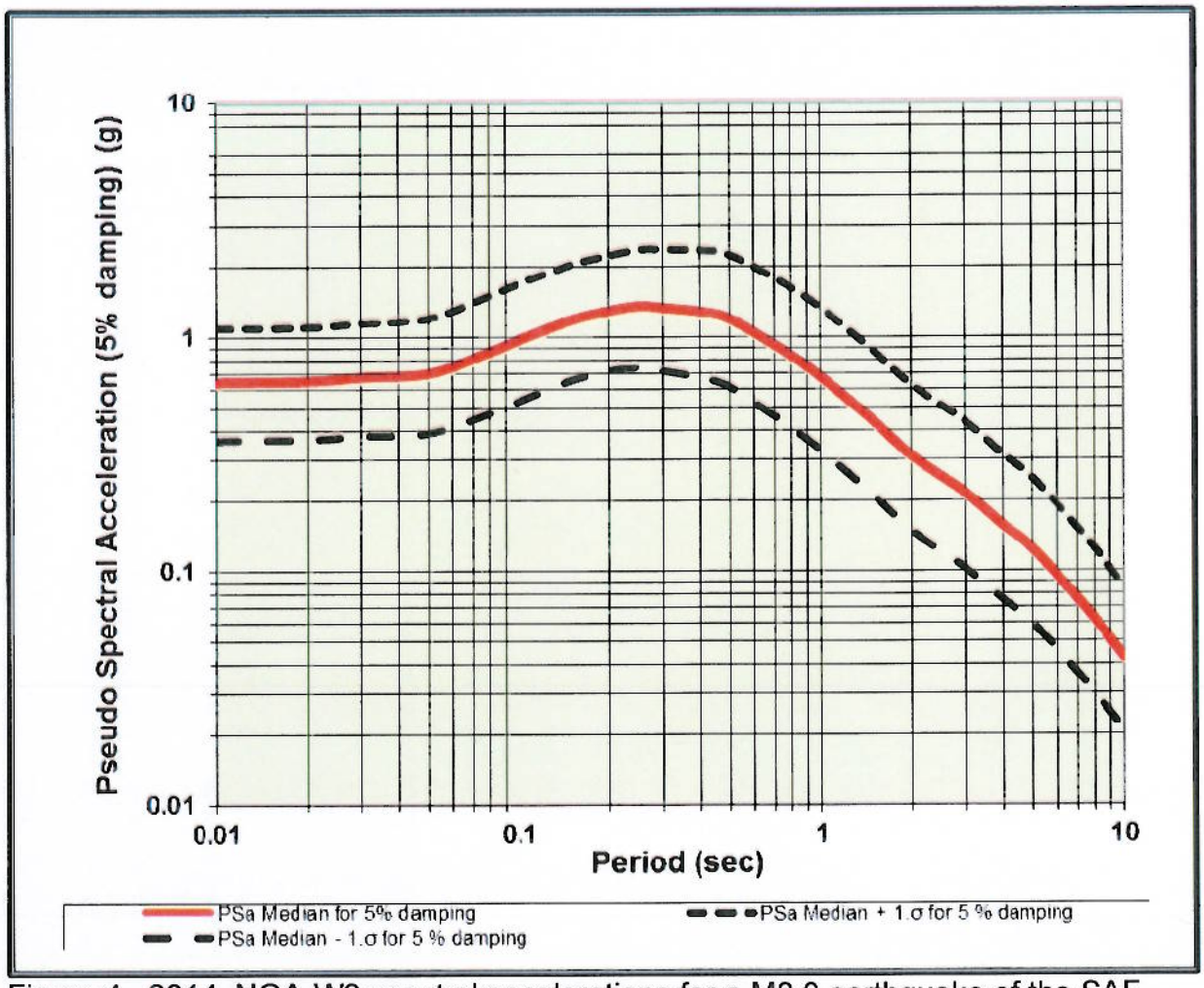


Figure 4. 2014, NGA-W2 spectral accelerations for a M8.0 earthquake of the SAF.

TABLES

2008 USGS Deaggregation Model Pearblossom Solar Array Vs30=324 m/s			
Percent	Years	Return Period (years)	Acceleration (g)
1	21	2089	1.03
1	30	2985	1.15
1	50	4975	1.32
1	75	7462	1.45
1	100	9950	1.54
1	200	19900	1.78
2	21	1039	0.82
2	30	1485	0.93
2	50	2475	1.09
2	75	3712	1.23
2	100	4950	1.32
2	200	9900	1.54
5	21	409	0.55
5	30	585	0.64
5	50	975	0.80
5	75	1462	0.92
5	100	1950	1.01
5	200	3899	1.24
10	21	199	0.37
10	30	285	0.45
10	50	475	0.59
10	75	712	0.71
10	100	949	0.79
10	200	1898	1.00
20	21	94	0.23
20	30	134	0.29
20	50	224	0.40
20	75	336	0.49
20	100	448	0.57
20	200	896	0.78
50	21	30	0.11
50	30	43	0.14
50	50	72	0.19
50	75	108	0.25
50	100	144	0.30
50	200	289	0.46

Table 1. 2008 USGS Deaggregation Model Ground Motion Return Periods for PBSA-1A.

Baseline: 5% Damping				
GMP	T (s)	PSa Median for 5% damping	PSa Median + 1.σ for 5% damping	PSa Median - 1.σ for 5% damping
PSa (g)	0.01	0.63	1.09	0.36
	0.02	0.64	1.11	0.37
	0.03	0.66	1.15	0.38
	0.05	0.69	1.21	0.39
	0.075	0.81	1.45	0.46
	0.1	0.95	1.69	0.53
	0.15	1.15	2.04	0.65
	0.2	1.26	2.23	0.71
	0.25	1.32	2.35	0.74
	0.3	1.30	2.36	0.72
	0.4	1.25	2.34	0.67
	0.5	1.17	2.23	0.61
	0.75	0.86	1.70	0.43
	1	0.66	1.33	0.33
	1.5	0.43	0.87	0.21
	2	0.30	0.62	0.15
	3	0.21	0.43	0.10
	4	0.15	0.31	0.07
	5	0.12	0.25	0.06
	7.5	0.07	0.14	0.03
	10	0.04	0.08	0.02
PGA (g)	0	0.63	1.09	0.36

Table 2. 2014 NGA-W2 spectral accelerations at PBSA-1A.

APPENDIX E

Laboratory Test Results Memo

OFFICE MEMO

TO: Brent Lamkin	**DATE:** Revised: March 13, 2015
FROM: Mark Strahm	**SUBJECT:** Test Request No 2015-01: Pearblossom Solar Project

Description

Attached are the results of laboratory testing performed under Test Request No. 2015-01: Pearblossom Solar. The samples were received at our laboratory on December 22, 2014. Testing was performed per the attached Test Request Form dated December 30, 2014.

Samples

A total of 166 samples were collected by others and delivered to our laboratory for testing. Delivered samples included core samples, brass cylinders, buckets, and sealed plastic sample bags. Testing was requested on 28 of the delivered samples.

Tests

Tests Performed:

- ASTM D2487: Classification of Soils
- ASTM D4318: Atterberg Limits
- ASTM D422: Particle Size
- ASTM D2216: Water Content of Soils
- ASTM D3080: Direct Shear Test of Soils under Consolidated Drained Conditions
- ASTM D1557(DWR): Maximum Density/Optimum Moisture Content Determination
- ASTM D5334: Thermal Resistivity
- Caltrans Method 417:Chloride Content
- Caltrans Method 421:Sulfate Content
- Caltrans Method 642: pH
- ASTM G57: Laboratory Resistivity

Results

<u>Classification Testing:</u>
Classification testing was performed on 11 of the delivered samples. Testing on these samples consisted of particle size analysis (ASTM D422), and/or Atterberg Limits (ASTM D4318). Classifications were performed ASTM D2487.

Gradation testing was performed per ASTM D422. Due to the course nature of the soil, no hydrometer testing was performed. Based upon our laboratory testing, all of the samples tested consisted of predominantly coarse grained sand and gravel materials.

Plasticity Index testing of the fine grained soils generally indicated that the soils were non-plastic to slightly plasticity, with Plasticity Indexes ranging from 0 to 12. Based on our testing, the materials may be classified as sands, clayey sands (SC), silty sands (SM), and silty, clayey sands with gravel (SC-SM).

Water Content:
As-received water content determinations were requested for 10 of the received samples. Laboratory determination of moisture content was performed per ASTM D2216, Method B. Water contents of the samples tested were observed to range from 1.7% to 8.3%.

Maximum Density/Optimum Moisture Testing:
Two composite samples were prepared at our laboratory to determine the maximum density and optimum moisture of the blended soils. Composite Sample #1 was prepared by blending equal amounts of soil from the bucket samples taken from TP-1 though TP-6. Composite Sample #2 was prepared by blending equal amounts of soil from the bucket samples taken from TP-7 and TP-8. Both samples were tested per ASTM D1557DWR, which has been modified to provide a compactive effort of approximately 20,337 ft. lbs. per cubic ft. Results of both tests are attached for reference. The following table provides a comparison of the results of the two comparison tests.

Sample #	Sample Location	Maximum Density (pcf)	Optimum Moisture (%)
2015-167	TP-1 through TP-6	125.5	8.6
2015-168	TP-7 & TP-8	126.9	8.6

Direct Shear Testing:
Direct shear testing was performed on three bulk samples collected from the upper 5 feet soil at the site. The testing was performed in accordance to ASTM D 3080.

The samples were moisture conditioned to approximately 2% over optimum moisture prior to testing. The samples were then remolded to approximately 95% relative compaction based on maximum density testing performed at our laboratory.

For each test, three samples were moisture conditioned, recompacted, and consolidated under the requested normal loads of 1 ksf, 2 ksf, and 4 ksf. The samples were then sheared horizontally at a rate of 0.05 in/minute for six cycles. The data for each point was plotted and used to establish an internal angle of friction and cohesion value for each test. The “peak” shear data represents the highest measured horizontal shear strength recorded during the first cycle of shearing. The “residual” shear data represents the measured shear strengths during the final cycle of shearing. The results of the direct shear testing for each sample are attached for your reference.

The following table summarizes the results of our testing:

Location	Relative Compaction	Sample#	Peak		Residual	
			C (ksf)	ϕ	C (ksf)	ϕ
TP-1	~95%	2015-159	2.1	46	1	46
TP-4	~95%	2015-162	0.2	45	0	44
TP-8	~95%	2015-166	1.1	47	0.5	45

Chemical/Resistivity Testing:

Corrosion and/or Thermal Resistivity testing was requested on eight of the samples. This testing was performed in general accordance with Caltrans Method 417 (Chloride Content), Caltrans Method 421 (Sulfate Content), Caltrans 642 (pH), ASTM G57 (Resistivity), and ASTM D5334 (thermal Resistivity). Two samples was/were selected to determine the concentration of soluble sulfates, chlorides, pH level, and resistivity of and within the on-site soils. The following table presents the results of this testing:

Sample Location	Sample #	Water-Soluble Sulfates, (ppm)	Chlorides (ppm)	Minimum Resistivity (ohm-cm)	pH	Thermal Resistivity (m*K)/w
TP-1	2015-159	67	3	7,040	8.0	
TP-2	2015-160	69	36	11,700	7.8	
TP-3	2015-161	73	135	7,620	7.8	0.566
TP-4	2015-162	66	24	6,010	7.4	
TP-5	2015-163	66	27	7,080	7.3	
TP-6	2015-164	15	51	7,970	7.3	
TP-7	2015-165	79	33	2,960	8.1	0.573
TP-8	2015-166	94	27	3,630	8.2	

Water soluble sulfate contents were observed to range from 15 to 94 ppm per Caltrans Test Method 417. Based on the testing performed, the concentration of sulfates in the sample may be considered to have a negligible risk with respect to sulfate attack on concrete. Minimum resistivity values ranged from 2,960 to 11,700 ohm-cm per ASTM G57. Resistivity values in this range indicate that the soil may be moderately to mildly corrosive to buried metals and reinforced concrete structures. Results of pH testing indicate that the soil is generally slightly alkaline.

Test results for the above referenced tests are attached for your reference. Unless otherwise directed, all remaining samples will be retained at our laboratory for three years from the date of this summary. Please feel free to contact me at the Bryte Lab (916-375-6012) if you have any questions or need any additional information.

State of California
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

CLASSIFICATION SUMMARY ANALYSIS

DIV. OF ENGINEERING
GEOTECH. SERVICES BRANCH
BRYTE SOILS AND CONCRETE LAB.

PROJECT: Pearblossom Solar Project **FEATURE:**

Lab No.	Borehole No.	Field Sample No.	Depth (ft)	PERCENT FINER														ATTERBERG LIMITS		MOISTURE CONTENT	DRY DENSITY	GROUP SYMBOL	ASTM D2487 CLASSIFICATION GROUP NAME
				MECHANICAL ANALYSIS											HYDROMETER								
				GRAVEL					SAND						SILT & CLAY								
				3"	1-1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	5M	2M	1M						
				75	37.5	19	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075	0.005	0.002	0.001						
				mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	LL	PI	%	pcf	SYMBOL	GROUP NAME
15-10	B-1	C01A	7.5-8.0																	4.2%			
15-21	B-2	C01A	12.0-12.5																	3.9%			
15-27	B-3	S01A	4.0-4.5			100	93	86	77	65	52	40	30	23				22	7			SC-SM	Silty, clayey sand
15-36	B-3	C01B	9.5																	4.2%	109.3		
15-43	B-4	S03A	15.0			100	98	93	81	66	51	36	24	15					NP				
15-49	B-4	C01A	7.0	100	100	100	97	91	78	60	46	36	28	22				27	12			SC	Clayey sand
15-52	B-4	C02A	17.0																	4.6%			
15-65	B-5	C01C	8.0																	6.2%	107.4		
15-69	B-7	S01A	4.0		100	97	96	91	80	66	52	34	20	12					NP			SW-SM	Well-graded sand with silt
15-78	B-7	C01B	12.5																	2.2%	121.7		
15-83	B-8	S01A	4.0				100	98	87	70	55	43	32	24									
15-91	B-8	C01B	12.5	100	100	100	99	96	83	66	52	41	31	23				24	9			SC	Clayey sand
15-92	B-8	C01C	8.0																	8.3%	95.7		
15-97	B-9	S02A	5.0	100	100	100	93	88	80	68	55	41	27	17					NP			SM	Silty sand
15-108	B-9	C01B	7.5																	4.5%	111		
15-119	B-11	C01B	7.5	100	100	100	100	97	86	67	53	44	38	31				24	8			SC	Clayey sand
15-159	TP-1	--	1-5		100	94	88	81	67	51	39	29	22	15									
15-162	TP-4	--	1-5	100	100	100	98	92	78	61	48	38	30	22									
15-166	TP-8	--	1-5		100	99	94	88	72	55	41	31	22	16									
15-130	B-12	C01B	12.5																	1.7%			
15-138	B-14	C01B	12.5																	2.9%	124.1		

DATE: 1/23/2015
INITIAL: SC
REQUEST NO.: 15-01

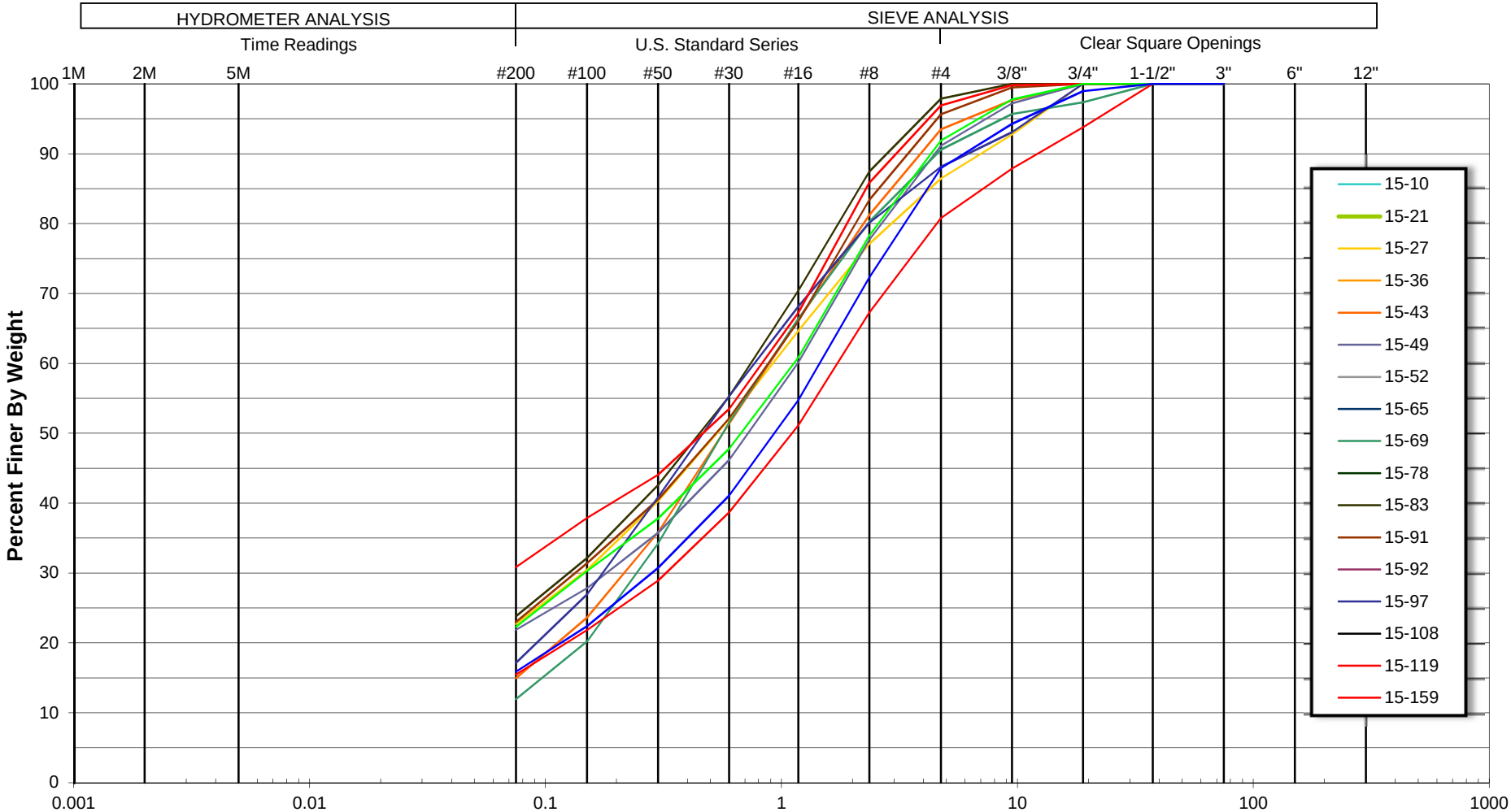
REMARKS:

IM - INSUFFICIENT MATERIAL
NP - NON-PLASTIC
NG - NO GOOD

State of California
The Resources Agency
Department of Water Resources

Particle Size Analysis Graph

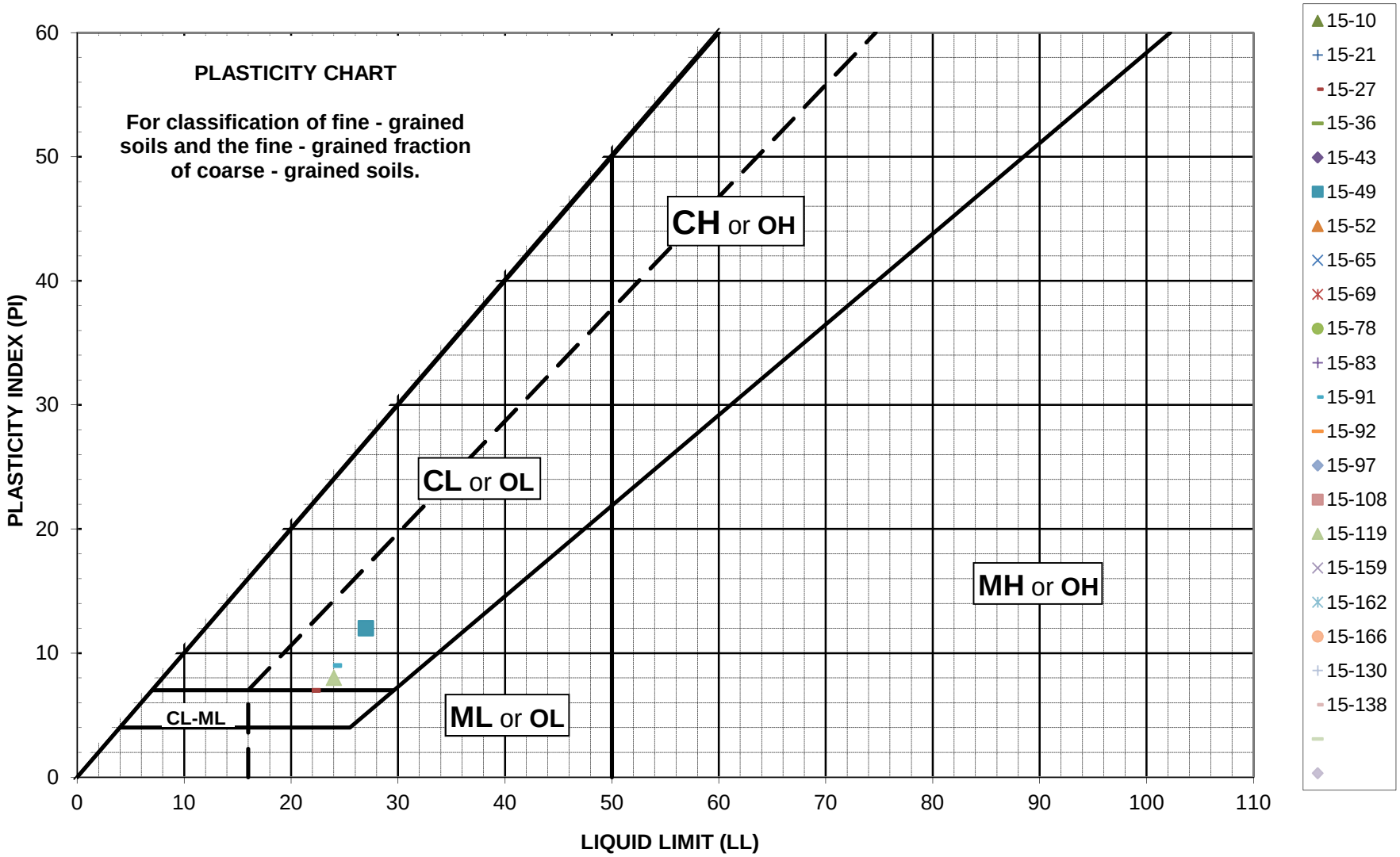
Division of Engineering
Civil Engineering
Dams and Canals Section



Grain Size in Millimeters

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY OR SILT FINES	SAND			GRAVEL		COBBLES
	Fine	Medium	Coarse	Fine	Coarse	


PLASTICITY CHART
For classification of fine - grained soils and the fine - grained fraction of coarse - grained soils.
CH or OH
CL or OL
MH or OH
ML or OL
CL-ML
PLASTICITY INDEX (PI)
LIQUID LIMIT (LL)
0
10
20
30
40
50
60
70
80
90
100
110
15-10
15-21
15-27
15-36
15-43
15-49
15-52
15-65
15-69
15-78
15-83
15-91
15-92
15-97
15-108
15-119
15-159
15-162
15-166
15-130
15-138

State of California
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

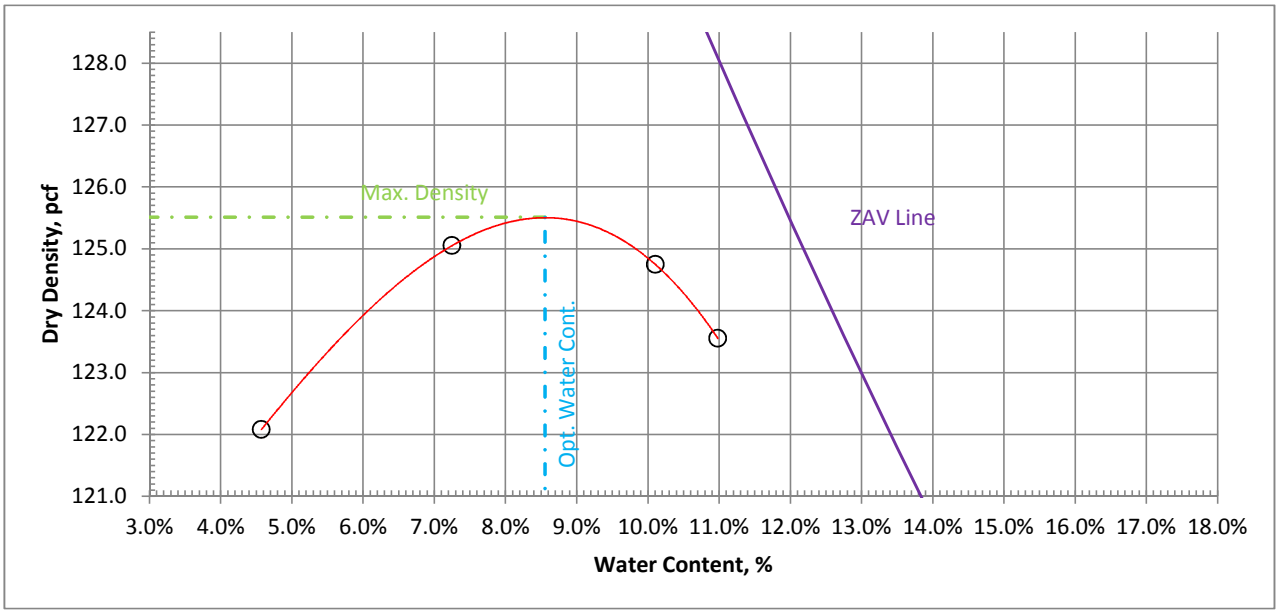
COMPACTION TEST

DIV. OF ENGINEERING
GEOTECH. SERVICES BRANCH
BRYTE SOILS AND CONRETE LAB.

Project	Pearblossom Solar Project			Date	1/15/2015
Feature	Composite #1			Test Request No.	2015-01
Soil Description	Not Available			Lab No.	2015-167
Oversize Correction	No			Tested By	CDG III
P_C, %		P_F, %	100	Max Size	<3/8
Method	B	Prep Method	Moist	Hole No.	1
Mold Size, ft^3	0.0333			F.S, No.	-
Number of Layers	3			Elevation	-
Blows per Layer	15			SG, Gs	2.65
Ram Weight, lbs	10			Max Dry Density, pcf	**125.5**
Drop Height, ft	1.5			Opt. Water Cont., %	**8.6%**
Ram Type	Mechanical				
Compactive Effort, ft-lbs/ft^3	20,270				

		2	4	6		
Determination No.	1	2	3	4	5	6
Wt. Mold & Soil, g	4006.2	4103.8	4152.7	4149.2		
Wt. Mold, g	2078	2078	2078	2078		
Wt. Soil, g	1928.2	2025.8	2074.7	2071.2		
Wet Density, pcf	127.7	134.1	137.4	137.1		
Dry Density, pcf	**122.1**	**125.1**	**124.7**	**123.6**	**#N/A**	**#N/A**

Container No.	A8	71	MR-10	T-1		
Wt. Tare + Wet Soil, g	836.14	1088.58	739.17	952.13		
Wt. Tare + Dry Soil, g	805.8	1024.03	684.17	871.67		
Wt. Water, g	30.34	64.55	55	80.46		
Wt. Tare, g	141.94	133.53	139.98	139.14		
Wt. Dry Soil, g	663.86	890.5	544.19	732.53		
Water Content, %	**4.6%**	**7.2%**	**10.1%**	**11.0%**	**#N/A**	**#N/A**



State of California
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DEPARTMENT OF WATER RESOURCES

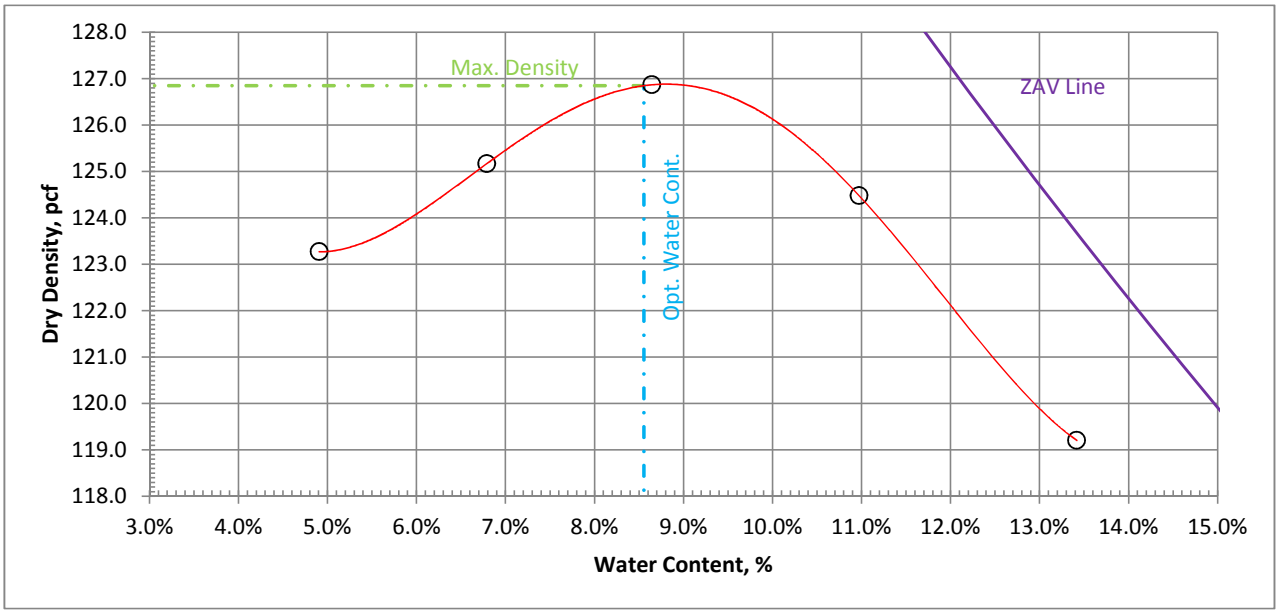
COMPACTION TEST

DIV. OF ENGINEERING
GEOTECH. SERVICES BRANCH
BRYTE SOILS AND CONRETE LAB.

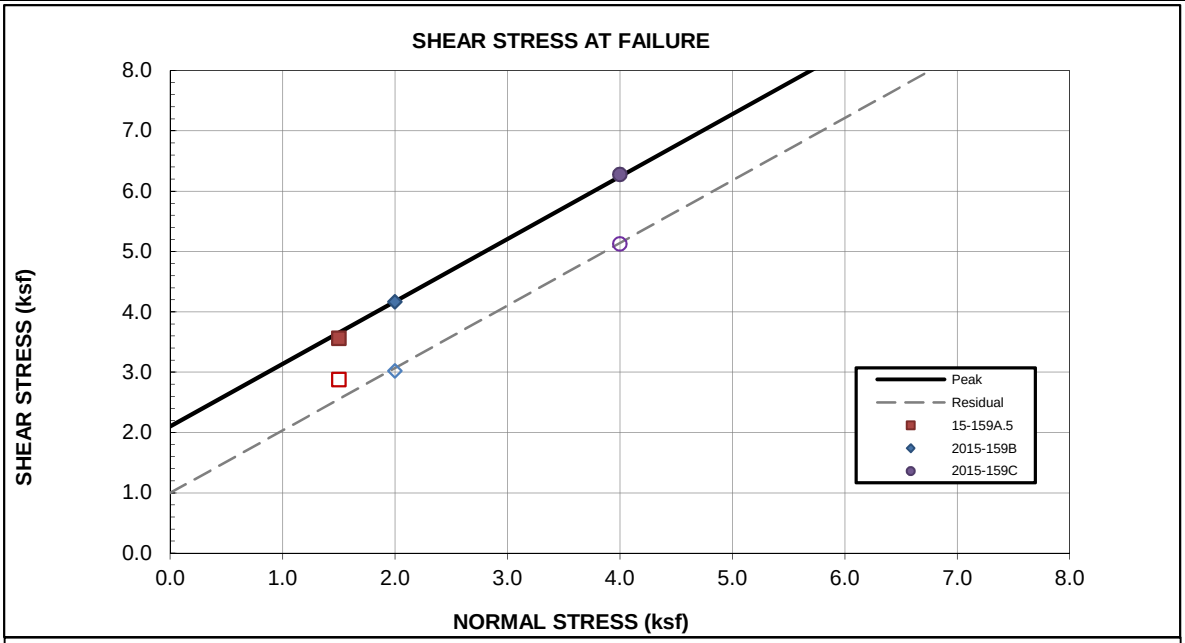
Project	Pearblossom Solar Project			Date	1/15/2015
Feature	Composite #2			Test Request No.	2015-01
Soil Description	Not Available			Lab No.	2015-168
Oversize Correction	No			Tested By	CDG III
P_C, %		P_F, %	100	Max Size	<3/8
Method	B	Prep Method	Moist	Hole No.	2
Mold Size, ft^3	0.0333			F.S, No.	-
Number of Layers	3			Elevation	-
Blows per Layer	15			SG, Gs	2.70
Ram Weight, lbs	10			Max Dry Density, pcf	**126.9**
Drop Height, ft	1.5			Opt. Water Cont., %	**8.6%**
Ram Type	Mechanical				
Compactive Effort, ft-lbs/ft^3	20,270				

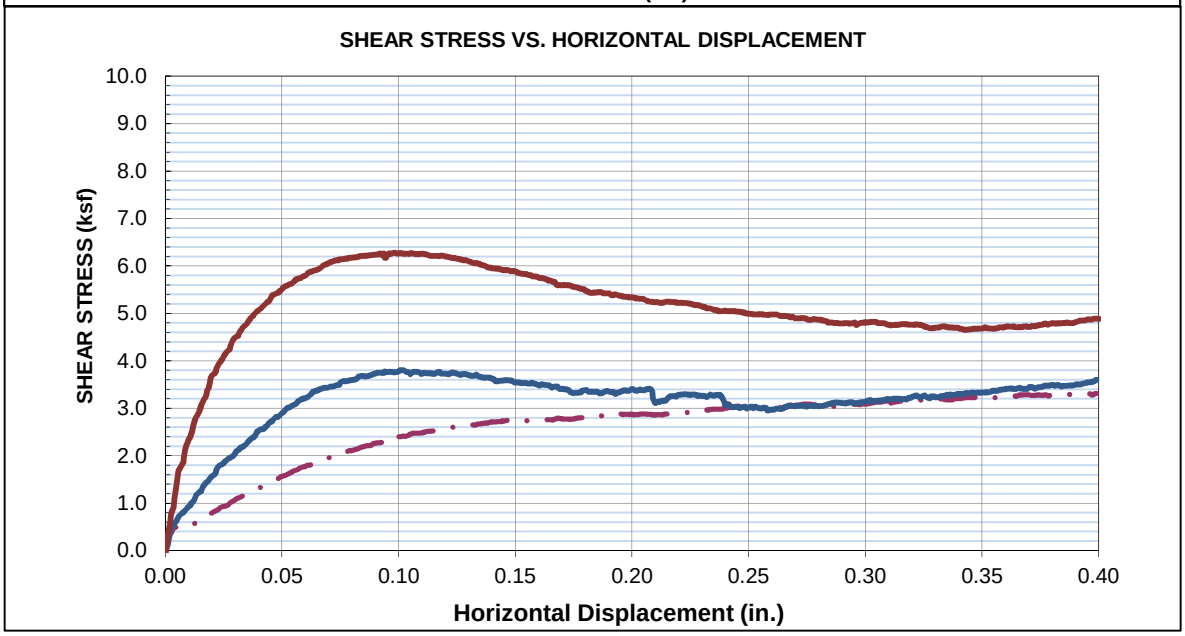
		2	4	6	8	
Determination No.	1	2	3	4	5	6
Wt. Mold & Soil, g	4031.3	4097	4160	4164.5	4120.1	
Wt. Mold, g	2078	2078	2078	2078	2078	
Wt. Soil, g	1953.3	2019	2082	2086.5	2042.1	
Wet Density, pcf	129.3	133.7	137.8	138.1	135.2	
Dry Density, pcf	**123.3**	**125.2**	**126.9**	**124.5**	**119.2**	**#N/A**

Container No.	DD	KIT	JM	BC-22	GE	
Wt. Tare + Wet Soil, g	607.82	1049	974.51	777.52	739.95	
Wt. Tare + Dry Soil, g	585.99	991.31	908.17	714.68	668.85	
Wt. Water, g	21.83	57.69	66.34	62.84	71.1	
Wt. Tare, g	141.11	141.75	140.76	142.14	138.97	
Wt. Dry Soil, g	444.88	849.56	767.41	572.54	529.88	
Water Content, %	**4.9%**	**6.8%**	**8.6%**	**11.0%**	**13.4%**	**#N/A**



Direct Shear Test
ASTM D3080-11





Sample ID:	Applied Normal Stress (ksf)	Peak Shear Stress (ksf)	Residual Shear Stress* (ksf)	Initial Moisture Content (%)	Final Moisture Content (%)	Dry Density (pcf)	Plastic Index (per ASTM D4318)	Percent Fines (per ASTM D1140)	Vertical Strain During Consolidation (%)
15-159A.5 ■	1.5	3.6	2.9	10.9	14.6	119.9	N/A	15	2.48
2015-159B ◆	2.0	4.2	3.0	10.3	13.1	121.3	N/A	15	3.05
2015-159C ●	4.0	6.3	5.1	10.3	13.0	122.2	N/A	15	1.42

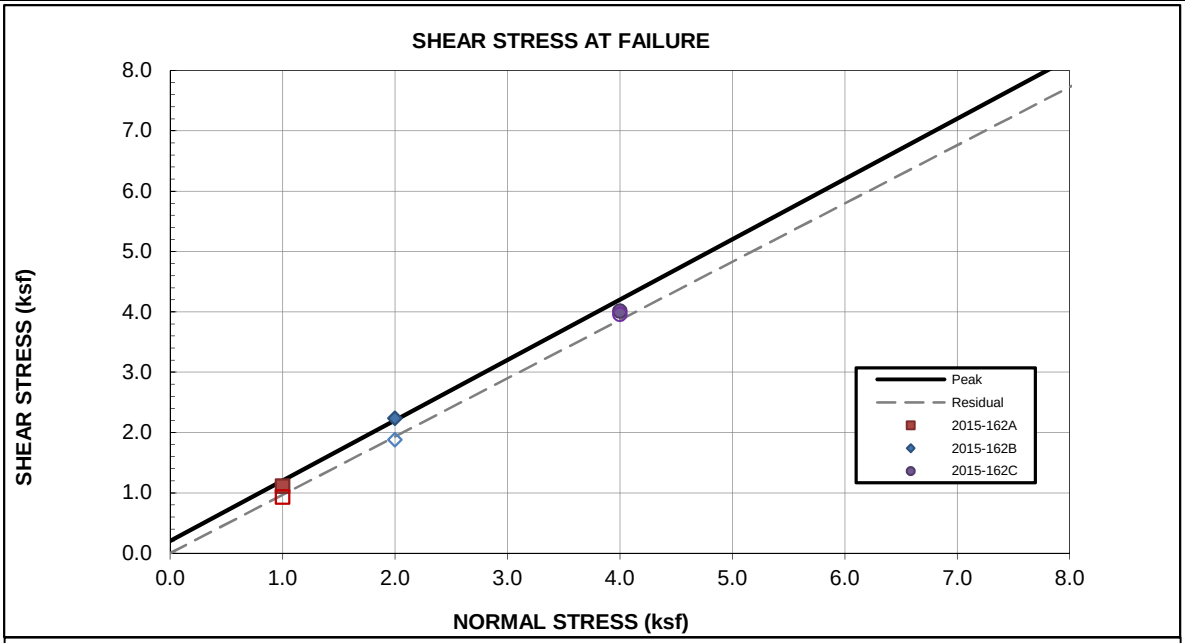
*Based on Final Cycle

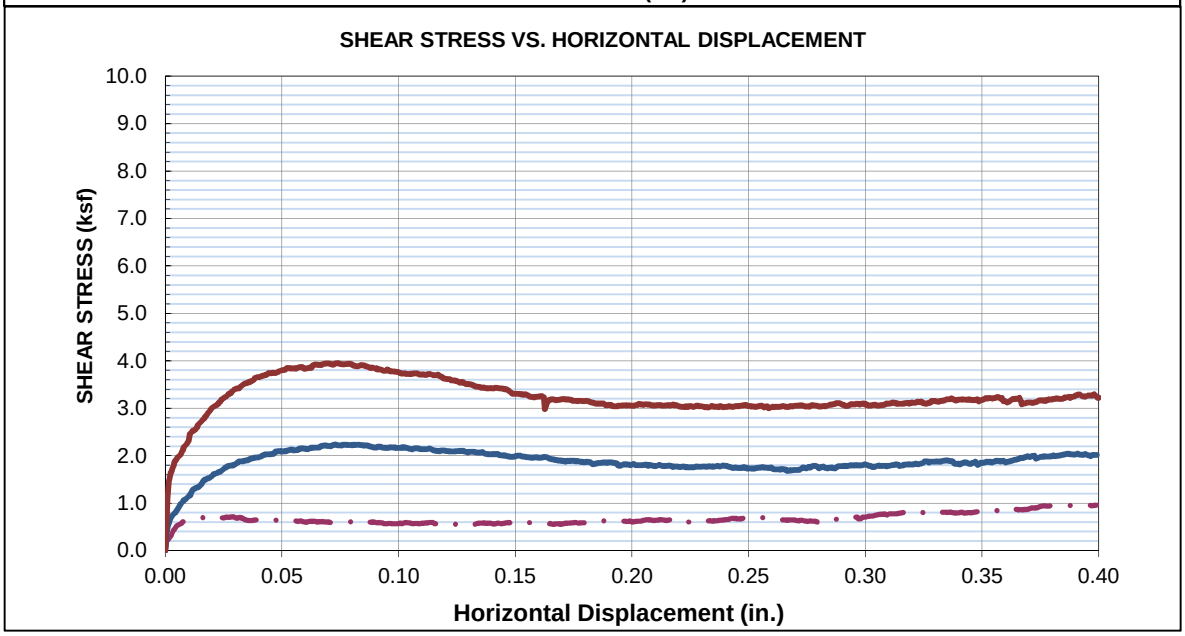
	Cohesion (c), ksf	Phi, deg.
Peak	2.1	46
Residual	1.0	46

Sample No:	2015-159	Project Name:	Pearblossom Solar Project
Test Req. No:	2015-1	Location:	TP-1
Sample Type:	remolded	Depth:	1'-5'
Num. of Cycles:	6	Classification:	SC-SM (Silty, Clayey Sand with Gravel)
Shear Rate: (in/min)	0.05		
Date:	re:3/13/15		

Bryte Soils and Concrete Lab
1450 Riverbank Road
West Sacramento, CA 95605
(916)375-6012

Direct Shear Test
ASTM D3080-11





Sample ID:	Applied Normal Stress (ksf)	Peak Shear Stress (ksf)	Residual Shear Stress* (ksf)	Initial Moisture Content (%)	Final Moisture Content (%)	Dry Density (pcf)	Plastic Index (per ASTM D4318)	Percent Fines (per ASTM D1140)	Vertical Strain During Consolidation (%)
2015-162A ■	1	1.1	0.9	12.2	14.6	118.7	N/A	22	1.20
2015-162B ◆	2	2.2	1.9	12.2	14.8	118.4	N/A	22	1.46
2015-162C ●	4	4.0	4.0	12.2	14.2	118.3	N/A	22	5.45

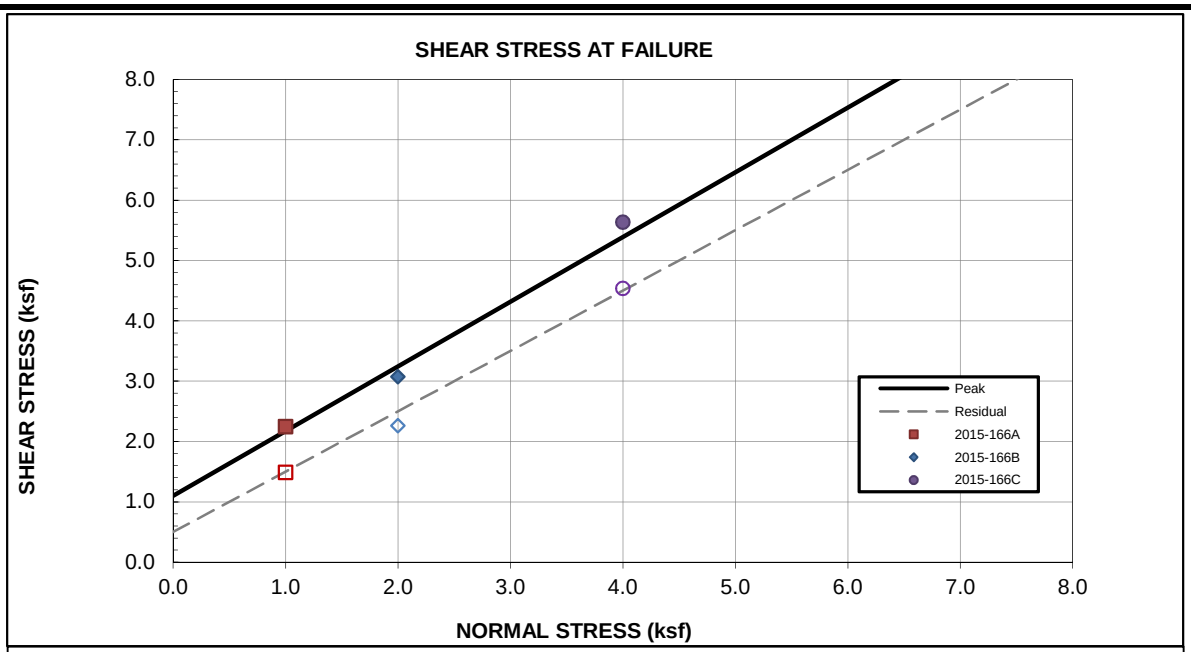
*Based on Final Cycle

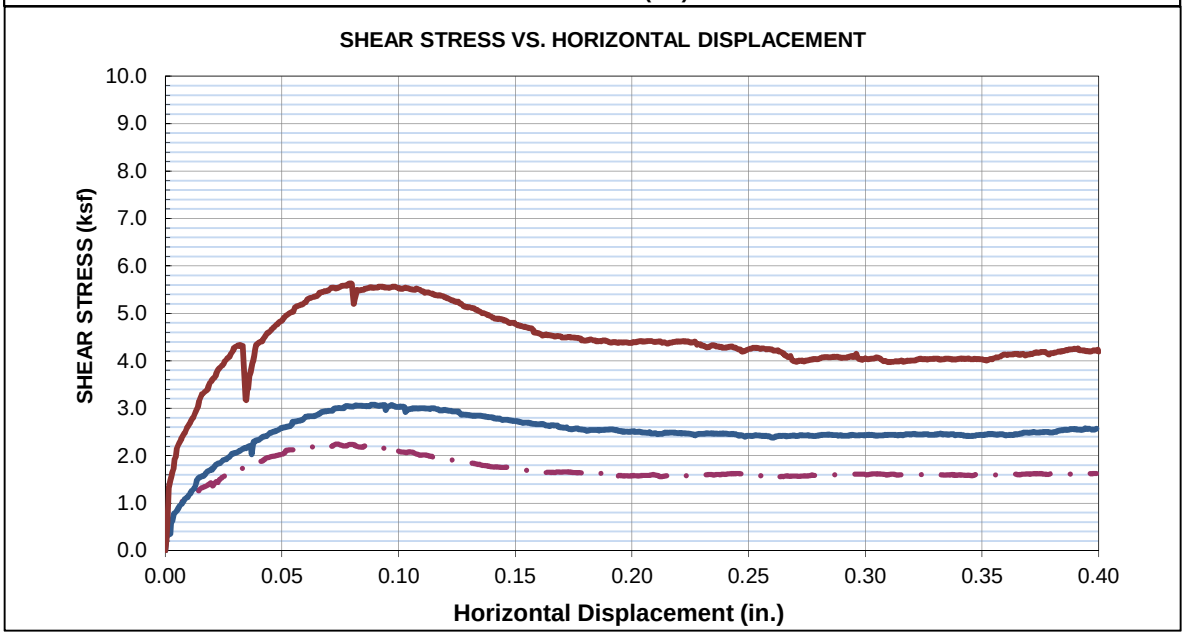
	Cohesion (c),	Phi, deg.
Peak	0.2	45
Residual	0	44

Sample No:	2015-162	Project Name:	Pearblossom Solar Project
Test Req. No:	2015-01	Location:	TP-4
Sample Type:	remolded	Depth:	1'-5'
Num. of Cycles:	6	Classification:	SC (Clayey Sand with Gravel)
Shear Rate: (in/min)	0.05		
Date:	1/28/2015		

Bryte Soils and Concrete Lab
1450 Riverbank Road
West Sacramento, CA 95605
(916)375-6012

Direct Shear Test
ASTM D3080-11





Sample ID:	Applied Normal Stress (ksf)	Peak Shear Stress (ksf)	Residual Shear Stress* (ksf)	Initial Moisture Content (%)	Final Moisture Content (%)	Dry Density (pcf)	Plastic Index (per ASTM D4318)	Percent Fines (per ASTM D1140)	Vertical Strain During Consolidation (%)
2015-166A ■	1	2.2	1.5	10.8	12.9	121.0	0	16	1.21
2015-166B ◆	2	3.1	2.3	10.8	12.6	121.6	0	16	2.39
2015-166C ●	4	5.6	4.5	10.8	12.2	121.4	0	16	4.39

*Based on Final Cycle

	Cohesion (c),	Phi, deg.
Peak	1.1	47
Residual	0.5	45

Sample No:	2015-166	Project Name:	Pearblossom Solar Project
Test Req. No:	2015-01	Location:	TP-8
Sample Type:	remolded	Depth:	1'-5'
Num. of Cycles:	6	Classification:	SC (Clayey Sand with Gravel)
Shear Rate: (in/min)	0.05		
Date:	1/28/2015		

Bryte Soils and Concrete Lab
1450 Riverbank Road
West Sacramento, CA 95605
(916)375-6012

APPENDIX F

Field Exploration

Logs of Borings

Logs of Test Pits

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,344,007.00 East 6,887,929.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/15/14**	DATE COMPLETED **12/15/14**	GROUND ELEVATION **3007 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **41.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **21 ft**
DRILLING METHOD **0 - 41.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **D. Perry**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **T. Butler/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 21.0'														
	1				SPT	33	4 12 19	31	44								S01A-0.0-0.5
3005	2		0.0 to 21.0' SILTY SAND, (SM): About 65% fine to coarse, angular sand; about 35% nonplastic fines; dense, light brown, dry; no reaction with HCl.														
	3																
	4																
	5																
	6				SPT	53	8 14 16	30	43								S02A-5.0-5.8
3000	7																
	8				MCAL		5 14 18					4					C01A-7.5-8.0 C02B-8.0-8.5
	9																
	10	SM		Auger													
	11				SPT	47	12 14 19	33	47								S03A-10.0-10.7
2995	12																
	13																
	14																
	15		15.0' Very dense.														
	16				SPT	73	14 19 18	37	53								S04A-15.0-16.1
2990	17		From 17.0' About 80% fine to coarse sand; about 20% nonplastic fines.														
	18				MCAL		8 16 11										C02A-17.5-18.0 C02B-18.0-18.5
	19																At 19.0' Rig chatter
	20																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,344,007.00 East 6,887,929.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20	SM	From 20.0' About 80% fine to medium sand; about 20% nonplastic fines; medium dense, reddish brown, moist; trace fine gravel.		SPT	80	8 8 9	17	24								S05A-20.0-21.2
	21		RECENT ALLUVIUM, 21.0 to 41.5'														
2985	22																
	23		21.0 to 41.5' SILTY SAND, (SM): About 65% fine to coarse, angular sand; about 35% nonplastic fines; dense, light brown, dry; no reaction with HCl.														
	24																
	25				SPT	100	3 4 5	9	13								S06A-25.0-26.5
	26																
2980	27																
	28																
	29																
	30		From 30.0' Very dense, light brown.	Auger	SPT	100	16 17 19	36	51								S07A-30.0-31.5
	31	SM															
2975	32																
	33																
	34																
	35				SPT	100	10 9 9	18	26								S08A-35.0-36.5
	36		From 36.0' About 70% fine to coarse, angular sand; about 30% nonplastic fines; medium dense, light brown, moist; trace fine gravel.														
2970	37																
	38																
	39																
	40		40.0' Dense.		SPT	100	13 14 14	28	40								S09A-40.0-41.5
	41																
2965	42		Reached target depth of 41.5'														
	43																
	44																
	45																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,344,003.00 East 6,888,523.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B2

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/15/14**	DATE COMPLETED **12/15/14**	GROUND ELEVATION **3001 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **40.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **24 ft**
DRILLING METHOD **0 - 40.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod, Dry Core**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**	AFTER DRILLING (DATE-TIME)	

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														
3000	1				DCORE	100											P01A-0.0-3.0
	2		0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; very dense, light brown, dry; no reaction with HCl; trace fine angular gravel.														
	3																
	4																
	5				SPT	0	12 22 31	53	76								
2995	6																P02A-5.5-7.8
	7				DCORE	66											
	8																
	9																S02A-9.0-10.0
	10	SM		Auger	SPT	67	17 20 38	58	83								
2990	11																
	12				MCAL		10 17 21					4					C01A-12.0-12.5
	13																C01B-12.5-13.0 C01C-13.0-13.5
	14																
	15		15.0' Medium dense.		SPT	67	6 10 10	20	29								S03A-15.0-16.0
2985	16																
	17		From 17.0' About 65% fine to medium sand; about 35% nonplastic fines; dense, brown, moist.		DCORE	88											P03A-16.5-18.7
	18																
	19				SPT	87	8 13	30	43								S04A-19.0-20.3
	20																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,344,003.00 East 6,888,523.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B2

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		FILL, 0.0 to 24.0'		SPT	87	17	30	43								
2980	21																
	22	SM	0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; very dense, light brown, dry; no reaction with HCl; trace fine angular gravel. *(Continued)*		MCAL		13										C02A-22.0-22.5
	23						12 11										C02B-22.5-23.0 C02C-23.0-23.5
	24		RECENT ALLUVIUM, 24.0 to 40.5'														S05A-24.0-24.5
	25				SPT	33	8 18 29	47	67								
2975	26		24.0 to 40.5' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; very dense, light brown, dry; no reaction with HCl.														P04A-25.5-28.5
	27		From 26.0' About 70% fine to medium sand; about 30% nonplastic fines; light brown, dry; trace fine angular gravel.		DCORE	86											
	28																
	29																S06A-29.0-30.3
	30			Auger	SPT	87	9 19 17	36	51								
2970	31																P05A-30.5-32.3
	32	SM			DCORE	51											
	33																
	34																S07A-34.0-35.2
	35				SPT	67	12 24 34	58	83								
2965	36																P06A-35.5-37.8
	37				DCORE	66											
	38																
	39																S08A-39.0-40.3
	40				SPT	87	16 26 16	42	60								
2960	41		Reached target depth of 40.5'														
	42																
	43																
	44																
	45																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,671.00 East 6,888,115.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B3

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/17/14**	DATE COMPLETED **12/17/14**	GROUND ELEVATION **3014 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **40.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **24 ft**
DRILLING METHOD **0 - 40.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **T. Butler/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**	AFTER DRILLING (DATE-TIME)	

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														
	1																
	2		0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; no reaction with HCl.														
	3																
3010	4		From 4.0' About 80% fine to coarse, angular sand; about 20% nonplastic fines; dense, light brown slightly mottled with pink, moist; no reaction with HCl; trace angular gravel.		SPT	100	12 16 17	33	47				22	7	23		S01A-4.0-5.5 At 4' [Lab] SILTY, CLAYEY SAND (SC-SM)
	5																
	6																
	7																
	8																
3005	9		From 9.0' Light brown, dry; trace angular to subangular gravel.		SPT	53	7 15 18	33	47								S02A-9.0-9.8
	10	SM		Auger													
	11																
	12				MCAL		22 31 39										C01A-12.0-12.5
	13											4				UW	C01B-12.5-13.0 C01C-13.0-13.5
3000	14		14.0' Very dense.		SPT	67	9 19 22	41	58								S03A-14.0-15.0
	15																
	16																
	17																
	18																
2995	19		19.0' Medium dense.		SPT	67	7 10	21	30								S04A-19.0-20.0
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,671.00 East 6,888,115.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B3

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		FILL, 0.0 to 24.0'		SPT	67	11	21	30								
	21																
	22	SM	0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; no reaction with HCl. *(Continued)*		MCAL		15										C02A-22.0-22.5
	23						15 15										C02B-22.5-23.0 C02C-23.0-23.5
2990	24		RECENT ALLUVIUM, 24.0 to 40.5'		SPT	47	6 7 8	15	21								S05A-24.0-24.7
	25																
	26		24.0 to 33.5' SILTY SAND, (SM): About 60% fine to medium, angular sand; about 40% nonplastic fines; medium dense, brown, moist; trace angular gravel.														
	27																
	28																
2985	29	SM	At 29.0' Very dense, 0.5' layer of fractured rock (from SPT?).		SPT	100	47 27 19	46	66								S06A-29.0-30.5
	30			Auger													Rig chatter
	31																
	32																
	33																
2980	34		33.5 to 38.0' Well-Graded SAND, (SW): About 90% fine to coarse, subrounded sand; about 10% nonplastic fines; dense, light brown, dry.		SPT	87	15 12 12	24	34								S07A-34.0-35.3
	35																
	36	SW															
	37																
	38		38.0 to 40.5' SILTY SAND, (SM): About 80% fine to coarse sand; about 20% nonplastic fines; dense, light brown, dry.														
2975	39	SM			SPT	80	10 11 15	26	37								S08A-39.0-40.2
	40																
	41		Reached target depth of 40.5'														
	42																
	43																
2970	44																
	45																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,603.00 East 6,888,617.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B4

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/17/14**	DATE COMPLETED **12/17/14**	GROUND ELEVATION **3009 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **41.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **24 ft**
DRILLING METHOD **0 - 41.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **D. Perry**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **T. Butler/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**	AFTER DRILLING (DATE-TIME)	

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														
	1																
	2		0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; very dense, light brown, dry; no reaction with HCl; trace angular fine gravel.		SPT	53	17 19 26	45	64								S01A-2.0-2.8
	3																
3005	4																
	5																
	6																
	7				MCAL		11					27	12	22			C01A-7.0-7.5 At 7' [Lab] CLAYEY SAND (SC)
	8						17 23										C01B-7.5-8.0 C01C-8.0-8.5
3000	9																
	10	SM		Auger	SPT	80	13 15 19	34	48								S02A-10.0-11.2
	11																
	12																
	13																
2995	14																
	15				SPT	100	15 17 22	39	56						15		S03A-15.0-16.5 At 15' [Lab] SILTY SAND (SM)
	16		From 16.0' About 80% fine to coarse sand; about 20% nonplastic fines; brown, moist; trace angular fine gravel.														
	17				MCAL		18					5					C02A-17.0-17.5
	18						20 22										C02B-17.5-18.0 C02C-18.0-18.5
2990	19																
	20																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,603.00 East 6,888,617.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B4

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		FILL, 0.0 to 24.0'														
	21				SPT	60	12 16 29	45	64								S04A-20.0-20.9
	22	SM	0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; very dense, light brown, dry; no reaction with HCl; trace angular fine gravel. *(Continued)*														
	23																
2985	24		RECENT ALLUVIUM, 24.0 to 41.5'														
	25																
	26		24.0 to 41.5' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; medium dense, light brown, dry.		SPT	53	7 8 9	17	24								S05A-25.0-25.8
	27		25.0' About 65% fine to medium sand; about 35% nonplastic fines; medium dense, brown, moist; trace coarse sand.														
	28																
2980	29																
	30		30.0' Dense.														
	31			Auger	SPT	100	12 15 15	30	43								S06A-30.0-31.5
	32																
	33	SM															
2975	34																
	35																
	36				SPT	67	6 12 15	27	38								S07A-35.0-36.0
	37																
	38																
2970	39																
	40																
	41				SPT	67	12 17 12	29	41								S08A-40.0-41.0
	42		Reached target depth of 41.5'														
	43																
2965	44																
	45																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,305.00 East 6,888,045.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B5

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED 12/17/14	DATE COMPLETED 12/17/14	GROUND ELEVATION 3024 ft	ELEVATION BASIS Estimated From Topo Map	TOTAL DEPTH OF BORING 41.5 ft
DRILLING CONTRACTOR Gregg Drilling & Testing, Inc.		DRILLER'S NAME Jeff Keithley	HELPER'S NAME Brian McDade	TOTAL DEPTH OF FILL 24 ft
DRILLING METHOD 0 - 41.5 ft: HSA		DRILL RIG MAKE AND MODEL CME 95		DWR/CONSULTANT COMPANY DWR
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 8 1/2" HSA bit		DRILLING ROD TYPE AND DIAMETER 8 1/2" HSA		FIELD LOGGER T. Butler
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH NA		FIELD LOG REVIEWER D. Perry/N. Hightower
SAMPLER TYPE(S) SPT, 2.5" O.D. Cal Mod		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP Marl, automatic, 140 lbs / 30-inch drop		HAMMER EFFICIENCY 85.5%
BOREHOLE BACKFILL OR COMPLETION Backfilled with bentonite chips		GROUNDWATER READING: DURING DRILLING Not encountered during drilling		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														
	1																
	2		0.0 to 24.0' SILTY SAND, (SM): About 80% fine to coarse, angular to subangular sand; about 20% nonplastic fines; dense, brown, moist; no reaction with HCl.														
	3				SPT	47	7 10 14	24	34								S01A-2.0-2.7
3020	4																
	5																
	6																
	7		From 7.0' About 70% fine to coarse, angular to subangular sand; about 30% nonplastic fines; medium dense, brown, moist.		MCAL		6 12 19										C01A-7.0-7.5
	8											6				UW	C01B-7.5-8.0 C01C-8.0-8.5
3015	9																
	10	SM		Auger	SPT	60	4 8 8	16	23								C02A-10.0-10.9
	11																
	12																
	13																
3010	14																
	15		15.0' Dense.		SPT	87	9 11 15	26	37								S03A-15.0-16.3
	16		At 16.0' 0.5' layer of granitic gravel/crushed rock.														
	17				MCAL		7 12 13										C02A-17.0-17.5
	18		At 18.0' Thin layer of rounded gravel.														C02B-17.5-18.0 C02C-18.0-18.5
3005	19																
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,305.00 East 6,888,045.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B5

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		FILL, 0.0 to 24.0'		SPT	67	8 8 8	16	23								S04A-20.0-21.0
	21																
	22	SM	0.0 to 24.0' SILTY SAND, (SM): About 80% fine to coarse, angular to subangular sand; about 20% nonplastic fines; dense, brown, moist; no reaction with HCl. *(Continued)*														
	23																
3000	24		From 21.0' About 70% fine to medium sand; about 30% nonplastic fines; medium dense, brown, moist.														
	25		RECENT ALLUVIUM, 24.0 to 41.5'		SPT	53	4 4 4	8	11								S05A-25.0-25.8
	26		24.0 to 41.5' SILTY SAND, (SM): About 80% fine to coarse, angular to subangular sand; about 20% nonplastic fines; medium dense, brown, moist; trace angular gravel.														
	27																
	28		From 25.0' About 60% fine to medium sand; about 40% nonplastic fines; medium dense, brown, moist.														
2995	29																
	30		From 30.0' About 70% fine to coarse sand; about 30% nonplastic fines; medium dense, dark brown, dry; trace angular gravel.	Auger	SPT	100	8 9 10	19	27								S06A-30.0-31.5
	31																
	32																
	33	SM															
2990	34																
	35		From 35.0' About 80% fine to coarse sand; about 20% nonplastic fines; dense, light brown, moist; trace angular gravel and trace cobbles.		SPT	87	13 13 14	27	38								S07A-35.0-36.3
	36																
	37																
	38		From 38.0' About 85% fine to coarse, angular to subangular sand; about 15% nonplastic fines; dense, light gray, dry.														
2985	39																
	40		40.0' Very dense.		SPT	100	7 17 22	39	56								S08A-40.0-41.5
	41																
	42		Reached target depth of 41.5'														
	43																
2980	44																
	45																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,953.00 East 6,888,409.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B7

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/17/14**	DATE COMPLETED **12/17/14**	GROUND ELEVATION **3029 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **40.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **24 ft**
DRILLING METHOD **0 - 40.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **D. Perry**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**	AFTER DRILLING (DATE-TIME)	

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														
	1																
	2		0.0 to 8.5' SILTY SAND, (SM): About 70% fine to medium sand; about 30% nonplastic fines; medium dense, brown, dry; trace of coarse sand. trace of fine gravel.														
	3																
3025	4	SM			SPT	100	4 12 12	24	34						12		S01A-4.0-5.5 At 4' [Lab] WELL-GRADED SAND with SILT (SW-SM)
	5																
	6																
	7																
	8																
3020	9		8.5 to 13.7' SILTY SAND with Gravel, (SM)g: About 50% fine to coarse sand; about 25% nonplastic fines; about 15% fine, angular gravel; dense, light brown, dry.	Auger	SPT	80	7 12 14	26	37								S02A-9.0-10.2
	10																
	11	(SM)g															
	12				MCAL		19 36 50										C01A-12.0-12.5
	13											2				UW	C01B-12.5-13.0 C01C-13.0-13.5
3015	14		13.7 to 24.0' SILTY SAND, (SM): About 70% fine to medium sand; about 30% nonplastic fines; very dense, light brown, dry; trace of fine angular gravel.		SPT	67	32 32 49	81	115								S03A-14.0-15.0
	15																
	16																
	17	SM															
	18																
3010	19				SPT	87	10 25	61	87								S04A-19.0-20.3
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,953.00 East 6,888,409.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B7

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		13.7 to 24.0' SILTY SAND, (SM): About 70% fine to medium sand; about 30% nonplastic fines; very dense, light brown, dry; trace of fine angular gravel. *(Continued)*		SPT	87	36	61	87								
	21																
	22	SM			MCAL		16				■						C02A-22.0-22.5
	23						36 38				■						C02B-22.5-23.0 C02C-23.0-23.5
3005	24		RECENT ALLUVIUM, 24.0 to 40.5'		SPT	47	11 16 21	37	53								S05A-24.0-24.7
	25																
	26		24.0 to 40.5' SILTY SAND, (SM): About 70% fine to medium sand; about 30% nonplastic fines; dense, light reddish brown, moist; Native?.														
	27																
	28																
3000	29		From 29.0 to 40.5' About 70% fine to coarse sand; about 30% nonplastic fines; medium dense, brown, moist; trace coarse gravel (fractured rock from SPT?).		SPT	47	8 8 8	16	23								S06A-29.0-29.7
	30			Auger													
	31																
	32	SM															
	33																
2995	34				SPT	80	12 11 10	21	30								S07A-34.0-35.2
	35																
	36																
	37																
	38																
2990	39		39.0' Dense.		SPT	93	8 10 20	30	43								S08A-39.0-40.4
	40																
	41		Reached target depth of 40.5'														
	42																
	43																
2985	44																
	45																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,579.00 East 6,888,137.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B8

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/15/14**	DATE COMPLETED **12/16/14**	GROUND ELEVATION **3039 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **40.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **24 ft**
DRILLING METHOD **0 - 40.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod, Dry Core**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 24.0'														P01A-0.0-3.8
	1																
	2		0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; medium dense, light brown, dry.		DCORE	95											
	3																
3035	4		From 4.0' Moist.		SPT	67	5 6 6	12	17						24		S01A-4.0-5.0 At 4' [Lab] SILTY SAND (SM)
	5																
	6		From 6.0' Reddish brown.														
	7				MCAL		7 12 14										C01A-7.0-7.5
	8											8	24	9	23	UW	C01B-7.5-8.0 At 7.5' [Lab] CLAYEY SAND (SC) C01C-8.0-8.5
3030	9			Auger	SPT	33	7 9 11	20	29								S02A-9.0-9.5
	10	SM	From 10.0' About 70% fine to medium sand; about 30% nonplastic fines; dark brown.														
	11				DCORE	34											P02A-10.5-11.7
	12																
	13																
3025	14		14.0' Very dense.		SPT	80	9 19 18	37	53								S03A-14.0-15.2
	15																
	16		From 16.0' About 60% fine to coarse, angular sand; about 40% nonplastic fines; very dense, brown, moist; trace angular fine gravel.														
	17				MCAL		6 11 12										C02A-17-17.5 C02B-17.5-18.0
	18																C02C-18.0-18.5
3020	19				SPT	80	9 15	31	44								S04A-19.0-20.2
	20																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,579.00 East 6,888,137.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B8

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		FILL, 0.0 to 24.0'		SPT	80	16	31	44								
	21																P03A-20.5-23.3
	22	SM	0.0 to 24.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; medium dense, light brown, dry. *(Continued)*		DCORE	80											
	23																
3015	24		RECENT ALLUVIUM, 24.0 to 40.5'														S05A-24.0-24.6
	25				SPT	40	3 4 4	8	11								
	26		24.0 to 40.5' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; medium dense, reddish brown.														P04A-25.5-27.1
	27				DCORE	46											
	28																
3010	29		From 29.0' Dense.														S06A-29.0-30.2
	30			Auger	SPT	80	10 12 14	26	37								
	31																P05A-30.5-33.4
	32	SM	At 32.0' 0.5' layer of angular granitic gravel.		DCORE	83											
	33																
3005	34						7										
	35				SPT	0	7 17	24	34								
	36																P06A-35.5-37.5
	37				DCORE	57											
	38																
3000	39						13										S08A-39.0-40.2
	40				SPT	80	16 19	35	50								
	41		Reached target depth of 40.5'														
	42																
	43																
2995	44																
	45																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,626.00 East 6,888,630.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
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State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED 12/18/14	DATE COMPLETED 12/18/14	GROUND ELEVATION 3034 ft	ELEVATION BASIS Estimated From Topo Map	TOTAL DEPTH OF BORING 51.5 ft
DRILLING CONTRACTOR Gregg Drilling & Testing, Inc.		DRILLER'S NAME Jeff Keithley	HELPER'S NAME Brian McDade	TOTAL DEPTH OF FILL 20 ft
DRILLING METHOD 0 - 51.5 ft: HSA		DRILL RIG MAKE AND MODEL CME 95		DWR/CONSULTANT COMPANY DWR
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 8 1/2" HSA bit		DRILLING ROD TYPE AND DIAMETER 8 1/2" HSA		FIELD LOGGER T. Butler
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH NA		FIELD LOG REVIEWER D. Perry/N. Hightower
SAMPLER TYPE(S) SPT, 2.5" O.D. Cal Mod		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP Marl, automatic, 140 lbs / 30-inch drop		HAMMER EFFICIENCY 85.5%
BOREHOLE BACKFILL OR COMPLETION Backfilled with bentonite chips		GROUNDWATER READING: DURING DRILLING Not encountered during drilling		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		FILL, 0.0 to 20.0'														
	1																
	2		0.0 to 20.0' SILTY SAND, (SM): About 70% fine to coarse, angular sand; about 30% nonplastic fines; light brown, dry; trace angular gravel.														
	3		From 2.0' Very dense.		SPT	87	4 14 23	37	53								S01A-2.0-3.3
3030	4																
	5																
	6				SPT	80	20 21 26	47	67						17		S02A-5.0-6.2 At 5' [Lab] SILTY SAND (SM)
	7		From 7.0' About 80% fine to coarse, angular to rounded sand; about 20% nonplastic fines; light brown, dry.														
	8				MCAL		8 8 22					5				UW	C01A-7.0-7.5 C01B-7.5-8.0 C01C-8.0-8.5
3025	9																
	10	SM		Auger	SPT	100	7 17 21	38	54								S03A-10.0-11.5
	11																
	12																
	13																
3020	14																
	15				SPT	87	16 22 24	46	66								S04A-15.0-16.3
	16																
	17				MCAL		12 19 28										C02A-17.0-17.5 C02B-17.5-18.0 C02C-18.0-18.5
	18																
3015	19																
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,626.00 East 6,888,630.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B9

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		RECENT ALLUVIUM, 20.0 to 51.5'														
	21				SPT	67	12 50										S05A-20-21.0; SPT refusal
	22		20.0 to 51.5' SILTY SAND, (SM): About 60% fine to coarse sand; about 40% nonplastic fines; dense, dark reddish brown, moist; trace rounded pea gravel.														
	23																
3010	24																
	25																
	26		From 26.0' About 65% fine to medium sand; about 35% nonplastic fines; medium dense, dark reddish brown, moist; trace coarse angular sand, trace rounded gravel.		SPT	60	6 6 9	15	21								S06A-25.0-25.9
	27																
	28																
3005	29																
	30		From 30.0' Dense.														
	31				SPT	87	9 15 16	31	44								S07A-30.0-31.3
	32			Auger													
	33	SM															
3000	34																
	35																
	36		From 36.0' About 60% fine to medium sand; about 40% nonplastic fines; dense, dark reddish brown, moist; trace of clay.		SPT	73	15 16 18	34	48								S09A-35.0-36.1
	37																
	38																
2995	39		At 39.0' Gypsum veinlets in auger cuttings.														
	40																
	41		From 41.0' About 80% fine to coarse, rounded sand; about 20% nonplastic fines; dense, light brown, moist; trace of angular pea gravel.		SPT	100	14 14 16	30	43								S10A-40.0-41.5
	42																
	43																
2990	44																
	45																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,626.00 East 6,888,630.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B9

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	45		RECENT ALLUVIUM, 20.0 to 51.5'				7										S11A-45.0-46.1
	46				SPT	73	13 14	27	38								
	47		20.0 to 51.5' SILTY SAND, (SM): About 60% fine to coarse sand; about 40% nonplastic fines; dense, dark reddish brown, moist; trace rounded pea gravel. *(Continued)*														
	48	SM		Auger													
2985	49																
	50		50.0' Very dense.				15										S12A-50.0-51.4
	51				SPT	93	29 49	78	111								
	52		Reached target depth of 51.5'														
	53																
2980	54																
	55																
	56																
	57																
	58																
2975	59																
	60																
	61																
	62																
	63																
2970	64																
	65																
	66																
	67																
	68																
2965	69																
	70																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,667.00 East 6,887,412.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B11

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/16/14**	DATE COMPLETED **12/16/14**	GROUND ELEVATION **3051 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **21.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **0 ft**
DRILLING METHOD **0 - 21.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		RECENT ALLUVIUM, 0.0 to 21.5'														
3050	1																
	2		0.0 to 21.5' SILTY SAND, (SM): About 70% fine to coarse sand; about 30% nonplastic fines; light brown, moist; no reaction with HCl; trace fine angular gravel.														
	3																
	4																
	5		From 5.0' Medium dense.		SPT	87	4 6 8	14	20								S01A-5.0-6.3
3045	6																
	7		At 7.0' Gypsum vienlets.		MCAL		9 18 24				☒						C01A-7.0-7.5
	8										☒		24	8	31		C01B-7.5-8.0 At 7.5' [Lab] CLAYEY SAND (SC)
	9																
	10	SM	From 10.0' Dense.	Auger	SPT	67	11 12 15	27	38								S02A-10.0-11.0
3040	11																Easy drilling
	12																
	13																
	14																
	15				SPT	80	8 12 12	24	34								S03A-15.0-16.2
3035	16																
	17				MCAL		11 15 27				☒						C02A-17.0-17.5
	18										☒						C02B-17.5-18.0
											☒						C02C-18.0-18.5
	19																
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,667.00 East 6,887,412.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B11

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		20.0' Very dense.	Auger	SPT	87	11 18 20	38	54								S04A-20.0-21.3
3030	21	SM	At 20.5' 1.0' layer of angular gray gravels.														
	22		Reached target depth of 21.5'														
	23																
	24																
	25																
3025	26																
	27																
	28																
	29																
	30																
3020	31																
	32																
	33																
	34																
	35																
3015	36																
	37																
	38																
	39																
	40																
3010	41																
	42																
	43																
	44																
	45																

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,764.00 East 6,887,758.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B12

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/16/14**	DATE COMPLETED **12/16/14**	GROUND ELEVATION **3043 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **30.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **0 ft**
DRILLING METHOD **0 - 30.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod, Dry Core**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**	AFTER DRILLING (DATE-TIME)	

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		RECENT ALLUVIUM, 0.0 to 30.5'														
	1																
	2		0.0 to 30.5' SILTY SAND, (SM): About 65% fine to coarse, angular sand; about 35% nonplastic fines; light brown, dry.		DCORE	100											P01A-1.5-4.0
3040	3																
	4		From 4.0' Loose, trace subrounded gravel.		SPT	53	2 3 2	5	7								S01A-4.0-4.8
	5																
	6				DCORE	51											P02A-5.5-7.3
	7																
3035	8																
	9		From 9.0' Medium dense.		SPT	80	5 6 7	13	19								S02A-9.0-10.2
	10	SM		Auger													
	11																
	12		From 12.0' About 60% fine to coarse, angular sand; about 40% nonplastic fines; medium dense, trace gravel.		MCAL		9 13 16										C01A-12.0-12.5
3030	13											2					C01B-12.5-13.0
	14																
	15		From 15.0' About 70% fine to coarse, angular sand; about 30% nonplastic fines; dense.		SPT	67	8 8 15	23	33								S03A-14.0-15.0
	16				DCORE	51											P03A-15.5-17.3
	17																
3025	18																
	19		19.0' Gypsum veinlets.		SPT	80	12 14	32	46								S04A-19.0-20.2
	20																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,764.00 East 6,887,758.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B12

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		RECENT ALLUVIUM, 0.0 to 30.5'		SPT	80	18	32	46								
	21																
	22		0.0 to 30.5' SILTY SAND, (SM): About 65% fine to coarse, angular sand; about 35% nonplastic fines; light brown, dry. *(Continued)*				38 50										C02A-22.0-22.5 C02B-22.5-23.0
3020	23																Cal Mod refusal
	24		From 24.0' Very dense.			96	39 50										S05A-24.0-24.8
	25	SM		Auger													SPT refusal P04A-24.8-28.3
	26																
	27				DCORE	83											
3015	28																
	29																S06A-29.0-30.0
	30				SPT	67	20 39 49	88	125								
	31		Reached target depth of 30.5'														
	32																
3010	33																
	34																
	35																
	36																
	37																
3005	38																
	39																
	40																
	41																
	42																
3000	43																
	44																
	45																

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1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,303.00 East 6,887,610.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B14

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

DATE STARTED **12/16/14**	DATE COMPLETED **12/16/14**	GROUND ELEVATION **3059 ft**	ELEVATION BASIS **Estimated From Topo Map**	TOTAL DEPTH OF BORING **23.5 ft**
DRILLING CONTRACTOR **Gregg Drilling & Testing, Inc.**		DRILLER'S NAME **Jeff Keithley**	HELPER'S NAME **Brian McDade**	TOTAL DEPTH OF FILL **0 ft**
DRILLING METHOD **0 - 23.5 ft: HSA**		DRILL RIG MAKE AND MODEL **CME 95**		DWR/CONSULTANT COMPANY **DWR**
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) **8 1/2" HSA bit**		DRILLING ROD TYPE AND DIAMETER **8 1/2" HSA**		FIELD LOGGER **T. Butler**
☒ VERTICAL ☐ INCLINED		CASING TYPE, DIAMETER, INSTALLATION DEPTH **NA**		FIELD LOG REVIEWER **D. Perry/N. Hightower**
SAMPLER TYPE(S) **SPT, 2.5" O.D. Cal Mod**		HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP **Marl, automatic, 140 lbs / 30-inch drop**		HAMMER EFFICIENCY **85.5%**
BOREHOLE BACKFILL OR COMPLETION **Backfilled with bentonite chips**		GROUNDWATER READING: DURING DRILLING **Not encountered during drilling**		AFTER DRILLING (DATE-TIME)

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	LABORATORY DATA: Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	0		RECENT ALLUVIUM, 0.0 to 23.5'														
	1																
	2		0.0 to 23.5' SILTY SAND, (SM): About 70% fine to coarse, angular to subangular sand; about 30% nonplastic fines; brown, moist.														
	3		From 2.0' Light brown, dry; gypsum veinlets.														
3055	4		From 4.0' About 65% fine to medium sand; about 35% nonplastic fines; dense, light brown, dry; trace gravels.		SPT	67	14 16 17	33	47								S01A-4.0-5.0
	5																
	6																
	7																
	8																
3050	9				SPT	80	6 10 16	26	37								S02A-9.0-10.2
	10	SM		Auger													
	11																
	12				MCAL		16 35 50					3				UW	C01A-12.0-12.5 C01B-12.5-13.0 C01C-13.0-13.5
	13																
			From 13.5' Very dense.														Cal Mod refusal Rig chatter
3045	14				SPT	67	17 40 49	89	127								S03A-14.0-15.0
	15																
	16																Rig chatter
	17		From 16.5' About 80% fine to coarse sand; about 20% nonplastic fines; very dense, light brown, dry; gypsum veinlets.														
	18																
3040	19				SPT	100	16 18	44	63								S04A-19.0-20.5
	20																

Final Report Version 3/10/2015

1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,303.00 East 6,887,610.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles

DRILL HOLE LOG
B14

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Drilling Method	Sampled Interval	Recovery %	Blows per 6 in.	SPT N Value	N_{60}(ASTM)	PP or TV, tsf	Retained Sample	Water Content %	Liquid Limit	Plasticity Index	Fines% < #200	Other Lab Tests	REMARKS
	20		RECENT ALLUVIUM, 0.0 to 23.5'	Auger	SPT	100	26	44	63								
	21																
	22	SM	0.0 to 23.5' SILTY SAND, (SM): About 70% fine to coarse, angular to subangular sand; about 30% nonplastic fines; brown, moist. *(Continued)*		MCAL		5				■						C02A-22.0-22.5
	23						45				■						C02B-22.5-23.0
							21				■						C02C-23.0-23.5
3035	24		Reached target depth of 23.5'														
	25																
	26																
	27																
	28																
3030	29																
	30																
	31																
	32																
	33																
3025	34																
	35																
	36																
	37																
	38																
3020	39																
	40																
	41																
	42																
	43																
3015	44																
	45																

Final Report Version 3/10/2015

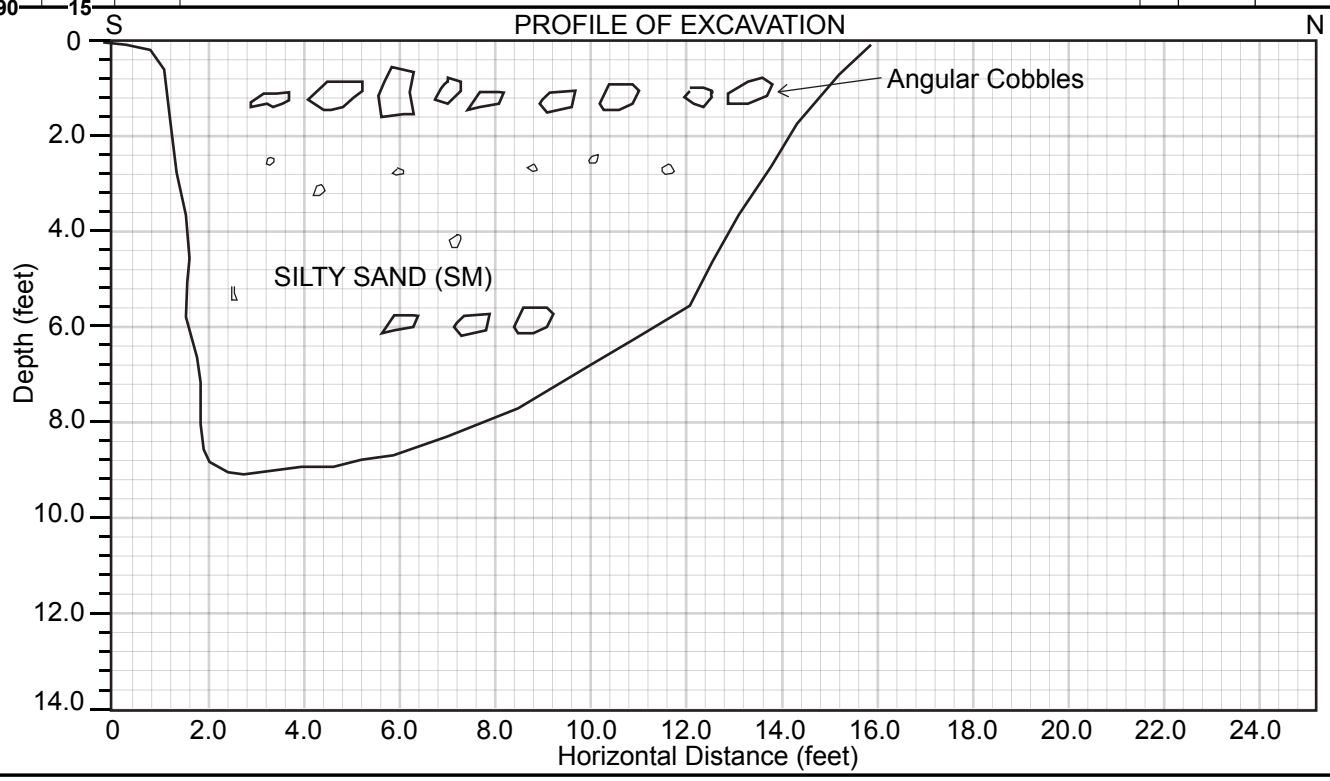
1 PROJECT GEOLOGY DRILL HOLE LOG; PEARBLOSSOM SOLAR.GPJ; DWR PROJECT GEOLOGY LIBRARY 03052014.GLB; 3/11/15

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,987.00 East 6,888,181.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 1
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
3005	0		FILL, 0.0 to 9.0'				
	1						
	2		0.0 to 9.0' SILTY SAND, (SM): About 65% fine to coarse, angular sand; about 35% nonplastic fines; light brown, dry; trace fine gravel.	Sample TP1, 1-5' BULK			
	3		At 1.0' 1 foot layer of angular cobbles, 8"-10" in diameter.				
	4	SM					
3000	5						
	6		At 6.0' 1 foot layer of angular cobbles, 8"-10" in diameter.				
	7						
	8						
	9		Terminated at 9.0'				
2995	10						
	11						
	12						
	13						
	14						
2990	15						



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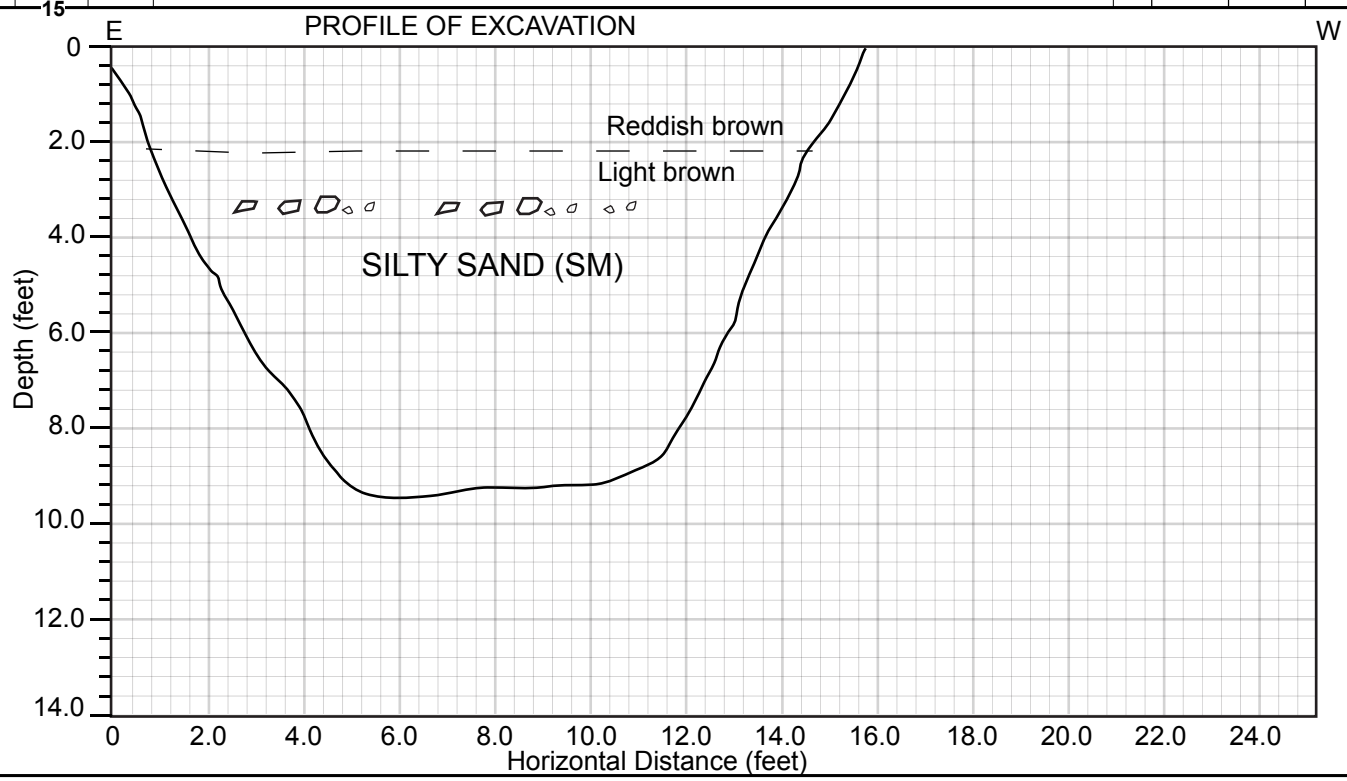
Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,943.00 East 6,888,683.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 2
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		FILL, 0.0 to 9.0'				
2995	1–2	SM	0.0 to 9.0' SILTY SAND, (SM): About 65% fine to medium sand; about 35% nonplastic fines; light brown, dry; trace fine gravel.	Sample TP2, 1-5' BULK			
	3–4		At 3.0' 0.5' fine to medium gravel layer.				
2990	5–8						
	9		Terminated at 9.0'				
2985	10–15						



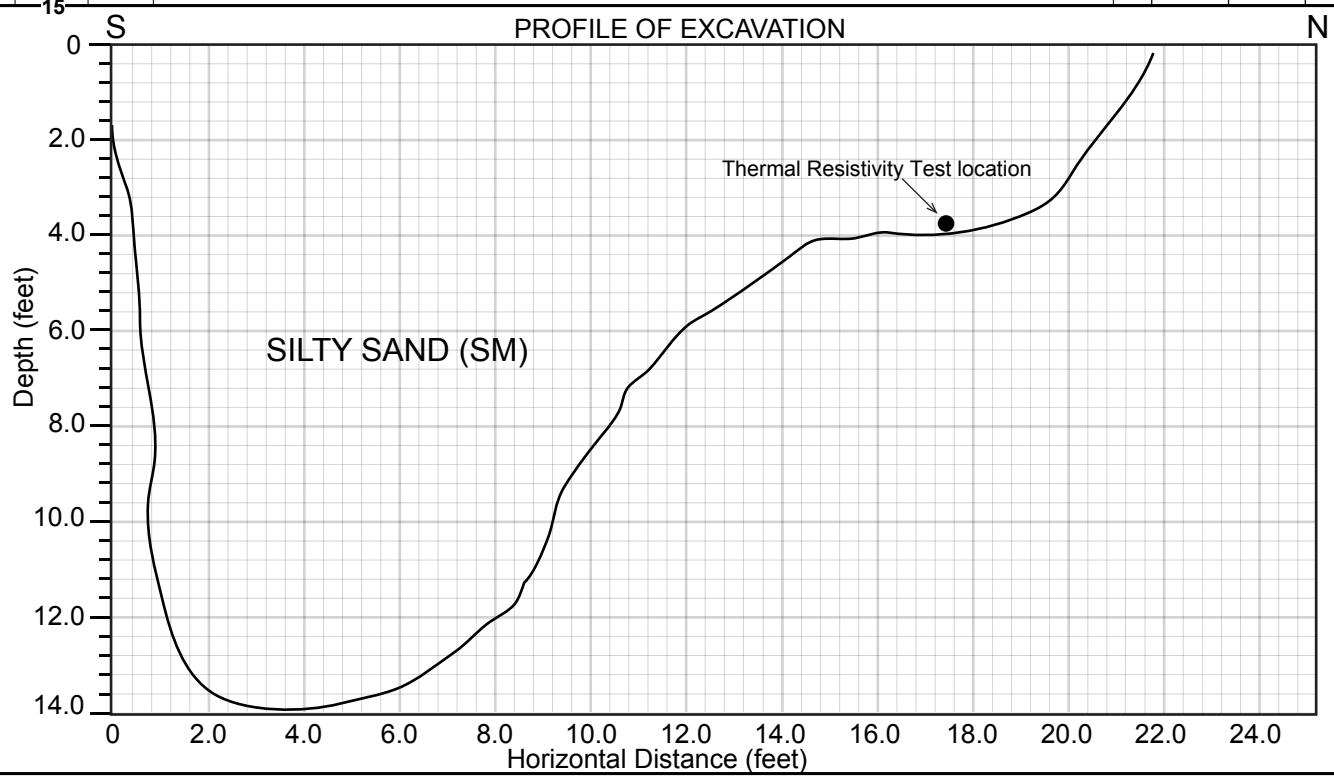
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,649.00 East 6,887,950.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 3
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		FILL, 0.0 to 14.0'				
	1			Bulk Sample TP3 1-5' BULK			
3015	2		0.0 to 14.0' SILTY SAND, (SM): About 70% fine to coarse sand; about 30% nonplastic fines.				
	3						
	4		At 4.0' Thermal Resistivity 0.258 w/mK, 15.198°C error: 0.0550				
	5						
	6						
3010	7	SM					
	8						
	9						
	10						
	11						
3005	12						
	13						
	14		Terminated at 14.0'				
	15						



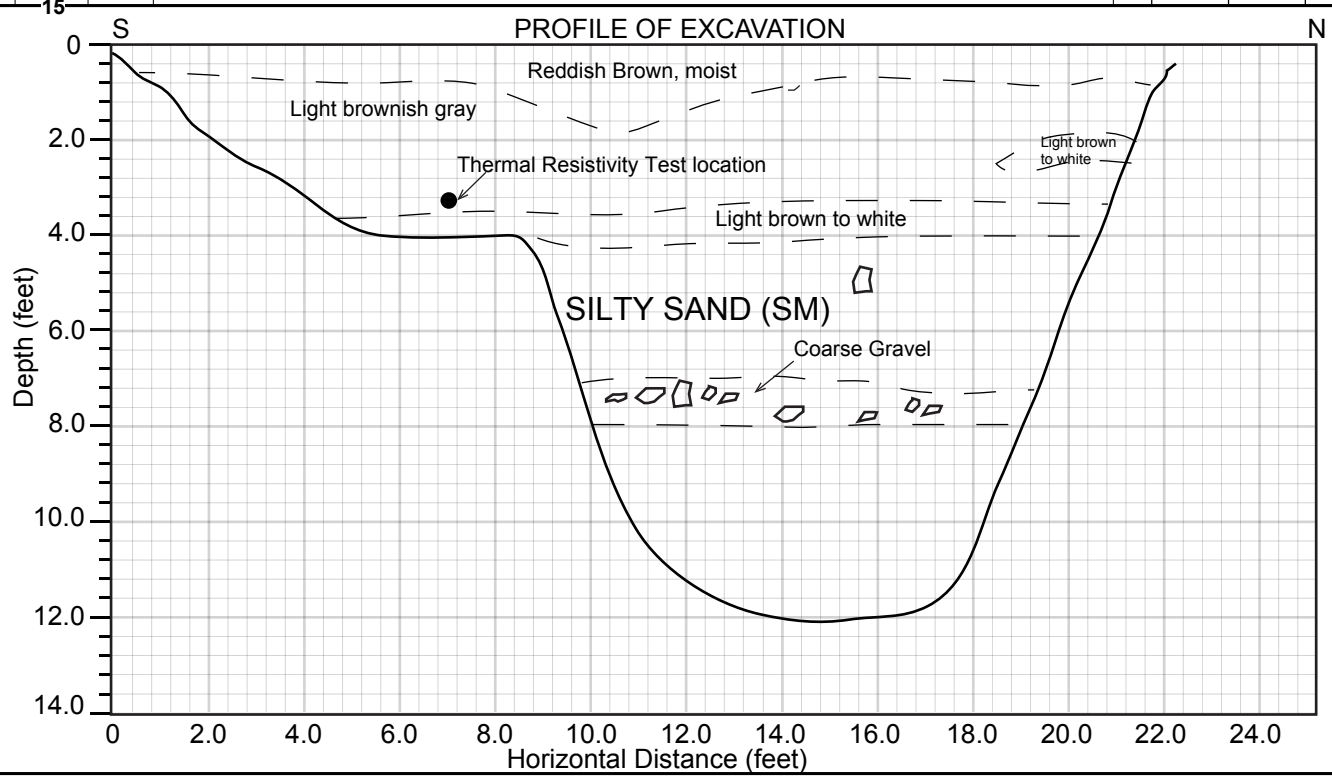
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,343,445.00 East 6,888,295.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 4
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		FILL, 0.0 to 12.0'				
	1			Bulk Sample TP4 1-5' BULK			
3015	2		0.0 to 12.0' SILTY SAND, (SM): About 70% fine to coarse sand; about 30% nonplastic fines; light brownish gray, dry.				
	3						
	4		From 3.8' to 4.0' Light brown to white in color.				
	5		At 4.0' Thermal Resistivity, KD2 0.138 w/mK, 14.02°C error: 0.0540				
	6	SM					
3010	7		From 7.0' to 8.0' Layer of coarse gravel.				
	8						
	9						
	10						
	11						
3005	12		Terminated at 12.0'				
	13						
	14						
	15						



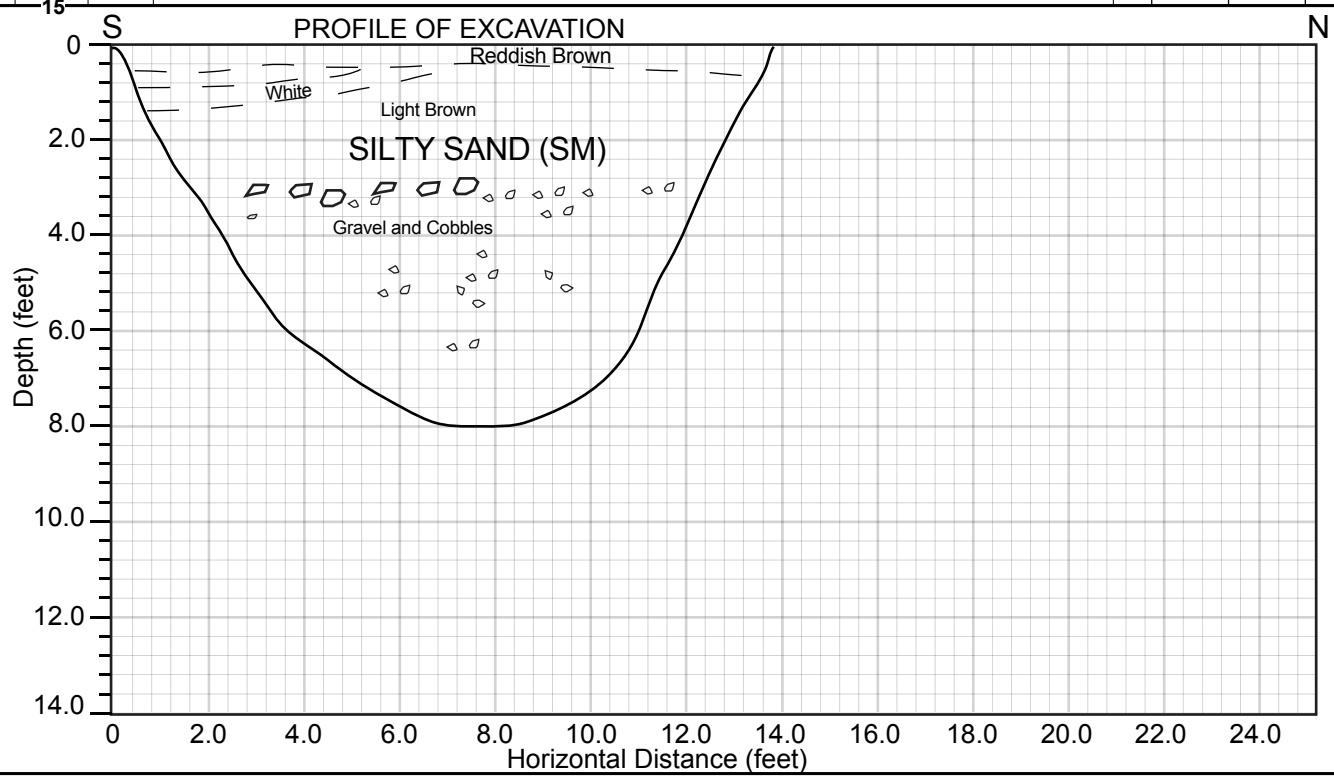
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,831.00 East 6,888,614.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 5
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		FILL, 0.0 to 8.0'				
	1						
	2		0.0 to 8.0' SILTY SAND, (SM): About 65% fine to coarse sand; about 35% nonplastic fines; light brown, dry; no reaction with HCl; trace fine gravel.	Sample TP5, 1-5' BULK			
3025	3		From 3.0' to 4.0' Gravel/cobbles.				
	4	SM					
	5						
	6						
	7						
3020	8		Terminated at 8.0'				
	9						
	10						
	11						
	12						
3015	13						
	14						
	15						



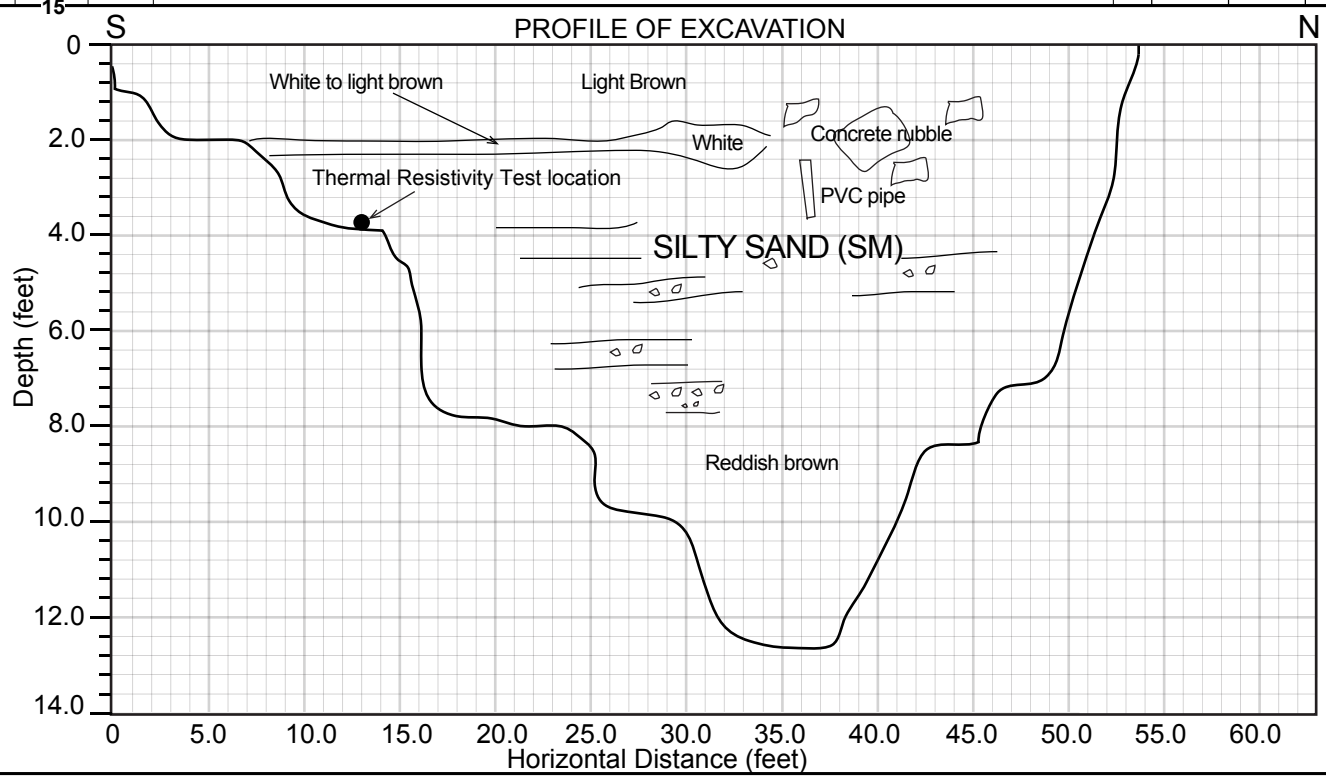
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 1A
Coordinates: North 1,342,654.00 East 6,888,299.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 6
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		FILL, 0.0 to 13.0'				
3035	2		0.0 to 13.0' SILTY SAND, (SM): About 65% fine to coarse sand; about 35% nonplastic fines; light brown, dry; no reaction with HCl; trace of fine gravel. Concrete and PVC pipe pieces.	Sample TP6, 1-4' BULK			
	4		At 4.0' Thermal Resistivity 0.104 w/mK, 11.55°C error: 0.0530				
	6	SM					
3030	7						
	8		From 8.0' Reddish brown.				
3025	12						
	13		Terminated at 13.0'				
	14						
	15						



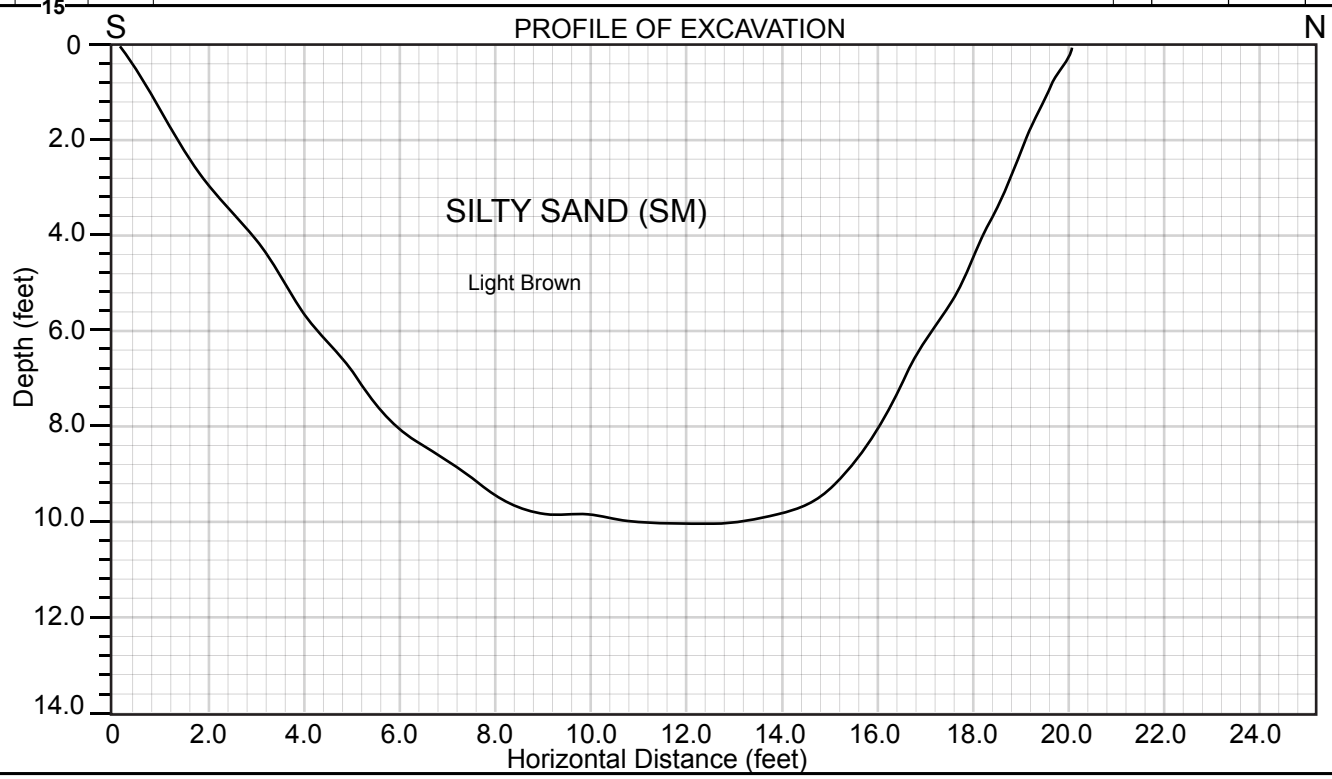
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,514.00 East 6,887,351.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 7
Sheet 1 of 1

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		RECENT ALLUVIUM, 0.0 to 10.0'				
3055	2		0.0 to 10.0' SILTY SAND, (SM): About 60% fine to medium sand; about 40% no to low plasticity fines; light brown, moist.	Sample TP7, 1-5' BULK			
	5	SM					
3050	7						
	10		Terminated at 10.0'				
3045	12						
	15						



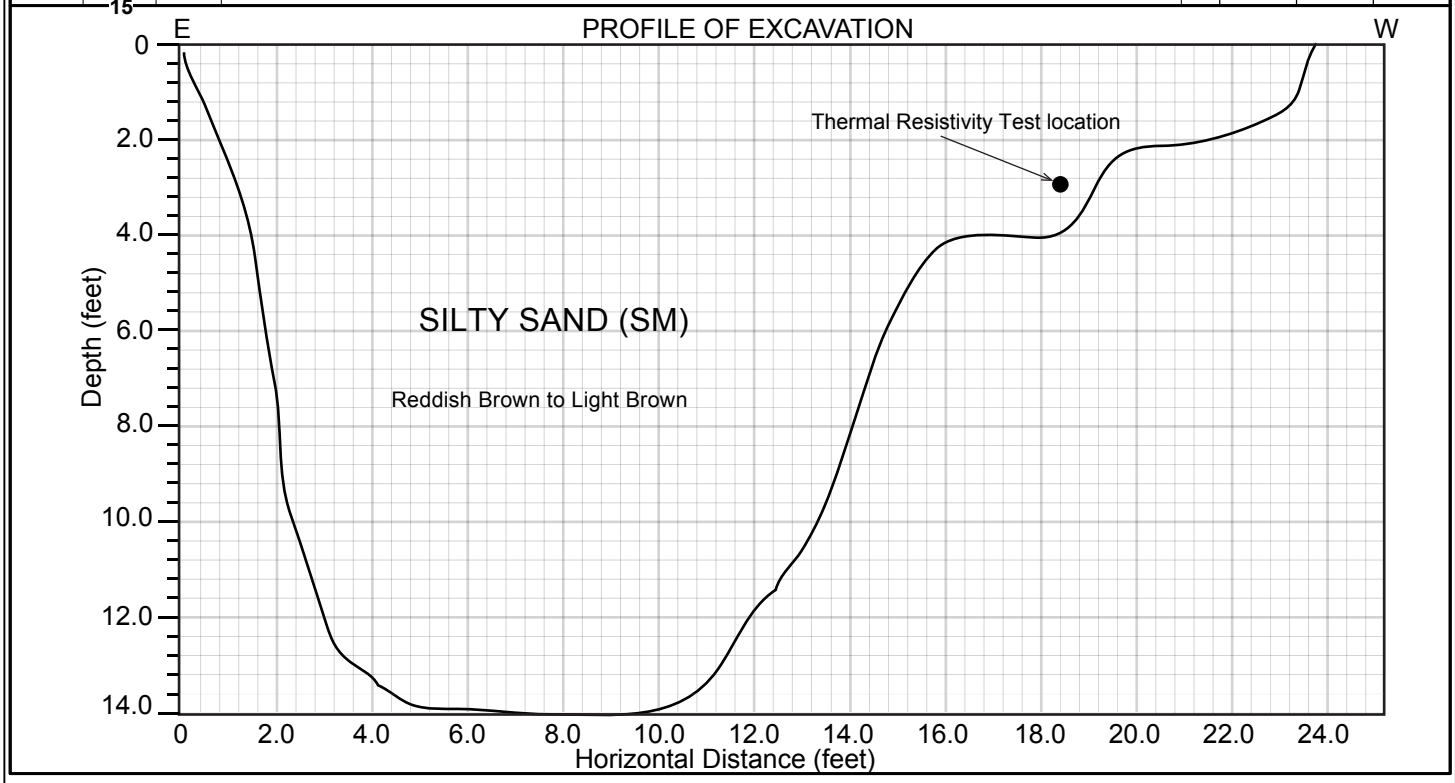
Final Report Version 3/10/2015

Project: PEARBLOSSOM SOLAR ARRAY
Feature: Pearblossom O&M Center / Parcel 5A
Coordinates: North 1,341,557.00 East 6,887,741.00
Survey Method: GPS GEO XT 2008 Trimble Datum: NAD83
GPS: Latitude Longitude
County: Los Angeles Date: 12/16/15

TEST PIT LOG
TP 8
Sheet 1 of 1

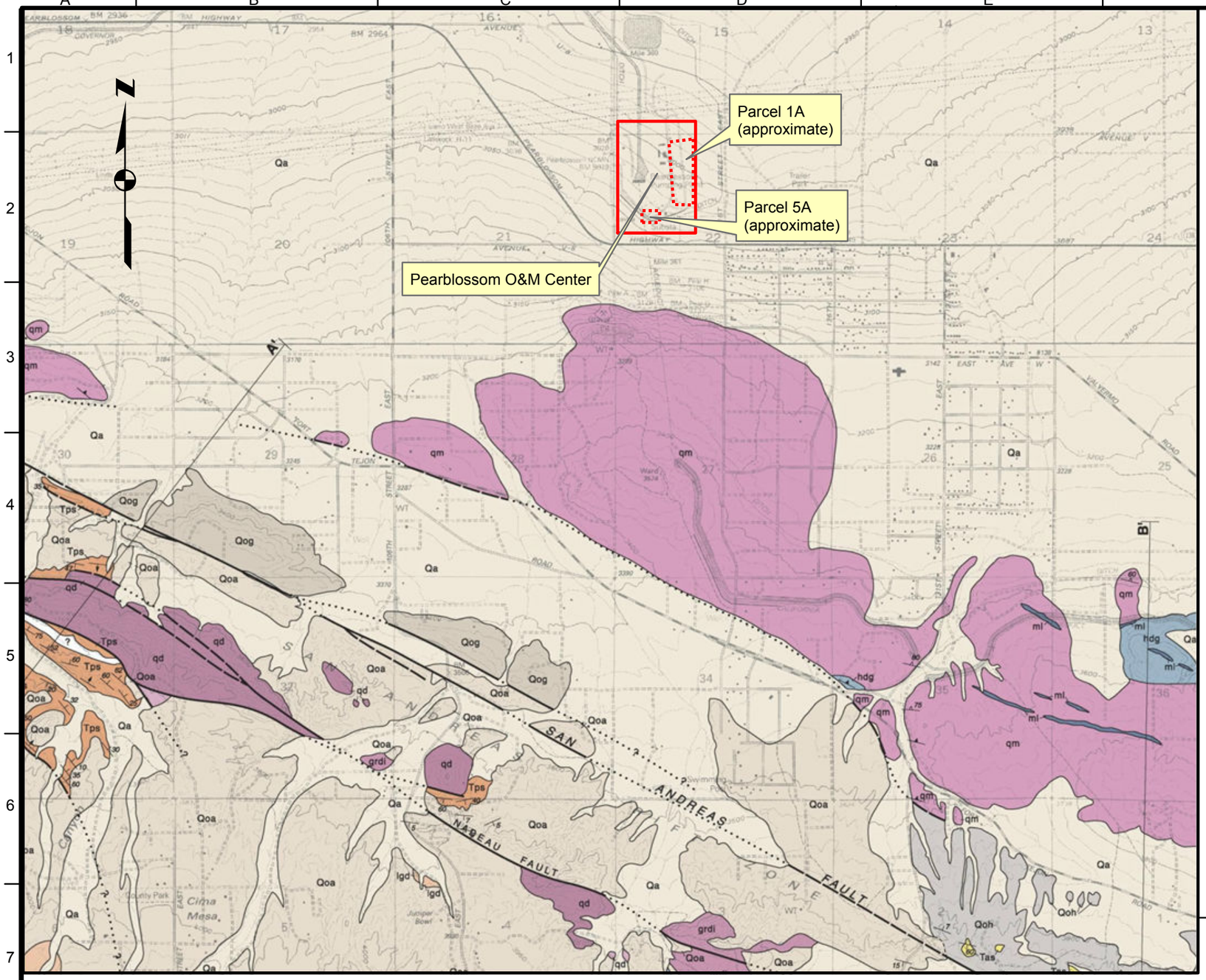
State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

Elevation, feet	Depth, feet	Graphic Log	FIELD CLASSIFICATION AND DESCRIPTION	Sample	PP or TV (tsf)	Moisture (%)	Dry Unit wt. (pcf)
	0		RECENT ALLUVIUM, 0.0 to 14.0'				
	1						
	2		0.0 to 14.0' SILTY SAND, (SM): About 65% fine to medium sand; about 35% nonplastic fines; reddish brown to light brown, moist.	Sample TP8, 1-5' BULK			
3045	3						
	4		At 4.0' Thermal Resistivity 0.145 w/mK, 10.58°C error 0.0503				
	5						
	6						
	7	SM					
3040	8						
	9						
	10						
	11						
	12						
3035	13						
	14		Terminated at 14.0'				
	15						



Final Report Version 3/10/2015

PLATES



Modified after: Dibblee, T.W., and Minch, J.A., 2002, Geologic map of the Juniper Hills Quadrangle [and southern Littlerock Quadrangle] (scale 1:24,000), Los Angeles County, California: Dibblee Geological Foundation, Dibblee Foundaton Map DF-79. http://ngmdb.usgs.gov/ngm-bin/pdp/zui_pdpViewer.pl?id=34308

LEGEND

Qa **Holocene** Surficial Sediments

alluvial gravel, sand, and clays of valley bottoms

- - - - - U N C O N F O R M I T Y - - - - -

Qog **Qoa** **Qoh** **Pleistocene** Older Dissected Surficial Sediments

Qog *alluvial boulder gravel or fanglomerate of granitic and gneissic detritus*
Qoa *alluvial gravel and sand of mostly granitic and gneissic detritus*
Qoh *Harold Fm alluvial gravel, sand, and silt, including basal caliche, NE San Andreas Fault*

- - - - - U N C O N F O R M I T Y - - - - -

Tas **Pliocene** Anaverde Formation

terrestrial sediments NE of San Andreas Fault, semi-indurated sandstone, light tan, arkosic, locally pebbly includes minor gray siltstone

- - - - - U N C O N F O R M I T Y - - - - -

Tps **Miocene** Punchbowl Formation

terrestrial; moderately lithified, coherent; sandstone, gray-white, bedded, arkosic; medium to coarse-grained; locally conglomeratic, includes greenish-brown claystone interbeds, mostly in upper part

- - - - - U N C O N F O R M I T Y - - - - -

gr **qm** **grdi** **Mesozoic** Granitic Rocks

gr *granite-quartz monzonite; gray-white, massive, hard; coherent but fractured; biotite-poor*
qm *quartz monzonite to granodiorite; gray-white; incoherent*
grdi *mostly granodiorite; medium gray; semi-coherent; moderately rich in biotite and hornblende*

qd **Mesozoic** Quartz Diorite

gray, massive, moderately coherent; medium-grained of mostly sodic plagioclase feldspar and biotite mica, hornblende, minor quartz and potassic feldspar

lgd **Triassic** Lowe Granodiorite

undivided, tan-white massice to vaguely gneissoid; medium to fine-grained; locally porphyritic; biotite-poor; hard but much fractured; locally contains scattered phenocrysts of potassic feldspar

hdg **Triassic** Hornblende diorite gabbro

dark gray to black; medium-grained, massive; of mostly hornblende, and plagioclase feldspar; coherent; age Mesozoic or older

ml Marble (unknown age)

limestone dolomite marble, linear pendants in qm and hdg; white, medium-grained, coherent; vaguely bedded to massive; locally contains calc-silicate tactite and mica schist

Fault (known, assumed, approximate)

Contact between geologic units

Approximate Pearblossom O&M Center property limits

THINK SAFETY - ACT SAFELY

REV.	DATE	DESCRIPTION

DRAWING SCALES: 0 ¼ ½ Miles 1 1½ — 1:32,500

GEOLOGY REPORT No. 57-31-25
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No.

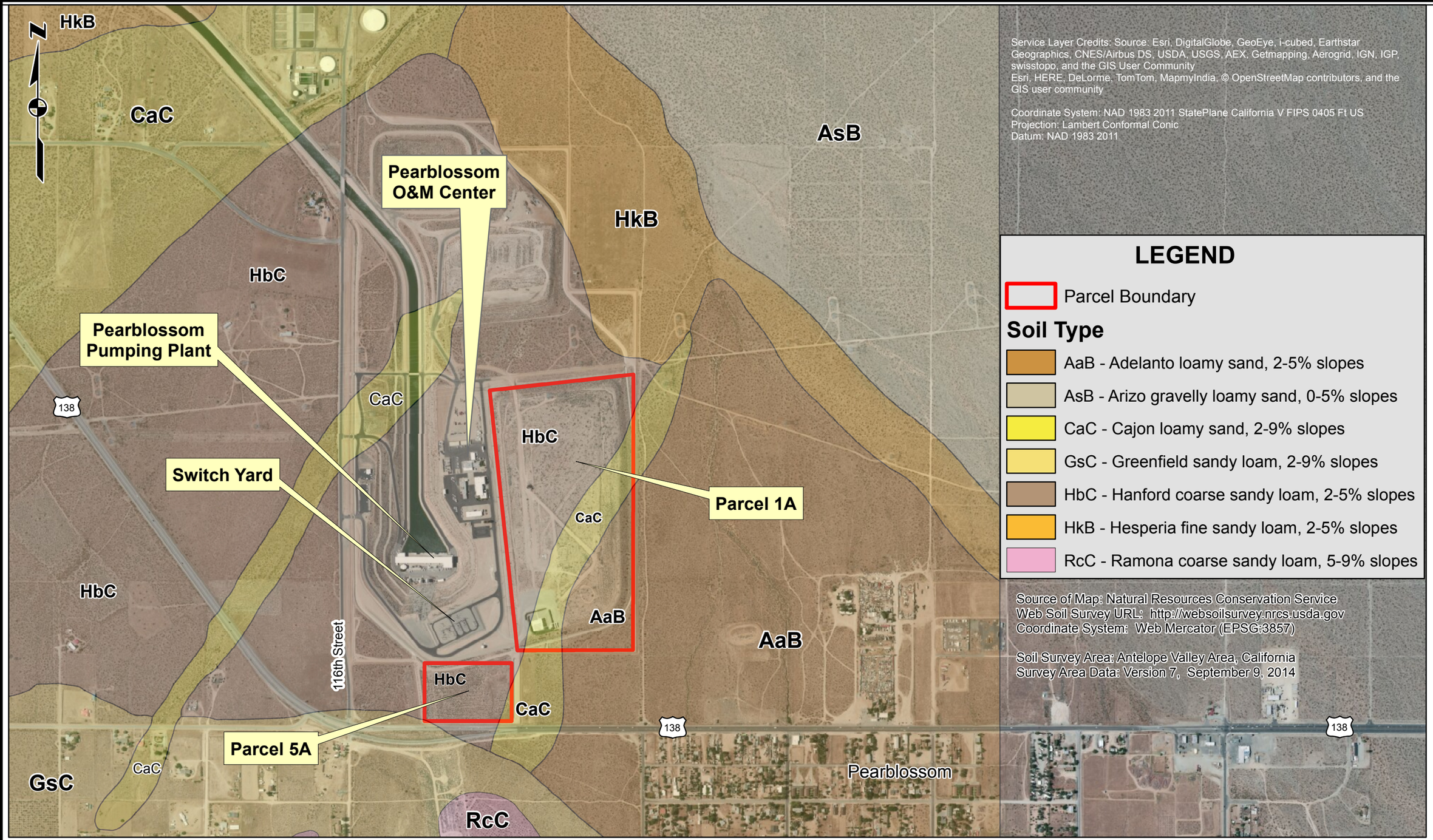
GEOLOGIC MAPPING AND/OR LOGGING BY: 1 T. Butler 2
DRAWING PREPARED BY: T. Butler DATE: 3/6/2015

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

CALIFORNIA AQUEDUCT
MOJAVE DIVISION
PEARBLOSSOM O&M CENTER
PEARBLOSSOM SOLAR ARRAY PROJECT
GEOLOGIC MAP

RELEASE DATE:
SHEET No: 1 of 1
PLATE 1

Date: 3/9/2015
Name: Pearblossom Geologic Map (Plate 1)



REV.	DATE	DESCRIPTION

DRAWING SCALES

0 250 500 1,000 Feet

1:10,000

GEOLOGY REPORT No. 57-31-25

CONSTRUCTION SPEC. No.

GEOLOGY DRAWING No.

GEOLOGIC MAPPING AND/OR LOGGING BY:
1 T. Butler
2

DRAWING PREPARED BY: T. Butler DATE: 3/4/2015

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY

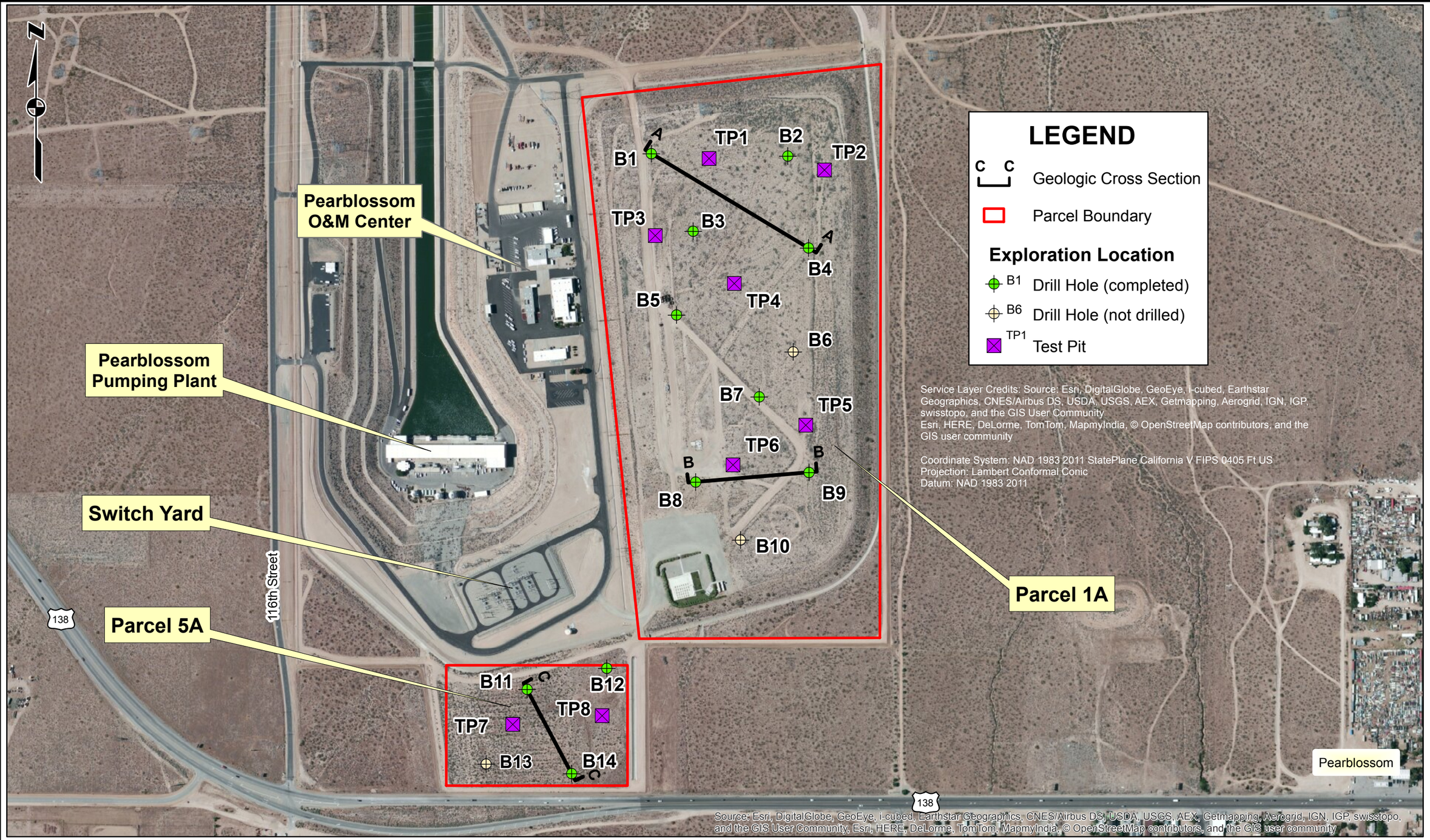
CALIFORNIA AQUEDUCT
MOJAVE DIVISION
PEARBLOSSOM O&M CENTER
PEARBLOSSOM SOLAR ARRAY PROJECT
SOILS MAP

RELEASE DATE:

SHEET No: 1 of 1

PLATE 2

Date: 3/9/2015
Name: Pearblossom Solar Soils Map (Plate 2)



REV.	DATE	DESCRIPTION

DRAWING SCALES

0 200 400 800 Feet

1:4,800

GEOLOGY REPORT No. 57-31-25

CONSTRUCTION SPEC. No.

GEOLOGY DRAWING No.

GEOLOGIC MAPPING AND/OR LOGGING BY:
1 T. Butler
2

DRAWING PREPARED BY: T. Butler DATE: 02/18/2015

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY - ACT SAFELY

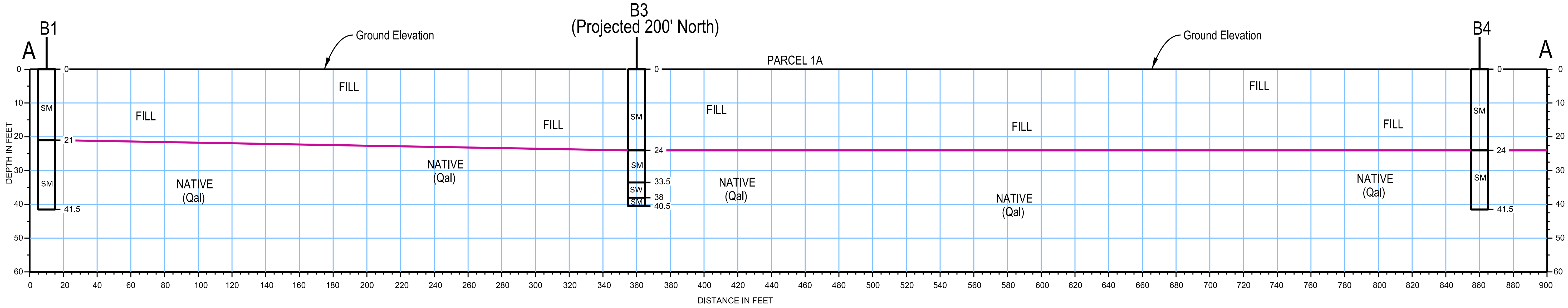
CALIFORNIA AQUEDUCT
MOJAVE DIVISION
PEARBLOSSOM O&M CENTER
PEARBLOSSOM SOLAR ARRAY PROJECT
EXPLORATION LOCATION MAP

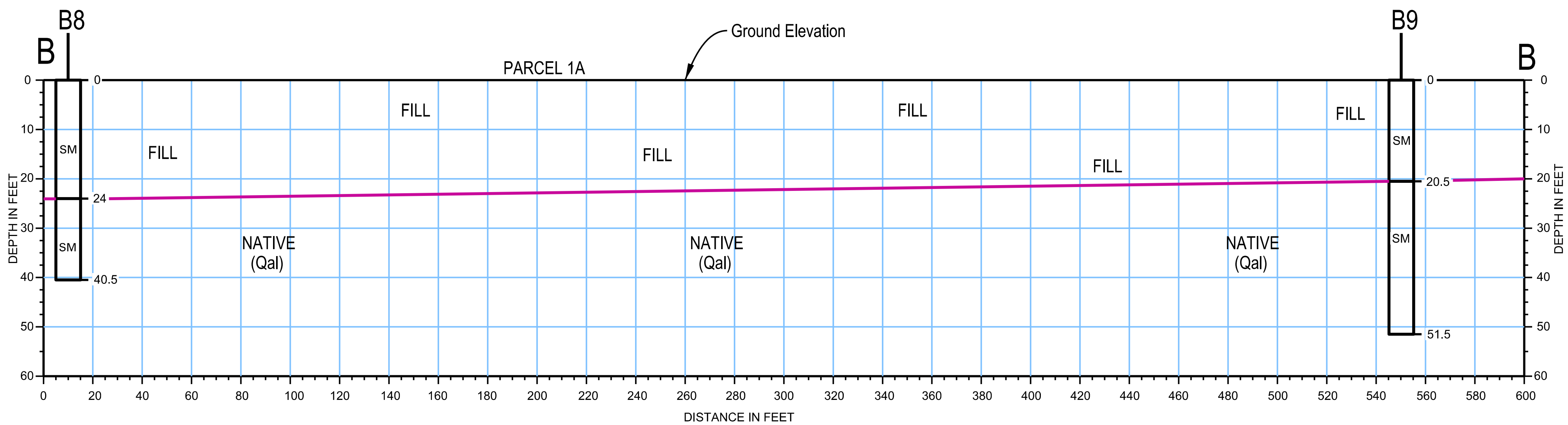
RELEASE DATE:

SHEET No: 1 of 1

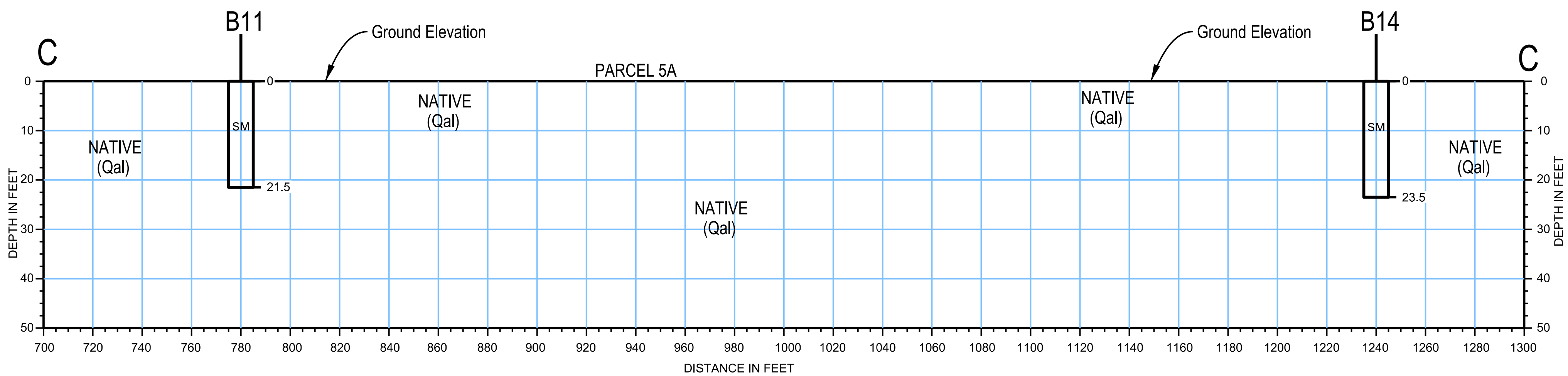
PLATE 3

Date: 3/9/2015
Name: Pearblossom Solar Exploration Map (Plate 3)





Note: Groundwater was not encountered.



EXPLANATION

SC = Clayey Sand

SM = Silty Sand

SW = Well graded Sand

(magenta line) = Contact between Fill and Quaternary Alluvium

Fill = Artificial fill composed of debris and silty, clayey sands (SC-SM)

REV.	DATE	DESCRIPTION

DRAWING SCALES

1" = 30' — VERTICAL SCALE OF FEET (15, 0, 15, 30, 45, 60)

1" = 60' — HORIZONTAL SCALE OF FEET (30, 0, 30, 60, 90, 120)

GEOLOGY REPORT No. 57–31–25

CONSTRUCTION SPEC. No.

GEOLOGY DRAWING No.

GEOLOGIC MAPPING AND/OR LOGGING BY:
1 TERESA BUTLER
2

DRAWING PREPARED BY: DATE:
ALBERT LAGUARDIA

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
PROJECT GEOLOGY SECTION
STATE WATER FACILITIES

THINK SAFETY – ACT SAFELY

CALIFORNIA AQUEDUCT
MOJAVE DIVISION
PEARBLOSSOM O&M CENTER
PEARBLOSSOM SOLAR ARRAY PROJECT
GEOLOGIC CROSS SECTIONS

RELEASE DATE :

SHEET No.

PLATE 4

VI= $$$$$PRFNAME$$$$$$$$$ 3/3/2015 $$$DESIGNFILESPECIFICA$$$$

$$$$$DESIGNFILESPECIFICATION$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$