Appendix G Geology & Soils

Appendix G-1 Geotechnical Review of Quarry Slope Stability & Geologic Hazards

Project No. RSG 13-01E
August 13, 2013

Riverbend Sand and Gravel, LLC
14962 E Fantz Ave
Parlier, CA 93648-9734

c/o Mr. John Buada
Buada Associates
4872 N Arcade Ave, Fig Garden Studio
Fresno, California 93704

Subject: **GEOTECHNICAL REVIEW OF QUARRY SLOPE STABILITY AND GEOLOGIC HAZARDS**
Proposed Riverbend Sand and Gravel Quarries
2.5 miles Southeast of Sanger, Fresno County, California

1. INTRODUCTION AND SCOPE OF WORK

Presented herein is Tetra Tech BAS GeoScience (Tt-BASg) geotechnical review of geologic hazards and pit slope stability for the proposed Riverbend Sand and Gravel quarries in Fresno County, California. The purpose of the study was to provide an opinion regarding the stability of the proposed temporary and long-term quarry slopes. Additionally, review of geologic hazards of potential significance to the project is also provided. The study was performed in general accordance with the scope of work outlined in our proposal dated April 24, 2013.

The following tasks were performed during the current study period:

- Review of client-provided site-specific reports and data generated by Cleath-Harris Geologists, Inc. (2010a, 2010b, 2011a, 2011b, 2011c).

- Review of County of Fresno and City of Sanger records pertinent to site and area geotechnical conditions (Benchmark Resources, Inc., 2010; Calaveras Materials, Inc., 2007; County of Fresno, 2013; Golder Associates, 2010; and Kenneth D. Schmidt and Associates, 2012).

- Review of USGS historical topography dating back to 1947 (Sanger and Wahtoke Quadrangles), historical aerial photographs, FEMA records, and available geologic and geotechnical records.

- Site reconnaissance visit on May 14, 2013 to view ground conditions in and adjacent to the project area.

- Review of archived soil samples from on-site borings drilled by Cleath-Harris Geologists, Inc. in 2010 and 2011 (Appendix A).

- Laboratory testing on selected remolded soil samples from the Cleath-Harris Geologists, Inc. borings to evaluate geotechnical engineering properties of the on-site soils. Testing was specific for the purpose of providing a basis for soil strength parameters for use in evaluating quarry slope stability (Appendix B).

- Engineering evaluation of the collected geotechnical data to develop geotechnical recommendations for the design and construction of the proposed development, including the following items:

  - An evaluation of general subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials.
  - Qualitative discussion regarding applicable specific geologic and geotechnical hazards addressed in CGS Notes 48 and 49, and CGS Special Publication 117A.
  - Consideration of SMARA requirements for project development specific to Sections 35302 (b) (3) and 3704 (d) and (f).
  - Determination of site seismic demand.
  - Stability analyses of proposed temporary and permanent quarry slopes under static and seismic conditions.
  - Preparation of this report, including the provision of reference maps and illustrations, a summary of the collected data, and geotechnical conclusions for the proposed project.

2. LIMITATIONS

The contracted scope of services described and reported herein was based on the information provided by the Client and reviewed from readily available referenced sources and on supplementary laboratory testing specific to slope stability. Additional site specific exploration may be required pending agency review.

3. DESCRIPTIVE GEOTECHNICAL SUMMARY

3.1. Site Description and Proposed Development

Riverbend Sand and Gravel, LLC (RS&G) proposes to mine sand and gravel aggregate from approximately 619 acres of property adjacent to the Kings River. An additional 214 acres of the property is not planned to be mined. General site boundaries include the Kings River to the west and south and Hanke Ditch and Riverbend Avenue to the east. Annadale Avenue is located approximately 1,200 feet to the north of the property. The southerly property boundary extends approximately 2,400 to 3,500 feet south of East Goodfellow Avenue (Figure 1).

In general the project site includes relatively flat ground with a gentle overall south-southwest gradient of about 0.18 percent. Grades range from a high of about 345 feet near the northerly property limit to about 325 feet at the southerly property limit. The adjacent Kings River maintains a similar southerly gradient with estimated corresponding elevations of about 330 feet near the northerly property limit to about 310 feet near the southerly property limit.

With the exception of the low areas located adjacent to the Kings River, site use is dominated by agriculture consisting, in order of decreasing coverage: vineyards, olive orchards and walnut orchards. Significant cultural improvements on the property include a few buildings associated with farming and living residences, East Goodfellow Avenue road and bridge, buried utilities, irrigation ditches, and associated water supply utilities.

RS&G intends to mine aggregate from the 619 acres of the property using surface recovery methods including dredges and draglines. Recovered materials will be processed on site. All mining is proposed to be done in wet condition with no dewatering planned. Overburden soils will be stockpiled on site. Non-marketable products consisting of non-economical wash operations will be disposed of on site in detention/settling ponds. Following the completion of mining, reclamation of the property will include a combination of quarry pits backfilled with overburden and wash material and permanent lakes. Permanent lakes are currently proposed adjacent to the Kings River and just north of East Goodfellow Avenue to maintain the regional groundwater flow direction and gradient. Reclaimed pits will be backfilled to the approximate existing grades for future farming use (Figure 2A). All temporary slopes for product recovery and permanent lake slopes will be excavated at a maximum gradient of 2(H):1(V). Currently the maximum depth of planned mining is 100 feet below the existing grades (Buada Associates, 2013; County of Fresno, 2013). Proposed mining limits include provisions for a minimum setback of 100 feet from the existing Kings River bank and established wetland areas, and East Goodfellow Avenue. FEMA maps indicate that a portion of the planned mining area is located within a currently established 100-yr flood zone (Figure 2B).

3.2. Historical Background

Historical topography and aerial photographs were reviewed to provide a basis for establishing historical site use and changes. The oldest records available included U.S. Geological Survey topographic maps dating back to 1947 (U.S. Geological Survey; 1947, 1950, 1965a, 1965b, 1966, 2012a, 2012b) and aerial photographs dating to 1957. The referenced topographic maps indicate that the project site had established farms in 1947, including the current Hanke Ditch. Additionally, East Goodfellow Avenue and bridge across the Kings River was in place at or very near their current locations. Annadale Avenue and its bridge at the Kings River are first apparent in aerial photographs dated August 15, 1957.

A comparison of river channel location from 1947 to 2012 suggests that only minor lateral channel migrations occurred during the period for the river stretch south of Annadale Avenue. Additionally, from a review of the available historical topography and aerial photographs, no evidence of significant lateral scour affects was noted on the property.

Site grade changes do not appear to be significant since the 1947 topography, however, information provided by RS&G personnel suggest that local grade change on the order of a few to several feet have been made locally to enhance surface drainage and access for farm equipment. RS&G personnel reported that local inundation of a low area within the project site (Figure 2A – near Section AA) has occurred historically during high winter runoff. No depth of water inundation or lateral extent of this reported temporary flooding was available for review.

3.3. Recent Site Characterization Studies

Resource recovery studies were performed for RS&G by Cleath-Harris Geologist, Inc. (Cleath-Harris) in 2010 and 2011. Their work consisted of advancing 14 soils borings to depths of about 100 feet below grade on the property, geologic logging of the recovered soils, laboratory testing of selected materials and reporting of results. Eleven borings were advanced within the property to the south of East Goodfellow Avenue (Cleath-Harris, 2010a, 2010b) and 3 borings were advanced within the property section north of East Goodfellow Avenue (Cleath-Harris, 2011a, 2011b, 2011c). The approximate boring locations are shown on Figure 3. Subsurface cross-sections developed based upon the Cleath-Harris data are also illustrated in Figure 3. For reference, copies of the exploration logs are included in Appendix A of this report.

In general, alluvial materials associated with the Kings River outwash fan (Figure 4) were encountered to the base of each of the borings. Bedrock was not encountered in any of the borings drilled. Alluvium was field logged as consisting primarily of sand, gravelly sand, and lesser amounts of silt-rich sands and silt and clay. Where tested, field classification was confirmed with laboratory testing.

For this study and to develop a basis for selection of geotechnical parameters for the engineering analyses Tt-BASg conducted supplementary laboratory tests on selected samples archived by Cleath-Harris from their 2010 and 2011 borings. Testing included the evaluation of:

- Atterberg Limits;
- Direct Shear on remolded samples;
- Gradation (including hydrometer);
- Maximum Dry Density (estimation).

The recent Tt-BASg testing, along with results of the Cleath-Harris testing, is presented in Appendix B.

Groundwater conditions within the property, as observed during drilling operations by Cleath-Harris are reported on the exploration logs in Appendix A. In general, first reported groundwater was encountered at depths ranging from 13 to 30 feet below the existing ground surface. Static water level measurements by Cleath-Harris prior to backfilling the borings were made in the majority of the 14 borings. Reported static water levels were significantly higher than the first reported levels, in some instances by up to 12.5 feet. Additional groundwater review for the project was performed by Kenneth D. Schmidt and Associates (Schmidt) in 2012 (Kenneth D. Schmidt and Associates, 2012). Schmidt's review included data from local irrigation and municipal wells, as well as data from the recent Cleath-Harris borings. Schmidt determined an overall south-southwesterly regional groundwater gradient across the site with interpreted groundwater elevations ranging from 330 feet at the northerly limit of the property to about 313 feet near the southerly property limit. Schmidt also reported groundwater highs for on-site monitoring wells during 2011 monitoring events of 8 to 11 feet below grade.

4. GEOLOGIC AND GEOTECHNICAL HAZARDS

Categories of potential geologic and geotechnical hazards to the project are itemized below and discussed in the following sections. Where applicable items from CGS Notes 48, 49 and SP 117A are addressed.

- Seismic Hazards – Surface Fault Rupture;
- Seismic Hazards – Ground Shaking;
- Seismic Hazards – Liquefaction and Permanent Ground Displacement;
- Flood Inundation;
- Tsunami and Seiche;
- Slope Stability;
- Ground Subsidence;
- Asbestos.

4.1. Seismic Hazards – Surface Fault Rupture

Official Maps of Earthquake Fault Zones were reviewed to evaluate the location of the project site relative to active fault zones. Earthquake Fault Zones (known as Special Studies Zones prior to 1994) have been established in accordance with the Alquist-Priolo Special Studies Zones Act enacted in 1972 (California Geological Survey, 2007). The Act directs the State Geologist to delineate the regulatory zones that encompass surface traces of active faults that have a potential for future surface fault rupture. The purpose of the Alquist-Priolo Act is to regulate development near active faults in order to mitigate the hazard of surface fault rupture.

The site is not located within a designated Alquist-Priolo Earthquake Fault Zone for fault surface rupture hazard. Further review of the 2010 Fault Activity Map of California (Figure 5; Jennings and Bryant, 2010) indicates that no surface traces of any active or potentially active faults pass directly through or in the vicinity of the site. The potential for surface rupture due to faulting occurring beneath the project site is considered to be minimal.

Risk and Mitigation: No significant risk identified; no mitigation measures are required.

4.2. Seismic Hazards – Ground Shaking

The state of California region is known to be seismically active. Earthquake potential is evaluated based on the known geological framework of active and potentially active faults. Active faults are defined as those that have experienced surface displacement within Holocene time (approximately the last 11,000 years). Potentially active faults are those that have experienced displacement within Quaternary time (approximately the last 1.8 million years).

Based on a review of available fault source information nearby active and potentially active faults to the site include:

Active faults:

- Great Valley Fault (Segments 13, 14), approximately 82 km west, southwest of site;
- Kern Canyon Fault, approximately 100 km east, southeast of site;
- Poso Creek Fault complex (closest active splay), approximately 112 km south of site;
- Independence Fault, approximately 113 km east of site;
- Owens Valley Fault Zone, approximately 120 km east of site.
- San Andreas Fault, approximately 120 km southwest of site.

Potentially active fault:

- Poso Creek Fault complex, approximately 88 km south of site;

Probabilistic analysis for the site, based on U.S. Geological Survey 2008 deaggregation methodology (https://geohazards.usgs.gov/deaggint/2008), computed a peak ground acceleration of 0.138 g and modal earthquake of magnitude Mw7.99 at a distance of 121 kilometers assuming:

- Location : N36.667, W 119.500;
- Exceedance probability of 10% in 50 years (475-yr return period);
- Vs_{30} = 350 m/s (Soil Type D; Bozorgonia and Bertero, 2004 [p. 4-12]);

Risk and Mitigation: No significant risk identified; no mitigation measures are required.

4.3. Liquefaction Potential

Maps of seismic hazard zones are issued by the California Geological Survey (formerly California Department of Conservation, Division of Mines and Geology) in accordance with the Seismic Hazards Mapping Act enacted in April 1997. The intent of the Seismic Hazards Mapping Act is to provide for a statewide seismic hazard mapping and technical advisory program to assist cities and counties in developing compliance requirements to protect the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes. However, the state of California mapping program has not included this portion of the central valley therefore a rational analysis of liquefaction potential was performed.

Liquefaction of soils can be caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils and low plastic silts are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays is not adversely affected by ground shaking. Liquefaction is generally known to occur in saturated or near-saturated cohesionless soils at depths shallower than about 50 feet.

The available geotechnical data for the site indicates that the percentage of fines (passing the #200 sieve) for the for the granular deposits within the planned depth of mining range from less than 5 percent to about 30 percent (clay and silt lens materials are greater than 50 percent). Whereas these materials may be generally considered potentially liquefiable, due to the relatively low seismic demand and the likely increase in density with increasing depth, the potential for liquefaction and its detrimental effects on the site performance is considered relatively minor.

Risk and Mitigation: Potentially limited risk identified.

4.4. Permanent Seismically-Induced Ground Displacement

Proposed slopes are anticipated to experience some lateral deformation as a consequence of a design earthquake event with 475-year return period. Estimated lateral deformations significantly less than 12 inches are anticipated. Limited seismically-induced settlement due to densification of loose near-surface materials or due to liquefaction may take place

Risk and Mitigation: No significant risk of lateral seismically-induced ground displacement identified. Limited risk of seismically-induced settlement may exist but it is not a concern because no structures that could be impacted are proposed within the reclaimed areas.

4.5. Flood Inundation

The closest significant dam to the site, the Pine Flat Dam, is located approximately 14 miles to the northeast. The dam constructed in 1956 for flood control and water storage purposes controls upstream flow of the Kings River. Jurisdiction of the structure is with the California State Division of Dam Safety.

Other, more local confined bodies of water include mining related ponds created as a result of reclamation or still in productive service as silt detention basins. These bodies of water are located adjacent to the Kings River. As the water elevations in the ponds/lakes are essentially at river level, no significant threat to the site from a breach in the bank and subsequent discharge into the river is anticipated.

The Flood Insurance Rate Map Nos. 06019C2160H and 06019C2170H, prepared by the Federal Emergency Management Agency (FEMA, 2009), indicate that the westerly portion of the site adjacent to the Kings River is located within Zones X, AE and AO. Zone X signifies that the site is within an area that has a 0.2 percent annual chance of flooding, a 1 percent annual chance of flooding with depths of less than 1 foot or with drainage areas less than 1 square mile, or an area that is protected by levees from a 1 percent annual chance flood. Zones AE and AO signify flood areas where 1 to 3 feet of inundation may occur (100-yr flood). Figure 2B illustrates the areas associated with Zones AE and AO.

Discussion with RS&G personnel indicate that historic flooding has occurred within a portion of the site associated with the FEMA zones. No indications of ground loss or significant erosion were reported or evidenced from field review during this study identified.

Risk and Mitigation: Potentially limited risk identified.

4.6. Tsunami and Seiche

Tsunami and seiche affects are not anticipated to be of significance to the project.

Risk and Mitigation: No significant risk identified; no mitigation measures are required.

4.7. Slope Stability and Landsliding

Slope stability is discussed in detail in subsequent Section 5. The site and surrounding adjacent properties are essentially flat. Mining stockpiles are not within a zone of engineering significance of the project. Additionally, slopes associated with the quarry activities are proposed to be set back over 100 feet from the Kings River bank. Based on the historic data, potential scour affects and lateral migration of the river into areas of active mining or reclamation areas (ponds or backfilled excavations) is generally considered low.

Risk and Mitigation: No significant risk identified; no mitigation measures are required.

4.8. Ground Subsidence

Groundwater dewatering is not anticipated for the project. As such, no significant ground subsidence from mining operations is anticipated. Future backfilling of selected cells with mining waste materials may result in local ground subsidence within backfilled cells depending on the backfilling methods and materials.

Risk and Mitigation: No significant risk identified outside the quarry pits; no mitigation measures are required. Subsidence within the backfilled cells is possible depending on the backfilling methods and material but it is not a concern because there are no development plans that would require structural fill support.

4.9. Naturally Occurring Asbestos

Tt-BASg reviewed the publication "A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos" (California Division of Mines and Geology, 2000). The site is not located in a region of California noted for rock types containing naturally occurring asbestos.

Risk and Mitigation: No significant risk identified; no mitigation measures are required.

5. QUARRY SLOPE STABILITY ANALYSIS

5.1. On-Site Materials

Geologic characterization of alluvial soils for this study was based upon the qualitative exploratory logs and on evaluation of mining-reserve laboratory data reported by Cleath-Harris and the recent supplemental geotechnical laboratory testing conducted by Tt-BASg. A summary of on-site material types/geologic units pertinent to the proposed mining operations is presented in Table 1 below:

Table 1
Site Material Distribution and General Characteristics

Geologic Unit (Alluvium)[1]	USCS Major Constituents[2]	Depth Range Encountered[3] (ft)	Groundwater Depth[4] (ft)	Physical Properties[5]
Overburden	SM, ML	0-30, Mean Depth=19 Mean Thick.=19	9-20	Very fine to fine grained; loose/soft Generally dry
Upper Unit	SP, SW, SC, GW	11-64 Mean Depth=13-51 Mean Thick.=38	submerged	Fine to coarse sand fraction, fine to coarse gravel fraction, (mean fines content <10%); gravels generally only slightly weathered (very hard), sub rounded to rounded, unknown cobble content Below water
[6]Transition Unit	SC	33-54 Mean Depth=36-50 Mean Thick.=14	submerged	Fine to coarse sand fraction, fine to coarse gravel fraction, (mean fines content <15%); gravels generally only slightly to moderately weathered (hard to very hard), sub rounded to rounded, unknown cobble content Below water

Geologic Unit (Alluvium)[1]	USCS Major Constituents[2]	Depth Range Encountered[3] (ft)	Groundwater Depth[4] (ft)	Physical Properties[5]
Middle Unit	SC, SW, GW, GC, CL	48-78 Mean Depth=54-73 Mean Thick.=19	submerged	Fine to coarse sand fraction, fine to coarse gravel fraction, (mean fines content 10-20%); gravels generally moderately weathered (hard), sub rounded to rounded, unknown cobble content Below water
Lower Unit	SC, SW, SP, CL, CH	Below 66-72 Likely >100 feet thick	submerged	Fine to coarse sand fraction, fine to coarse gravel fraction, (mean fines content 15-28%); gravels generally moderately to highly weathered (weakly resistant to hammer blows), sub rounded to rounded, unknown cobble content Below water
Clay Zones	CL, CH	various	submerged	Field logged by Cleath-Harris as lean to fat clays; thicknesses recorded ranged from a few inches to 19 feet (SJ-10-10). No shearing or evidence of internal deformation noted. Majority of occurrences recorded in Middle and Lower units.

Notes: [1] Cleath-Harris layer/interval designation (unit designation in this report).
[2] Visual classification unless confirmed by laboratory testing.
[3,4] Depth in feet below existing grade.
[5] Laboratory test results summarized in Appendix B.
[6] Cleath-Harris borings RL-11-01 through RL-11-03.

Significant clay zone thicknesses were reported by Cleath-Harris in several borings drilled within the southerly part of the property; namely at depths between 50 and 70 feet. The presence of reported clay zones appears, in general, to be more limited within the northerly portion of the site (Appendix A; Borings RL-11-01 through RL-11-03). Based on the Cleath-Harris data, the lateral continuity of the clay zones over large distances also appears to be limited. Furthermore, based on the Cleath-Harris borings, the reported presence of clay zones is concentrated within the middle and lower alluvial units which are located at depths of 50+ feet below existing grades. Only relatively thin clay zones were encountered within the upper 50 feet (Overburden, Upper- and Transitional-Units) and no continuity between borings was reported. The apparent lack of continuity of clay zones between borings is interpreted to be a product of the original depositional environment. Contribution of sediment from the Kings River within a braided environment generally precludes the deposition of laterally continuous fine-grained materials (e.g., clay) over large areas. Re-entrenchment of active fan channels across the outwash plain result in dissection of previous deposits.

5.2. Shear Strength Parameters

Shear strength parameters for the slope stability analysis were selected based on the results of laboratory direct shear tests on selected soil samples and based on published correlations with soil index parameters (e.g., particle size distribution and Coefficient of Uniformity, C_u, and Atterberg Limits/clay fractions).

Direct shear tests were performed on selected soil samples from two of the granular units:

- Overburden Unit – RL-11-01, depth of 9.5-12 feet;
- Middle Unit – RL-11-02, depth of 67-69.5 feet;

and from two selected fine-grained layers

- Middle Unit – SJ-10-10, depth of 55-60 feet.
- Lower Unit RL-11-01, depth of 80-82 feet;

Due to the restrictions on the maximum particle size, shear testing on granular units was performed only on material passing the #4 sieve. This removal of gravel and cobble sizes from the soil matrix is expected to result in a significant decrease of shear strength due to the increase in uniformity of the material grain sizes. As such, this test is intended to establish a lower-bound estimate of shear strength.

Tests were performed on inundated samples remolded to 85 percent of the Maximum Dry Density (ASTM D1557) for the Overburden Unit, and to 90 percent of the estimated (based on a single-point test) Maximum Dry Density for other materials. The target relative compaction values for remolding were considered a lower-bound condition for the in-situ samples. Laboratory test results are graphically presented in Appendix B. Results of Cleath-Harris' laboratory testing program are also included in Appendix B.

Furthermore, for granular units, correlations published by Duncan (2004) were utilized to estimate the friction angle based on the grain size distribution and the associated Coefficient of Uniformity. This correlation method also includes an estimate of the standard deviation of the resulting friction angle. As a point of reference, slope stability analyses of quarry slopes for the nearby proposed Carmelita Quarry site (Golder, 2010; Benchmark Resources, 2010) employed for granular materials a friction angle of 38 degrees and a corresponding cohesion of 0 psf.

For fine-grained soil correlations published by Stark & Choi (2005) based on the clay fraction and Liquid Limit was used for estimation of the friction angle for fully softened material.

The interpreted results of the laboratory tests and correlations effort as well as the selected shear strength parameters for subsequent geotechnical analyses are summarized in Table 2 and Appendix C.

Table 2
Shear Strength Parameters used in Slope Stability Analyses

Geologic Unit	Tt-BASg Laboratory Testing	Correlations	Additional Reference	Selected Design Parameters
Granular units Overburden, and Upper, Transition, Middle, and Lower Units Unconsolidated/normally consolidated alluvium.	$\phi = 31^o$ -32^o c = 50 - 100 psf	$\phi = 38^o$-49^o (Duncan, 2004)	$\phi = 38^o$ c = 0 psf (Golder, 2010)	$\phi = 38^o$ c = 0 psf γ = 120 pcf
Fine-grained Zones Assumed to be normally consolidated alluvium. No pre-shearing related to pre-historic landsliding	$\phi = 31^o$ c = 100 psf	$\phi = 27^o$ -31^o (Stark & Choi, 2005)		$\phi = 29^o$ c = 100 psf γ = 120 pcf

5.3. Groundwater Conditions

Based on the depth to groundwater range encountered in Cleath-Harris' borings of 13 to 30 feet, a conservative depth to groundwater of 15 feet was used in the stability analyses.

5.4. Seismic Conditions

The site seismic demand for a design event with a 10 percent probability of exceedance in 50 years, i.e., 475-yr return period, was described in Section 4.2 Seismic Hazards – Ground Shaking. For the computed peak ground acceleration of 0.138g and modal earthquake of magnitude Mw7.99 at a distance of 121 kilometers, the screening earthquake coefficient for permanent seismic deformations of 12 inches per Bray and Travasarou (2009) is $k_{eq} = 0.034$.

5.5. Slope Stability Analyses

Slope stability analyses were performed consistent with the Recommended Procedures for Implementation of DMG Special Publication 117A Guidelines For Evaluating and Mitigating Seismic Hazards in California (CGS, 2008) (SP 117A), which are considered the standard of practice and conceptually state-of-the-art for slope stability analyses in California. Both static and pseudo-static stability analyses to determine the yield acceleration were evaluated using the computer program SLOPE/W (Geo-Slope Office, 2012) using Spencer's limit equilibrium method.

To estimate seismically-induced permanent displacements during a seismic event, the method developed by Bray and Travasarou (2007) was used. This method is a simplified Newmark (1965) method which is based on determination of displacements of a rigid block resting on an inclined sliding plane subjected to earthquake-type accelerations. The premise is that the block will undergo displacement only during periods when the ground acceleration (k_{max} = PGA = MHA) exceeds the yield acceleration (k_y) for the sliding block. The yield acceleration k_y is that which causes incipient failure (i.e. FS = 1) in a pseudo-static slope stability analysis. Thus, no displacements are anticipated when k_y is greater than k_{max}. Bray and Travasarou (2007) refined the procedure to incorporate the dynamic response of the on-site materials and the intensity, frequency content, and duration of ground motions to yield results that are consistent with the observed performance of slopes during recent earthquakes.

In order to evaluate the performance of the slope under the design seismic event, first a screening analysis is performed. The screening analysis consists of pseudo-static analysis utilizing an earthquake coefficient based on seismic response of the site and on the acceptable magnitude of seismically induced slope movements. The acceptable magnitude of permanent seismically induced slope movement is conventionally selected as 12 inches. For the associated earthquake coefficient of $k_{eq} = 0.034$, if the pseudo-static Factor of Safety is greater than 1, the slope passes the screening analysis and is considered seismically stable. If the Factor of Safety is less than 1, then a quantification of deformations is required.

Slope stability analyses were performed for a proposed typical quarry slope cross-section assuming a 100 feet high slope. Temporary mining cut slopes and final slopes are proposed to be inclined at 2(H):1(V). No fill slopes are proposed for this project. Based upon the available data, clay layers are present at depth across the property and in adjacent offsite areas (Gronberg et al., 1998; Kenneth D. Schmidt and Associates, 2012). Therefore, several configurations were included within the analyses to evaluate the impact of clay layers at depths of 30, 60, and 90 feet below the top of slope on the stability of the proposed quarry slopes.

The results of all critical slope stability analyses are summarized in the Table 3 below, static and pseudostatic conditions, respectively. The graphical outputs of the slope stability analyses are presented in Appendix C.

Table 3
Stability Analyses for Planned Temporary and Permanent Quarry Slopes[1]

Factor of Safety Static / Screening Pseudostatic $k_{eq} = 0.034$	**Analysis Description**	Appendix page
1.555 / 1.332	Overall stability of the 100-foot-high slope without clay layers.	C-1a/1b
1.546 / 1.378	Overall stability of the 100-foot-high slope with clay layer[1] at 30 feet below grade.	C-2a/2b
1.580 / 1.371	Overall stability of the 100-foot-high slope with clay layer[1] at 60 feet below grade.	C-3a/3b
1.583 / 1.360	Overall stability of the 100-foot-high slope with clay layer[1] at 90 feet below grade.	C-4a/4b

Note: [1] For analysis purposes clay layers were assumed to be horizontal.

5.6. Slope Stability Acceptance Criteria

For the static analyses a minimum Factor of Safety of 1.3 is recommended for temporary and permanent quarry slopes (i.e., lakes).

For the screening pseudostatic analyses and considering the horizontal seismic coefficient of $k_{eq} = 0.034$, the resulting Factor of Safety is required to be greater than 1, in order for the slope to pass the screening and be considered seismically stable with permanent seismically induced slope movement of less than 12 inches

5.7. Slope Stability Conclusions

The results of the stability analyses indicate that, under the assumed site conditions, proposed 100 feet high quarry slopes excavated at a maximum gradient of 2(H):1(V) will be stable for static and pseudostatic conditions.

6. CLOSURE

This report has not been prepared for use by parties or projects other than those named or described above. It may not contain sufficient information for other parties or other purposes. It has been prepared in accordance with generally accepted geotechnical practices and makes no other warranties either express or implied, as to the professional advice or data included in it. This opportunity to be of continued service is sincerely appreciated. Please contact the undersigned at (909) 860-5096 if you have any questions or if further information is required.

Respectfully submitted,
Tetra Tech BAS GeoScience

David M. Luka, C.E.G.
Senior Geologist

Yonglang Li, Ph.D., P.E.
Project Engineer

Peter Skopek, Ph.D., G.E.
Principal Engineer

Attachments:

- Figure 1 – Project Location Map
- Figure 2 – Proposed Reclamation Plan, Regional Mining Sector, 100-yr Flood Map
- Figure 3 – Subsurface Exploration Location Plan and Geologic Cross Sections
- Figure 4 – Regional Geologic Map
- Figure 5 – Regional Fault Map

- Appendix A – Subsurface Exploration Logs, Cleath-Harris Geologists (A-1 through A-31)
- Appendix B – Laboratory Testing (B-1 through B-40)
- Appendix C – Slope Stability Analyses (C-1 through C-12)
- Appendix D – Deaggregation Analysis (D-1 through D-12)

Distribution: Addressee (pdf via e-mail jcbuada@buada.com)

Filename: RS&G Geotechnical Slope Stability Review RPT 2013-08-13 FINAL rev.1.doc

REFERENCES

Buada Associates, 2013, Operational Statement – Riverbend Sand and Gravel Project, Fresno County, California: consultant report prepared for Riverbend Sand and Gravel, LLC, submitted to Fresno County Department of Public Works and Planning, 25 p., attachment (dated January, 2013).

Benchmark Resources, 2010, Carmelita Project – Geology and Soils Environmental Assessment: consultant report prepared for Carmelita Resources, LLC (Operator), 21 p., attachments.

Bozorgonia, Y. and Bertero, V.V. (eds.), Earthquake Engineering from Engineering Seismology to Performance-Based Engineering: CRC Press.

Bray, J.D. and Travasarou, T., 2007, Simplified Procedure for Estimating Earthquake-Induced Deviatoric Slope Displacements: ASCE GTJ Vol. 133, No. 4, pp. 381-392.

_____, 2009, Pseudostatic Coefficient for Use in Simplified Seismic Slope Stability Evaluation: Technical Note *in* Journal of Geotechnical and Geoenvironmental Engineering, Vol. 135, No. 9.

Calaveras Materials, Inc., 2007, Kings River Sand and Gravel Surface Mining and Reclamation Plan – Fresno County, California Unclassified Conditional Use Permit Application 3052, Revised February 12, 2007.

California Department of Conservation, 1975, Surface Mining and Reclamation Act and Associated Regulations (Updated January 2012): Office of Mine Reclamation, *Surface Mining and Reclamation Act (SMARA) Regulations - California Code of Regulations, Title 14, Division 2, Chapter 8, Subchapter 1, Sections 3502 and 3704*.

California Department of Conservation, 2000, A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos: Division of Mines and Geology, Open-File Report 2000-19, 7 p., Map scale: 1:1,100,000.

California Geological Survey, 2002, Guidelines for Evaluating the Hazard of Surface Fault Rupture, California Geological Survey Note 49, 4 p.

_____, 2007, Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake fault Zones Maps: California Department of Conservation, California Geological Survey, Special Publication 42, Interim Revision 2007, 42 p.

_____, 2008, Guidelines for Evaluating and Mitigating Seismic Hazards in California: Special Publication 117A, 102 p.

_____, 2011, Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings, California Geological Survey Note 48, 2 p.

Cleath-Harris Geologists, Inc., 2010a, Boring Logs for Exploration Drilling for the Samantha Jean Project at the Running Luck Ranch, Fresno County, California: consultant report prepared for Running Luck Ranch, 4 p., Attachment A (dated October 21, 2010).

_____, 2010b, Boring Logs for Exploration Drilling for the Samantha Jean Project at the Running Luck Ranch, Fresno County, California: consultant report prepared for Running Luck Ranch, 4 p., Attachment A (dated October 21, 2010).

_____, 2011a, Potential Reserves and Rock Quality for Proposed Samantha Jean Gravel Quarry: consultant report prepared for Running Luck Ranch, 14 p., Appendix 1 (dated January 18, 2011).

_____, 2011b, Boring Logs for Exploration Drilling for the Riverbend Sand and Gravel Project at the Running Luck Ranch, Fresno County, California: consultant report prepared for Running Luck Ranch, 4 p., Attachment A (dated July 1, 2011).

_____, 2011c, Potential Reserves and Rock Quality for Proposed Riverbend Gravel Quarry: consultant report prepared for Running Luck Ranch, 13 p., Appendix 1 (dated August 7, 2011).

County of Fresno, 2013, Request for Proposal for Environmental Consulting Services to Prepare an Environmental Impact Report for Riverbend Sand & Gravel Project, Unincorporated Fresno County, California: Department of Public Works and Planning, development Services Division, 12 p., attachments (Issuance date January 28, 2103).

Duncan, J.M., 2004, Friction Angles for Sand, Gravel and Rockfill: Lecture Notes Presented at the Kenneth L. Lee Memorial Seminar, Long Beach, California, April 28, 2004.

FEMA, 2009, Flood Insurance Rate Map, Fresno County, California and Unincorporated Areas, Panel 2160 of 3525 (Map No. 06019C2160H) and 2170 of 3525 (Map No. 06019C2170H), scale: 1"=1000', Maps Revised February 18, 2009.

Golder Associates, 2010, Reclamation Slope Stability Evaluation, Proposed Carmelita Project: consultant report prepared for Law Office of Michael P. Mallery, 12 p., attachments (Project No. 093-97527; dated January 11, 2010).

Gronberg, J.M., Dubrovsky, N.M., Kratzer, C.R., Domagalski, J.L., Brown, L.R. and Burrow, K.R., 1998, Environmental Setting of the San Joaquin-Tulare Basins, California: U.S. Geological Survey Water Resources Investigations Report 97-4205, National Water-Quality Assessment Program, 45 p.

Kenneth D. Schmidt and Associates, 2012, Groundwater Conditions at the Riverbend Sand and Gravel Project: consultant report prepared for Buada Associates, 35 p., attachments (dated October 29, 2012).

Jennings, C.W. and Bryant, W.A., 2010, Fault Activity Map of California: California Geological Survey Geologic Data Map No. 6, scale: 1:750,000.

Matthews, R.A and Burnett, J.L., 1965, Geologic Map of California: Fresno Sheet: California Division of Mines and Geology, Unseriesed, scale: 1:250,000.

Newmark, N.M., 1965, Effects of Earthquakes on Dams and Embankments: Geotechnique, Vol. 15, No 2, pp. 139-160.

Southern California Earthquake Center (SCEC), 1999, University of Southern California, Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California, dated March.

Stark, T.D., Choi, H. and McCone, S., 2005, Drained Shear Strength Parameters for Analysis of Landslides: ASCE JGGE, May 2005

U.S. Geological Survey, 1947, Sanger Quadrangle, 7-1/2 Minute Series Topographic Map, scale 1:24,000, Edition of 1947 (1916 and 1921 mapping).

_____, 1950, Wahtoke Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, Edition of 1950 (1921 plane table mapping and 1946 aerial photography).

_____, 1965a, Sanger Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, 1965 (1962 aerial photography and 1965 plane table).

_____, 1965b, Sanger Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, 1965, Photorevised 1981 (1962 aerial photography and 1965 plane table).

_____, 1966, Wahtoke Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, 1966 (1963 aerial photography).

_____, 2012a, Sanger Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, 2012 (2010 imagery).

_____, 2012b, Wahtoke Quadrangle, 7.5 Minute Series Topographic Map, scale 1:24,000, 2012 (2010 imagery).

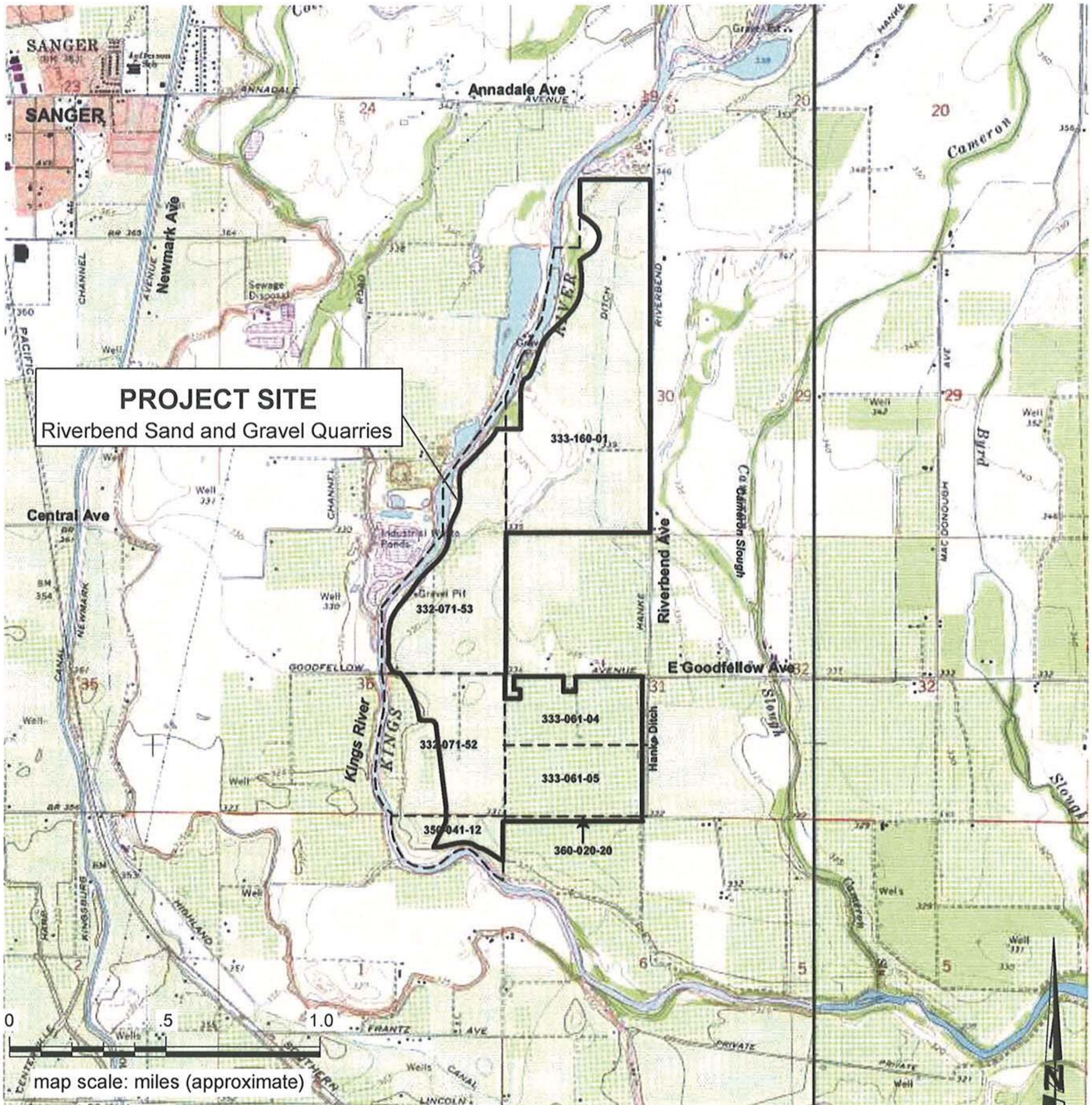
Vardanega, P.J. and Bolton, M.D., 2011, Strength Mobilization of Clays and Silts: Canadian Geotechnical Journal, 48:1485-1503.

AERIAL PHOTOGRAPHS

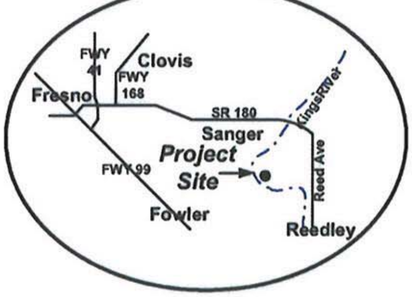
Photograph Date	Flight/Frame	Scale	Source
1957-08-15	ABI-1957 54T-92, 54T-94	1:20,000	UCSB
1965-06-25	CAS-FRE 1-15, 1-17	1:20,000	UCSB
1970-06-17	CAS-2866 9-110, 9-112	1:20,000	UCSB
1988-07-16	*NAPP 492-42	1:40,000	UCSB
1998-09-11	UKN	NA	Google Earth
2004-08-14	**UKN	NA	Google Earth
2005-12-30	**UKN	NA	Google Earth
2006-07-30	**UKN	NA	Google Earth
2006-09-20	**UKN	NA	Google Earth
2009-06-05	**UKN	NA	Google Earth
2011-04-25	**UKN	NA	Google Earth
2012-08-26	**UKN	NA	Google Earth

*color infrared. ** color. All other images black and white.

FIGURES



Source: USGS 7.5" Quad - Sanger



Regional Location

Legend:

- - - - - Parcel Lines
——— Project Boundary
350-041-12 Assessors Parcel No.

Reference Source: Exhibit A - *Buada Associates, 2013, Operational Statement, Riverbend Sand and Gravel Project:* consultant report prepared for Riverbend Sand and Gravel, LLC, 25 p., attachement.

Project Location Map

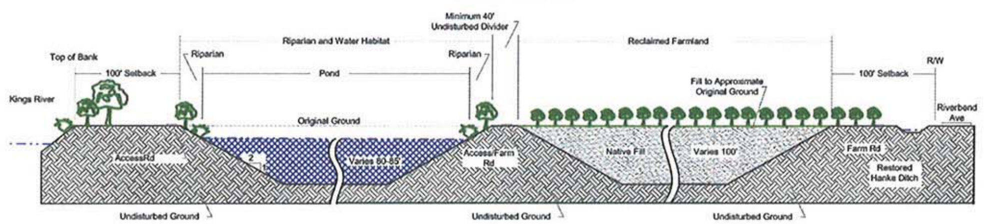
TETRA TECH BAS GEOSCIENCE

1360 Valley Vista Drive
Diamond Bar, CA 91765
Phone (949) 860-5096

Project Name: Riverbend Sand and Gravel Quarries, Fresno County, CA		
Project No.: RSG 13-01E	Date: July 2013	Figure No. 1

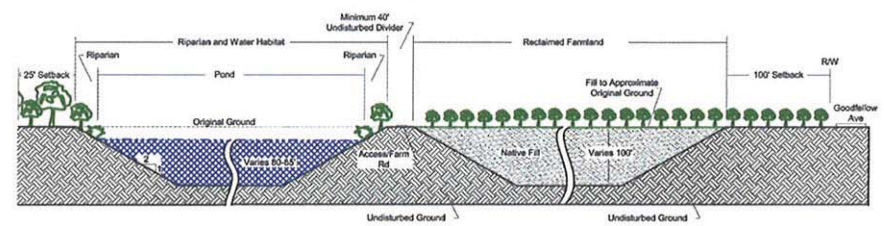
Typical Reclamation Cross-Sections
NTS

Cross-Section A-A



Typical Reclamation Cross-Sections
NTS

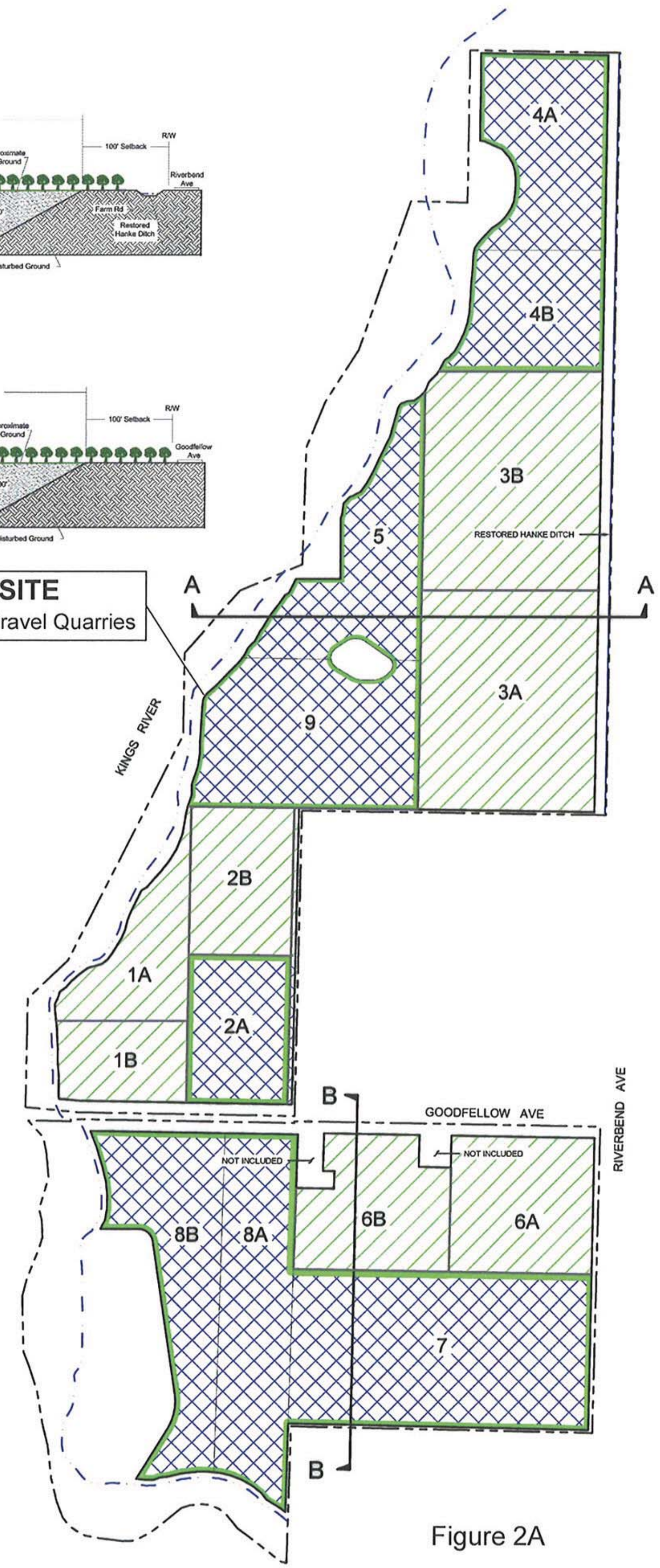
SECTION B-B

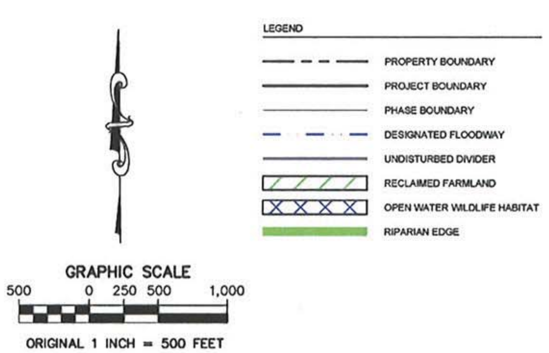


Reclamation End Uses and Estimated Schedule[1]

Phase	Acres[2, 3] Pre-Mining	Farmland	Open Water	Riparian	Complete Reclamation
1A	23	23			2028
1B	18	18			2032
2A	27		23	4	2026
2B[4]	27	27			2043/2090
3A	67	67			2054
3B	68	68			2090
4A	38		34	4	2050
4B	29		26	3	2053
5	37		33	4	2090
6A	34	34			2069
6B	31	31			2083
7	80		73	7	2072
8A	44		40	3	2077
8B	44		39	5	2083
9	52		49	4	2090
Totals	**619**	**268**	**318**	**33**	

[1] Dates are estimates only. Actual excavation and reclamation dates will vary with permit approval date, market demand and actual depth and volume of
[2] Gross acres, includes farm roads
[3] Actual final reclamation and areal extent of each end use will depend on the volume and availability of overburden and process fines suitable for use as fill
[4] To be used for portable plant during mining of plant site (Phase 9)





GENERAL NOTES:

1. CONFIGURATION AND AREAL EXTENT OF RECLAIMED AREAS ARE REPRESENTATIONAL AND WILL VARY ACCORDING TO ACTUAL DEPTH OF AGGREGATE MATERIALS, VOLUME OF OVERBURDEN AND PROCESS FINES SUITABLE FOR FILL AND OTHER CONDITIONS FOUND AT THE TIME OF MINING.

Figure 2A

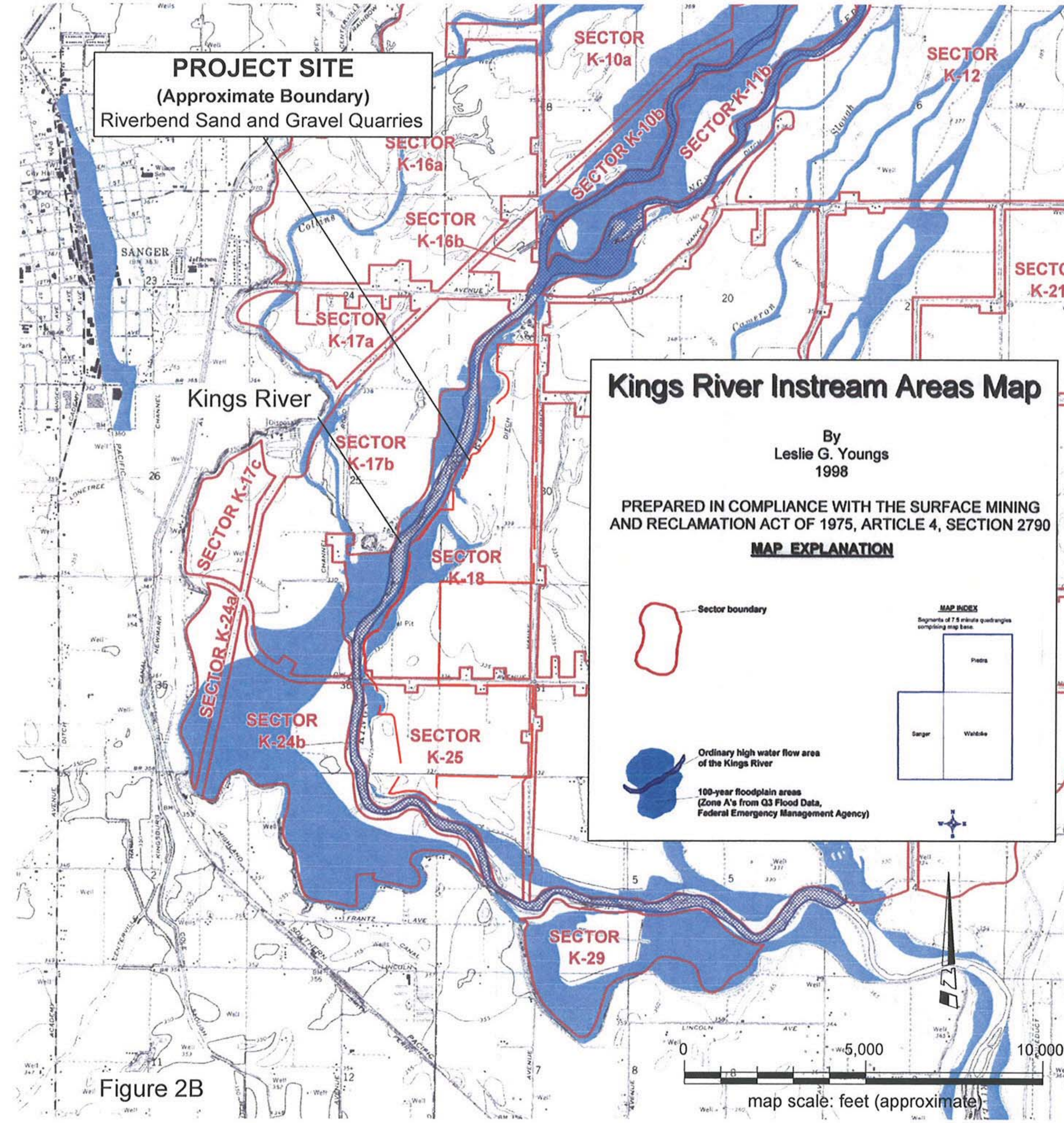


Figure 2B

Figure 2A Reference: Excerpt of Exhibit F - Reclamation Plan from *Buada Associates, 2013, Operational Statement, Riverbend Sand and Gravel Project:* consultant report prepared for Riverbend Sand and Gravel, LLC, 25 p, attachment.

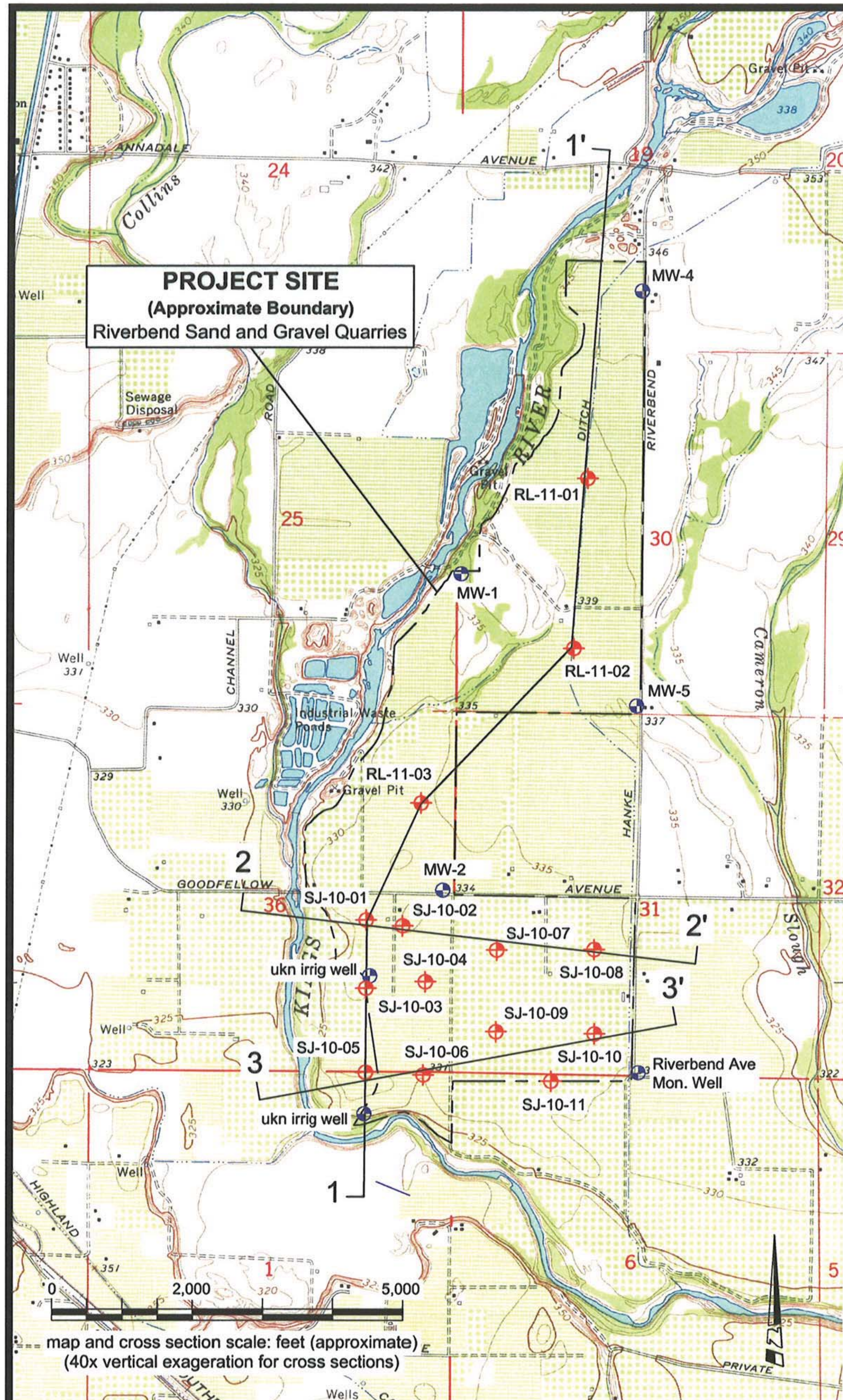
Figure 2B Reference: Excerpt of Youngs, L. G., 1998, Kings River Instream Areas Map: California Division of Mines and Geology, Open File Report 99-02, Plate 9 of 9, map scale: 1:24,000.

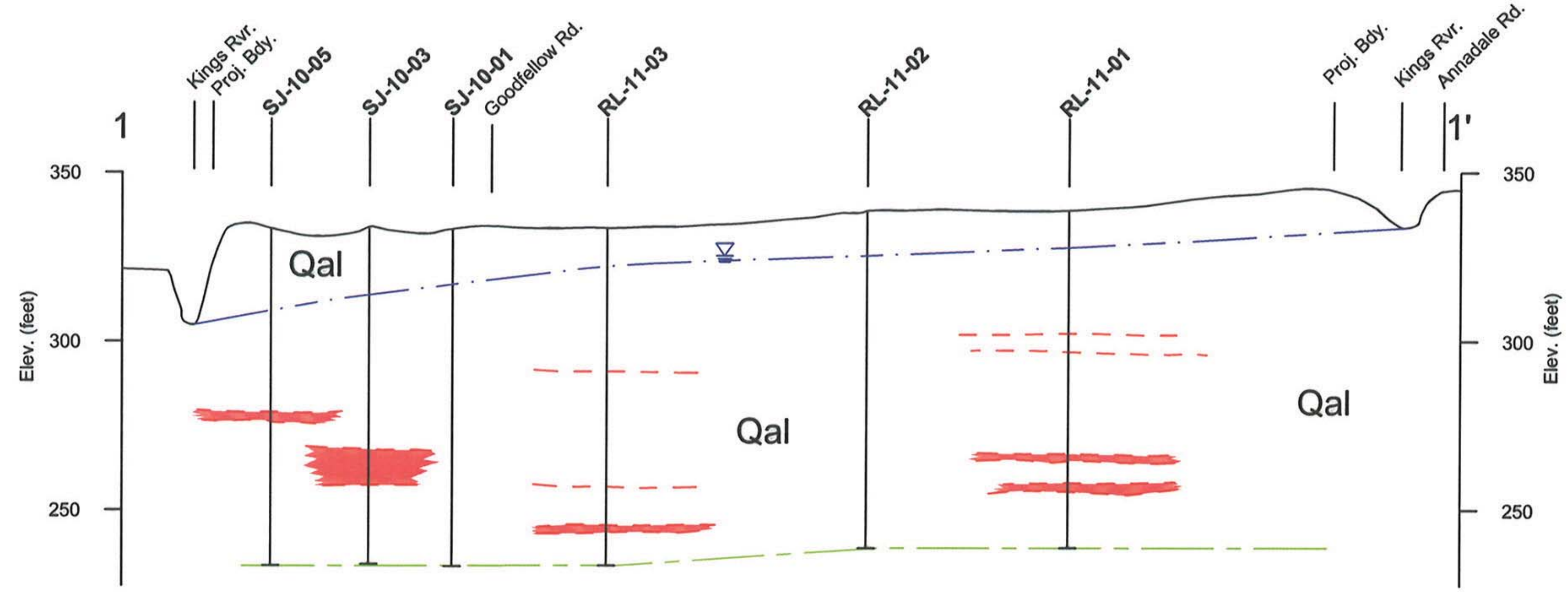
Proposed Reclamation Plan, and Regional Mining Sector and 100-yr Flood Map

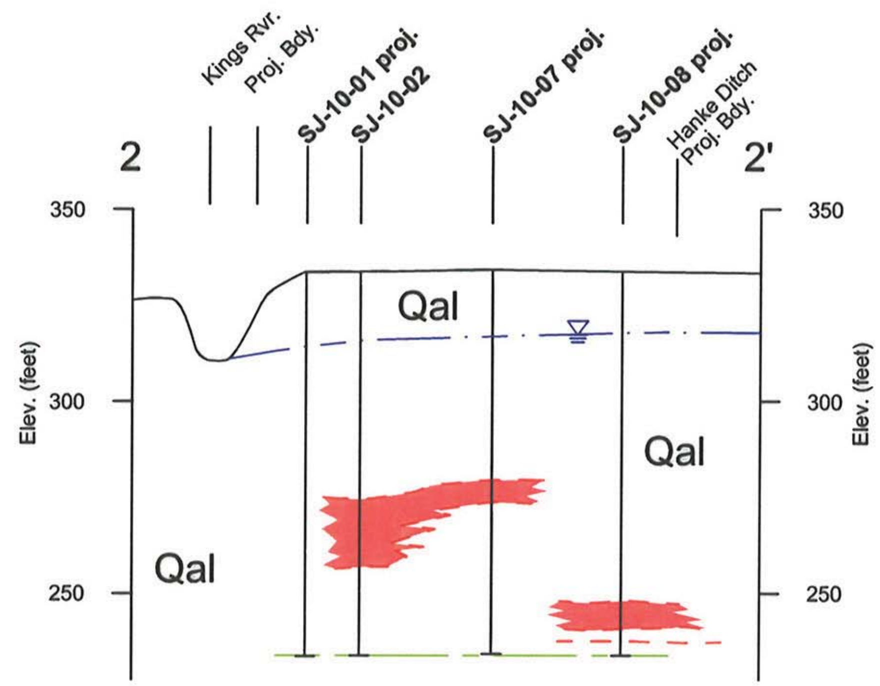
TETRA TECH BAS
GEOSCIENCE
1360 Valley Vista Drive
Diamond Bar, CA 91765
Phone (949) 860-5096

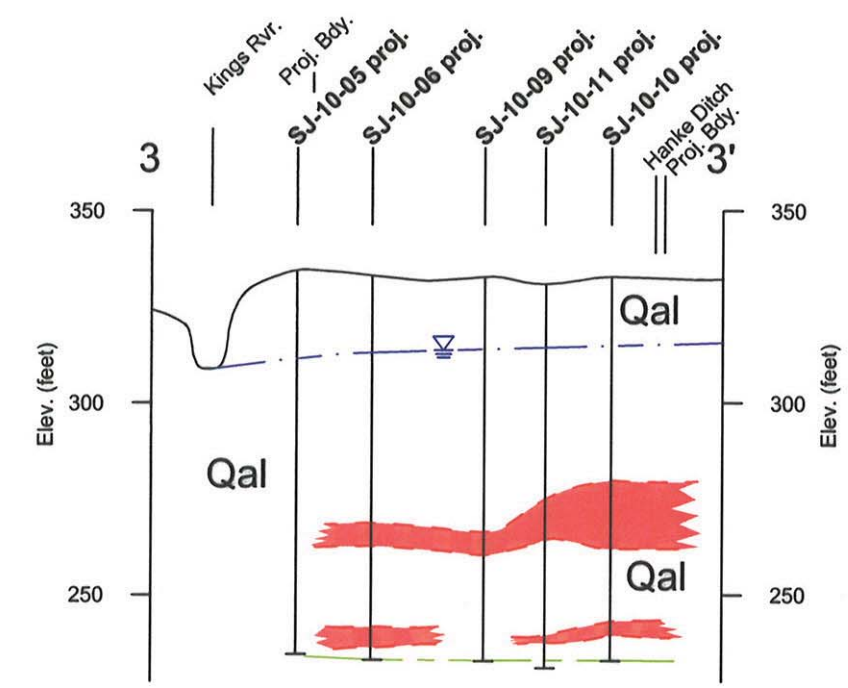
Project Name:	Riverbend Sand and Gravel Quarries, Fresno County, CA		
Project No.: RSG 13-01E	Date: July 2013	Figure No. 2	

FILE: RSG 13-01E FIGURE 2 Riverbend Sand and Gravel Quarries_PLOT DATE 2013/06/27









Legend

- Qal — Holocene - Alluvium (fan deposits)
- SJ-10-10 — Cleath-Harris Geologists, Inc. 2010 sonic boring
- RL-11-01 — Cleath-Harris Geologists, Inc. 2011 percussion hammer boring
- MW-2, irrig well — Well (Monitoring - MW, Riverbend Ave Mon. Well; Irrigation Well - ukn irrig well)
- 2 2' — Cross Section Line
- Groundwater (static water level - Cleath-Harris Geologist, Inc.)
- Clay lens (Cleath-Harris Geologists, Inc.)
- Clay layer (Cleath-Harris Geologists, Inc.)
- Approximate Maximum Depth of Planned Mining

Map Reference: U.S. Geological Survey, Sanger Quadrangle, 7-1/2 Minute Series Topographic Map, scale: 1:24,000, 1965 (1962 aerial photgoraphy and 1965 plane table).

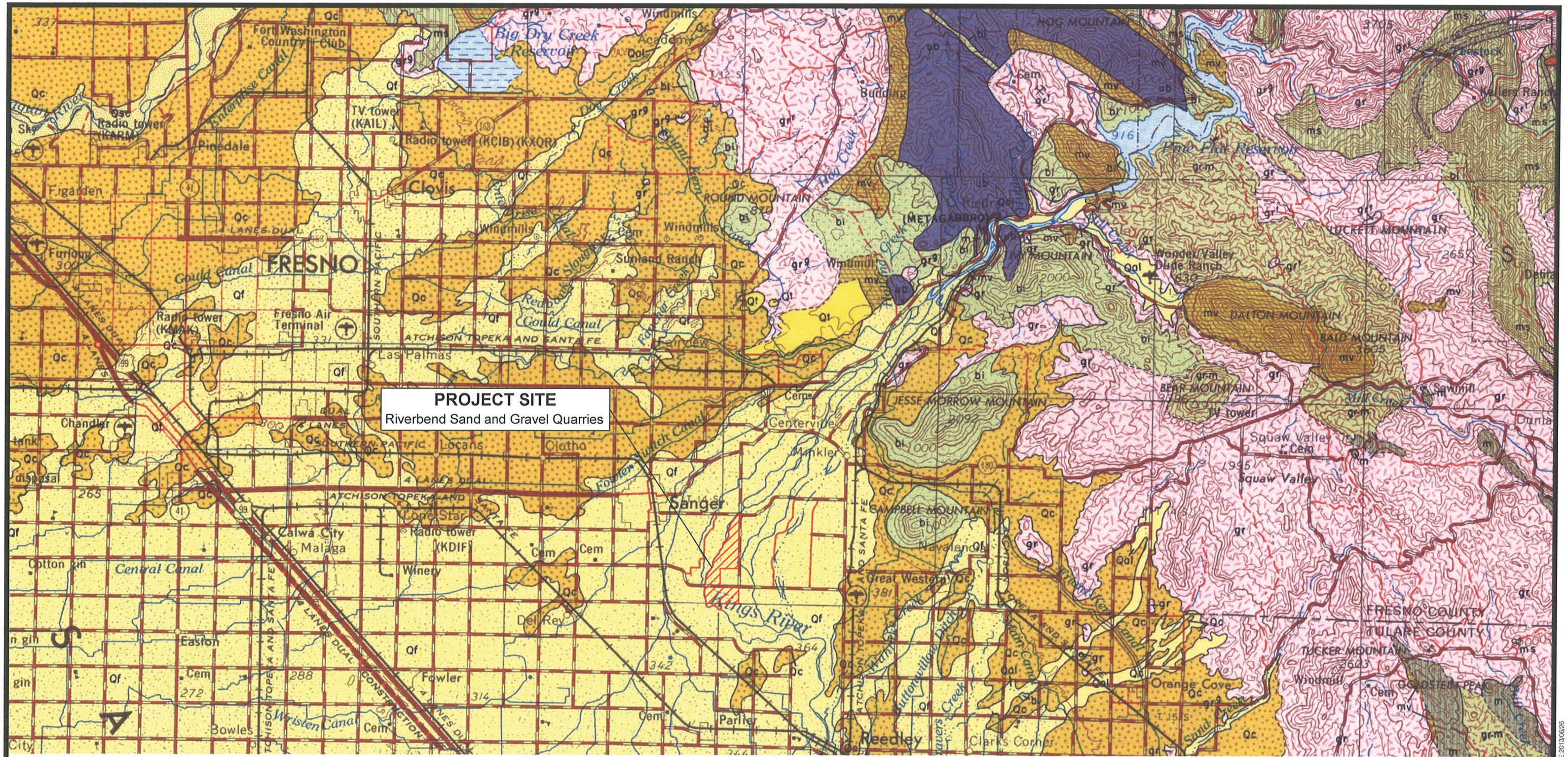
Subsurface Exploration Location Plan (Cleath-Harris Geologists, Inc.) and Geologic Cross Sections

TETRA TECH BAS GEOSCIENCE
1360 Valley Vista Drive
Diamond Bar, CA 91765
Phone (949) 860-5096

Project Name: Riverbend Sand and Gravel Quarries, Fresno County, CA

Project No.: RSG 13-01E	Date: July 2013	Figure No. 3

FILE: RSG 13-01E FIGURE 3 Riverbend Sand and Gravel Quarries_PLOT DATE 2013/06/28



Reference: Excerpt of *Mathews, R.A. and Burnett, J.L., 1965, Geologic map of California: Fresno Sheet: California Division of Mines and Geology, Unseriesed, scale 1:250,000.*

N

0 5 10

map scale: miles (approximate)

Major Geologic Units

Qf	Holocene - Alluvium (fan deposits)
Qt	Quaternary - Alluvium (non-marine terrace deposits)
Qc	Pleistocene - Non-marine deposits
$gr^{o,g,t}$	Mesozoic granitic rocks - o-granitic and adamellite, g-granodiorite, t-tonalite
bi	Mesozoic basic intrusive rocks
ub	Mesozoic ultrabasic intrusive rocks
mv	Pre-Cretaceous metavolcanic rocks
gr-m	Pre-Cretaceous granitic and metamorphic rocks
ms	Pre-Cretaceous metasedimentary rocks

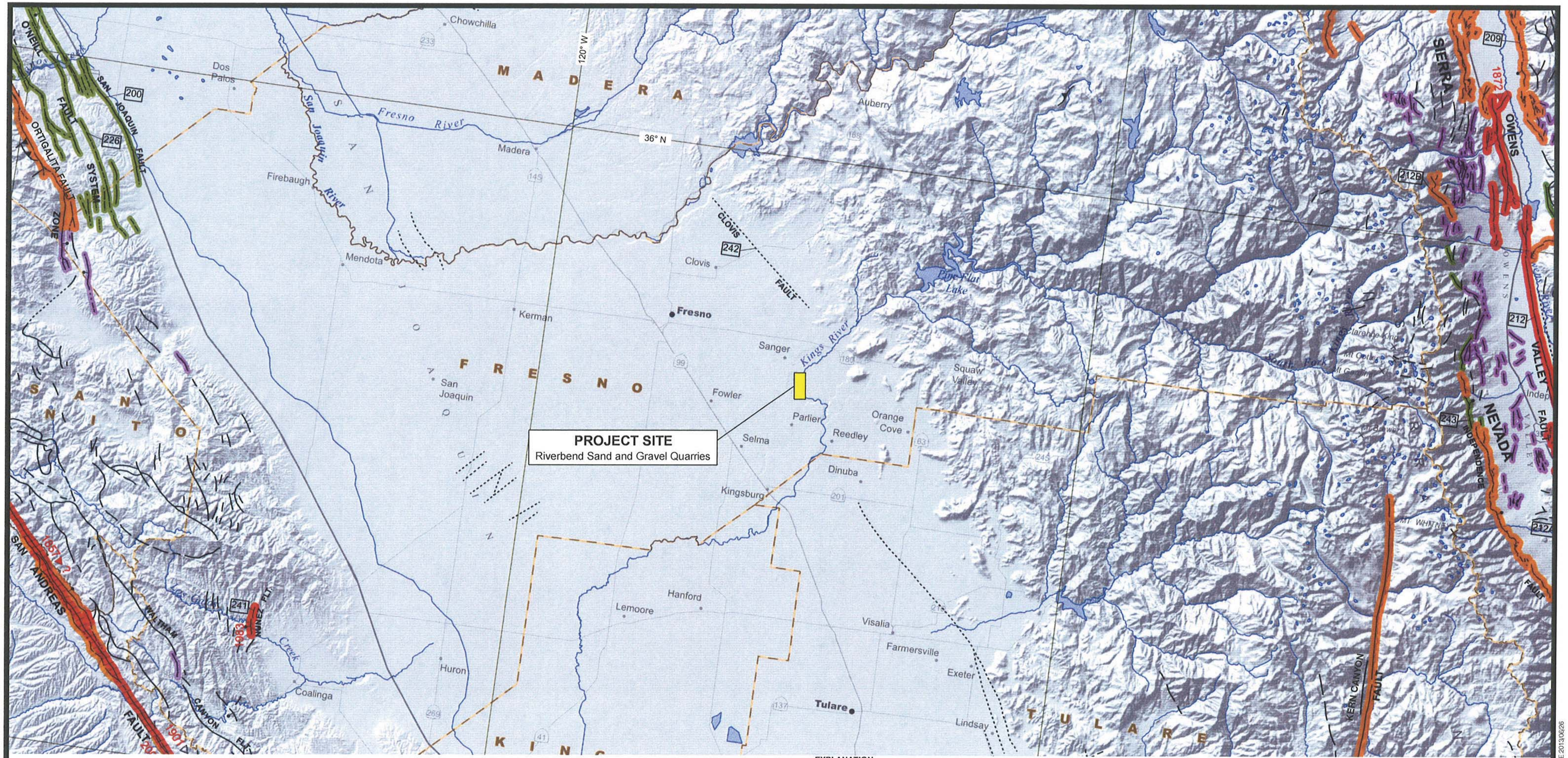
Regional Geologic Map

TETRA TECH BAS GEOSCIENCE
1360 Valley Vista Drive
Diamond Bar, CA 91765
Phone (949) 860-5096

Project Name: Riverbend Sand and Gravel Quarries, Fresno County, CA

Project No.: RSG 13-01E | Date: July 2013 | Figure No. 4

FILE: RSG 13-01E FIGURE 4 Riverbend Sand and Gravel Quarries_PLOT DATE 2013/06/26



Reference: Excerpt of *Jennings, C.W., and Bryant, W.A., 2010, Fault activity map of California: California Geological Survey, Data Map No. 6, map scale 1:750,000.*

Used by permission from California Geological Survey.

0 10 20 30 40 50

SCALE IN MILES

EXPLANATION

Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE
Quaternary	Late Quaternary	Historic	200			Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	11,700			Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	700,000			Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
	Early Quaternary		1,600,000			Undivided Quaternary faults – most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			4.5 bya (Age of Earth)			Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive	Fault cuts strata of Pliocene or older age.

MAP SYMBOLS

- Triangle - termination point data. Square – fault creep slippage. Hachure – linear extent of fault creep (other symbols – see below)
- Approximately located trace
- Location uncertain
- Bar and ball on downthrown side
- Arrows along fault indicate relative or apparent direction of lateral movement
- Direction of fault dip
- Low angle fault (barbs on upper plate)
- 171 Numbers refer to annotations listed in explanatory text of map.

Regional Fault Map

TETRA TECH BAS GEOSCIENCE
1360 Valley Vista Drive
Diamond Bar, CA 91765
Phone (949) 860-5096

Project Name: Riverbend Sand and Gravel Quarries, Fresno County, CA

Project No.: RSG 13-01E | Date: July 2013 | Figure No. 5

FILE: RSG 13-01E FIGURE 5 Riverbend Sand and Gravel Quarries_PLOT DATE 2013/06/26

APPENDIX A

CLEATH-HARRIS GEOLOGISTS, INC. BORING LOGS

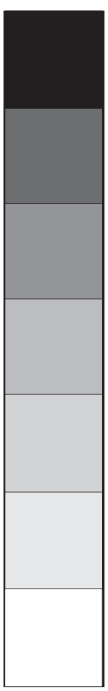
Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

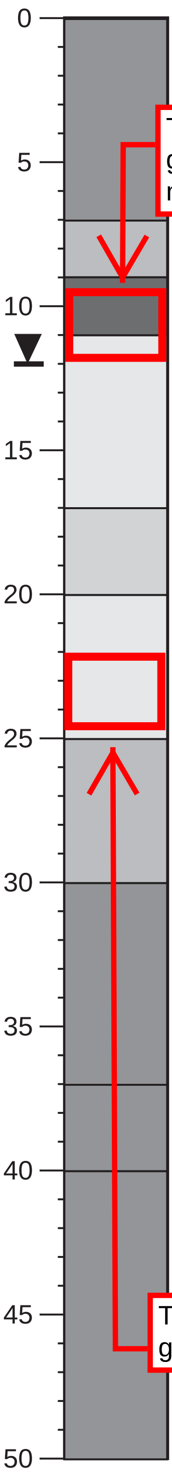
Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.68653° N
Longitude: 119.51395° W
Elevation: 339.9 feet (project topo)

Log of boring: RL-11-01
Date drilled: 6/24/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-7’ **Silty Sand (SM);** dark yellowish brown (10YR 4/4); 70% fine grained sand; 30% soft silt; micaceous; dry.

7-9’ **Sand with Silt (SP-SM);** yellowish brown (10YR 5/4); 90% fine grained sand; 10% silt; micaceous; dry.

9-11’ **Sandy Silt (ML);** dark yellowish brown (10YR 3/6); 65% soft silt; 35% fine grained sand; micaceous; moist.

11-17’ **Gravelly Sand (SP);** trace clay; trace cobbles; dark yellowish brown (10YR 4/4); 65% mostly fine to medium sand, lesser coarse; 35% clasts to 5”, slightly weathered light gray granitics and gneiss, with lesser dark gray aphanitic mafics, minor iron oxide staining on granitic clast rims, clasts are resistant to strong hammer blows; micaceous; becomes wet at 12’ depth.

17-20’ **Sand with Gravel (SW);** dark yellowish brown (10YR 4/4); 85% fine to coarse grained sand; 15% gravel to 2”; micaceous; wet.

20-25’ **Gravelly Sand (SW);** with cobbles; trace clay; dark yellowish brown (10YR 4/4); 60% sand, fine to coarse grained, quartzose; 40% clasts to 6”, mostly slightly weathered granitics and lesser dark gray mafics, trace moderately weathered granitics, most clasts resistant to strong hammer blows.

25-30’ **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% sand, fine to coarse grained; 35% clasts to 6”, mostly slightly weathered, trace moderately weathered; 10% clay. Gravel content decreased to 30%, sand increased to 60% from 27’ to 30’ depth.

30-37’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/6); 55% fine to coarse sand; 30% clasts to 5”, mostly slightly weathered, lesser moderately weathered, clasts predominantly granitics with lesser very resistant mafics; 15% clay; micaceous. Clay content increased to 20%, sand decreased to 50% from 33’ to 35’ depth, and clay increased to 25% from 35’ to 37’ depth. 3” thick clay lens at 36’ depth.

37-40’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/4); 55% fine to coarse sand; 30% clasts to 5”, mostly slightly weathered, lesser moderately weathered, 15% clay.

40-59’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 30% clasts to 5”, slightly to moderately weathered; 20% clay. 2” thick clay lens at 41’ depth.

Driler: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

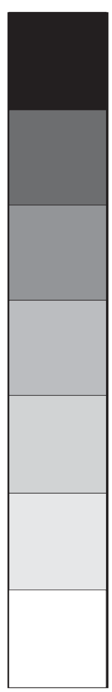
Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

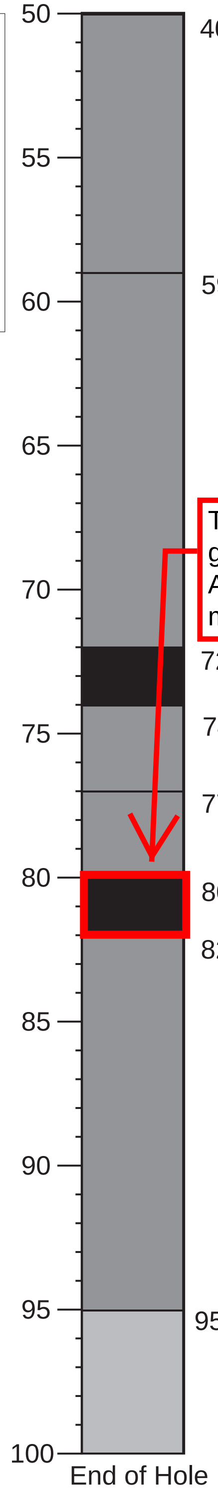
Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.68653° N
Longitude: 119.51395° W
Elevation: 339.9 feet (project topo)

Log of boring: RL-11-01
Date drilled: 6/24/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





40-59' **Clayey, Gravelly Sand (SC);** trace cobbles; as above.
Clay increased to 25%, sand decreased to 45% from 51' to 59' depth, clasts become mostly moderately weathered from 54' to 59' depth with trace highly weathered granitic clasts from 57' to 59' depth.

59-72' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/8); 45% fine to medium sand; 30% clasts to 5", mostly moderately weathered granitics, lesser slightly weathered mafics and lesser highly weathered coarse grained granitics, trace decomposed; 25% clay.

Clay decreased to 20%, sand increased to 50% from 65' to 72' depth.

Tetra Tech BASg: gradation, shear, Atterberg Limits, maximum density

72-74' **Clay with Sand (CL);** yellowish brown (10YR 5/8); 80% stiff clay; 20% fine sand; micaceous.

74-77' **Clayey Sand (SC);** dark yellowish brown (10YR 4/4); 80% fine sand; 20% soft disseminated clay.

77-80' **Clayey Sand (SC);** yellowish brown (10YR 5/4); 85% fine to medium sand; 15% clay; slightly micaceous.

80-82' **Clay (CH);** yellowish brown (10YR 5/6); stiff, strong reddish brown mottling.

82-95' **Clayey, Gravelly Sand (SC);** yellowish brown (10YR 5/6); 50% mostly fine to medium sand, lesser coarse; 30% gravel to 3", mostly moderately weathered, lesser highly weathered; 20% clay.

Clay increased to 25%, sand decreased to 45% from 87' to 95' depth.

Trace decomposed coarse grained granitics from 90' to 95' depth.

95-100' **Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 90% sand, fine grained from 95' to 96' depth, fine to medium grained from 96' to 100' depth; 10% clay; micaceous.

First water was observed at 12' depth.

Driller: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

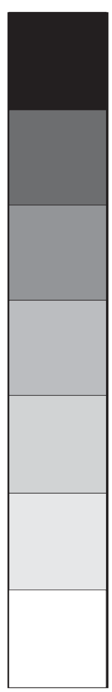
Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.67894° N
Longitude: 119.51469° W
Elevation: 338.9 feet (project topo)

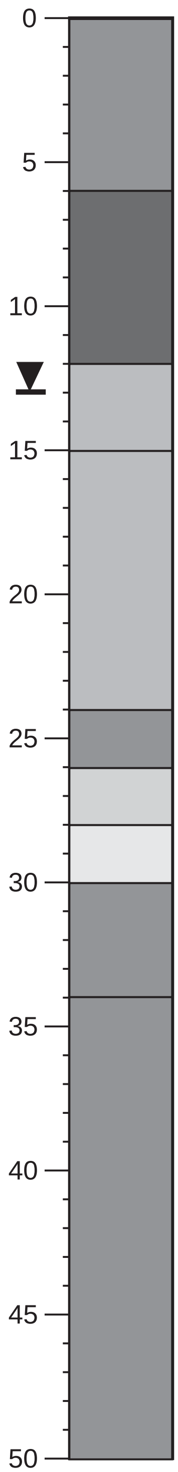
Log of boring: RL-11-02

Date drilled: 6/25/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-6' **Silty Sand (SM);** dark yellowish brown (10YR 4/4); 70% fine grained sand; 30% soft silt; micaceous; dry.

6-12' **Sandy Silt (ML);** dark yellowish brown (10YR 4/4); 65% soft silt; 35% fine grained sand; micaceous; moist.

12-15' **Sand with Silt (SP-SM);** dark yellowish brown (10YR 4/6); 90% sand, fine to medium grained; 10% silt; micaceous; moist. Becomes wet at 13' depth.

15-24' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/6); 55% sand, fine to coarse grained; 35% clasts to 4", slightly weathered, mostly light gray granitics with lesser dark gray aphanitic mafics; 10% clay; wet.

24-26' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% fine to coarse sand; 30% clasts to 5", mostly slightly weathered, lesser moderately weathered, most granitic clasts and all mafic clasts are resistant to strong hammer blows; 15% clay.

26-28' **Sand (SP);** dark yellowish brown (10YR 4/6); fine to medium; micaceous.

28-30' **Gravelly Sand (SP);** with cobbles; trace clay; dark yellowish brown (10YR 4/4); 65% fine to medium sand; 35% clasts to 5", slightly weathered.

30-34' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 35% clasts to 5", mostly slightly weathered, trace moderately weathered, 15% clay.

34-55' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 35% clasts to 5", slightly to moderately weathered, granitic clasts are moderately resistant to strong hammer blows, dark gray mafic clasts are less than 1/4 of the gravel/cobble fraction and are very resistant to strong hammer blows; 15% clay. Clay content increased to 20%, sand decreased to 45% from 37' to 50' depth.

Driler: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

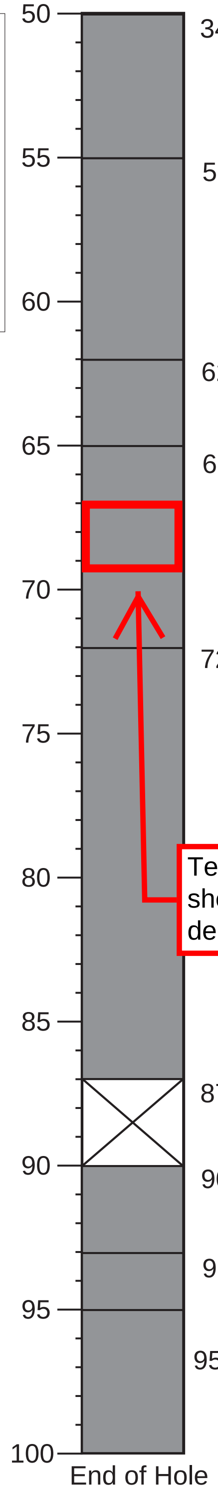
CHG

Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.67894° N
Longitude: 119.51469° W
Elevation: 338.9 feet (project topo)

Log of boring: RL-11-02
Date drilled: 6/25/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.



34-55' **Clayey, Gravelly Sand (SC);** trace cobbles; as above. Color change to dark yellowish brown (10YR 4/4), clay content decreased to 15%, sand content increased to 50% from 50' to 55' depth.

55-62' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 55% fine to coarse sand; 30% clasts to 5", mostly moderately weathered, lesser slightly weathered aphanitic mafics and some finer grained granitics, trace highly weathered coarse grained granitics; 15% clay.

62-65' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 50% fine sand; 30% clasts to 5", mostly moderately weathered; 20% clay; micaceous.

65-72' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 30% clasts to 5", mostly moderately weathered granitics with pervasive iron oxide staining, moderately resistant to strong hammer blows, lesser slightly weathered dark gray mafics; 20% clay. Color changes slightly to 10YR 5/8 from 67' to 72' depth.

72-87' **Clayey, Gravelly Sand (SC);** yellowish brown (10YR 5/6); 50% fine to coarse sand; 30% gravel to 3", moderately to highly weathered, most clasts break readily with moderate hammer blow, coarse grained granitics have pervasive iron oxide staining and nearly completely weathered feldspars; 20% clay.

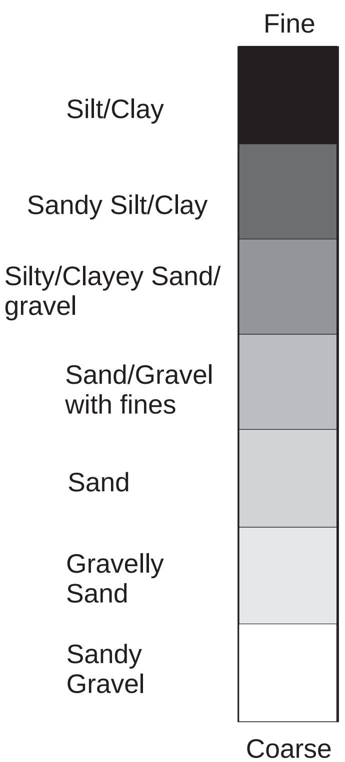
87-90' No recovery.

90-93' **Clayey Sand (SC);** trace gravel; yellowish brown (10YR 5/4); 75% sand, mostly fine to medium, lesser coarse grained; 15% clay; 10% gravel to 1".

93-95' **Clayey, Gravelly Sand (SC);** yellowish brown (10YR 5/6); 50% fine to coarse sand; 30% gravel to 3", mostly moderately to highly weathered, trace slightly weathered dark gray mafics; 20% clay; micaceous.

95-100' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/6); 50% fine to coarse sand; 30% clasts to 4", moderately to highly weathered, trace decomposed; 20% clay; micaceous.

Graphic scale



First water was observed at 13' depth.

Driller: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

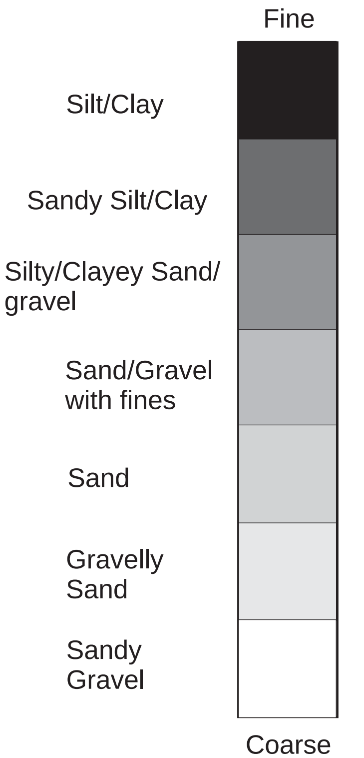
Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.67385° N
Longitude: 119.52225° W
Elevation: 333.7 feet (project topo)

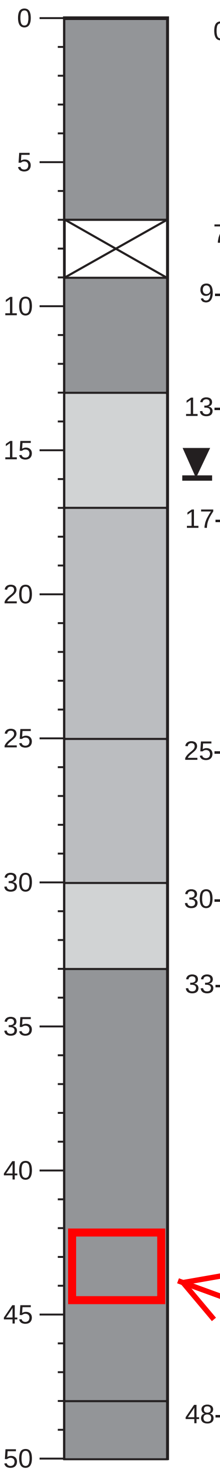
Log of boring: RL-11-03

Date drilled: 6/25/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-7' **Silty Sand (SM);** dark yellowish brown (10YR 4/4); 70% fine grained sand; 30% soft silt; micaceous; dry.

7-9' No recovery.

9-13' **Silty Sand (SM);** dark yellowish brown (10YR 4/4); 70% fine grained sand; 30% soft silt; micaceous; dry.

13-17' **Sand (SP);** dark yellowish brown (10YR 4/6); fine to medium grained; micaceous; moist. Becomes wet at 16' depth.

17-25' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% sand, fine to coarse grained; 35% clasts to 4", slightly weathered, mostly light gray coarse grained granitics with lesser dark gray aphanitic mafics; 10% clay; wet.

2" thick clay lens at 24' depth.

25-30' **Sand with Clay (SW-SC);** trace gravel; yellowish brown (10YR 5/4); 80% fine to coarse sand; 10% clay; 10% gravel to 2".

2" thick clay lens at 29' depth.

30-33' **Sand with Gravel (SP);** yellowish brown (10YR 5/4); 85% mostly fine to medium sand, lesser coarse; 15% gravel to 3", slightly weathered.

33-48' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 35% clasts to 6", slightly to moderately weathered granitics with lesser slightly weathered dark gray mafics, common iron oxide staining on rims and fractures of granitic rocks; 15% clay. Trace highly weathered granitic clasts from 38' to 48' depth. Clay content increased to 20%, sand decreased to 45% from 38' to 48' depth.

5" thick clay lens at 42' depth.

Tetra Tech BASg: gradation

48-70' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/4); 50% sand, fine to coarse grained; 30% clasts to 4", mostly moderately weathered, 20 to 30% of clasts are highly weathered; 20% clay.

Driller: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

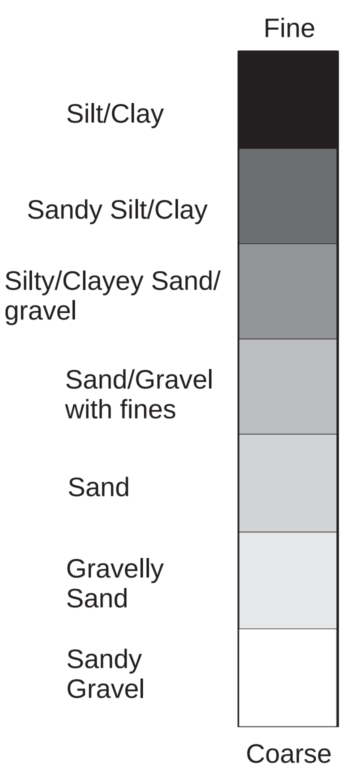
Project: Riverbend Sand & Gravel Project, Running Luck Ranch
Fresno County, California

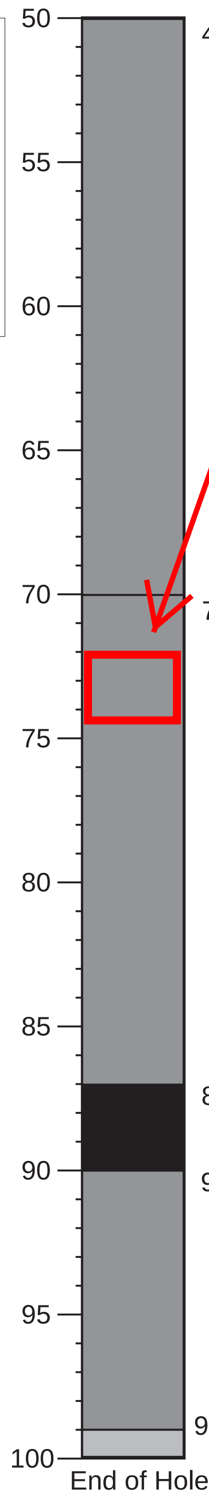
Client: Running Luck Ranch
Site: North of Goodfellow Road
Latitude: 36.67385° N
Longitude: 119.52225° W
Elevation: 333.7 feet (project topo)

Log of boring: RL-11-03
Date drilled: 6/25/11
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





48-70' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/4); 50% sand, fine to coarse grained; 30% clasts to 4", mostly moderately weathered, 20 to 30% of clasts are highly weathered; 20% clay.

Tetra Tech BASg: gradation

70-87' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/8); 50% fine to coarse sand; 30% clasts to 5", moderately to highly weathered coarse grained granitics, lesser slightly weathered dark gray aphanitic mafics (<20% of clasts), trace completely decomposed granitics; 20% clay.

3" thick clay lens at 76' depth.

Clay content increased to 25%, sand content decreased to 45% from 79' to 87' depth.

3" thick light gray clayey decomposed layer at 81' depth.

87-90' **Clay (CH);** dark grayish brown (10YR 4/2); soft, plastic; micaceous.

90-99' **Clayey Sand (SC);** dark grayish brown (10YR 4/2); 70% fine sand; 30% soft disseminated clay; micaceous.

Clay content decreased to 15%, sand increased to 85% from 96' to 99' depth.

99-100' **Sand with Clay (SP-SC);** yellowish brown (10YR 5/6); 90% sand, mostly fine grained, lesser medium; 10% clay.

First water was observed at 16' depth.

Driller: Boart Longyear
Rig: full size truck mount
Method: Sonic, 8-inch casing, 6-inch core barrel

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

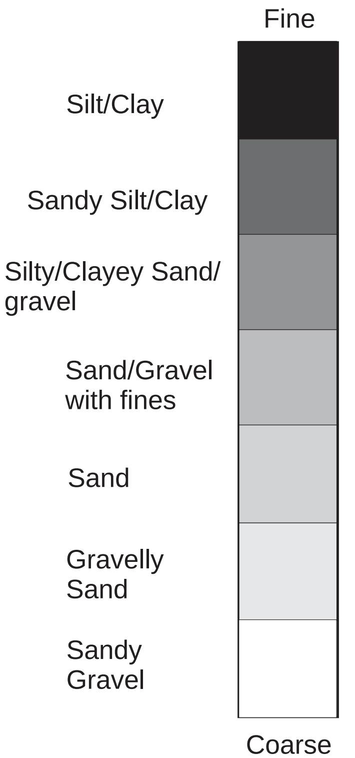
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66927° N
Longitude: 119.52492° W
Elevation: 333 feet (topo)

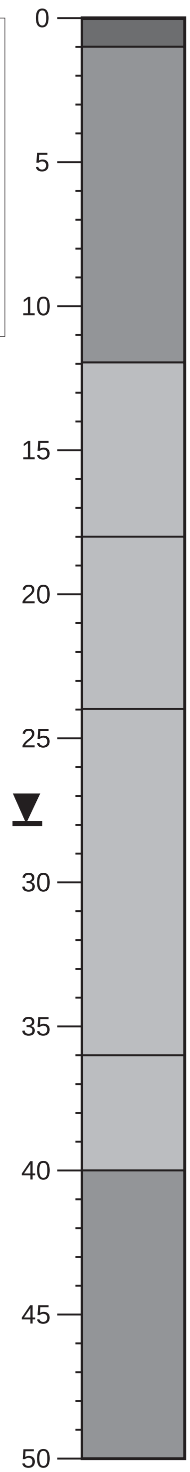
Log of boring: SJ-10-01

Date drilled: 9/28/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-1’ **Sandy Silt (SM);** dark yellowish brown (10YR 3/4); 60% soft silt; 40% fine sand; dry.

1-12’ **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

12-18’ **Sand with Silt (SP-SM);** dark yellowish brown (10YR 4/4); 90% sand, mostly fine to medium grained, lesser medium; 10% silt; slightly micaceous; moist.

18-24’ **Gravelly Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 60% fine to medium sand; 30% gravel to 2”, slightly to moderately weathered; 10% clay; moist.

24-36’ **Gravelly Sand with Clay (SW-SC);** yellowish brown (10YR 5/4); 55% fine to coarse sand; 35% gravel to 3”, slightly to moderately weathered; most clasts resistant to strong hammer blow; 10% clay; moist.

Becomes wet at 28’ depth.

36-40’ **Sandy Gravel with Clay (GW-GC);** trace cobbles; yellowish brown (10YR 5/4); 50% clasts to 4”, slightly to moderately weathered, light gray granitics and dark greenish gray aphanitic mafics, trace fragmental quartz and quartzite; 40% sand, fine to coarse; 10% clay; wet. High water production.

40-52’ **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/4); 50% sand, fine to coarse grained; 35% clasts to 5”, mostly slightly to moderately weathered, trace highly weathered coarse grained granitics; 15% clay.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

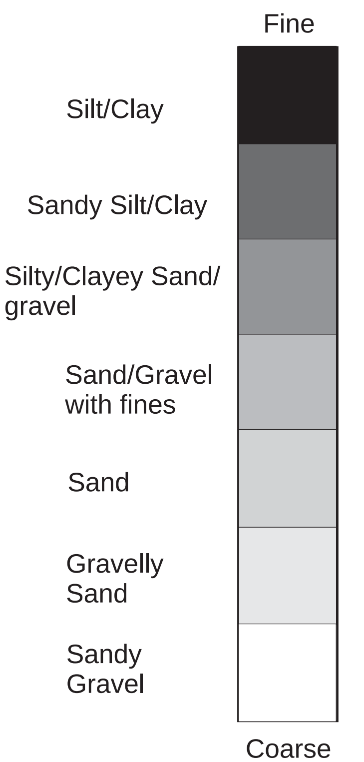
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

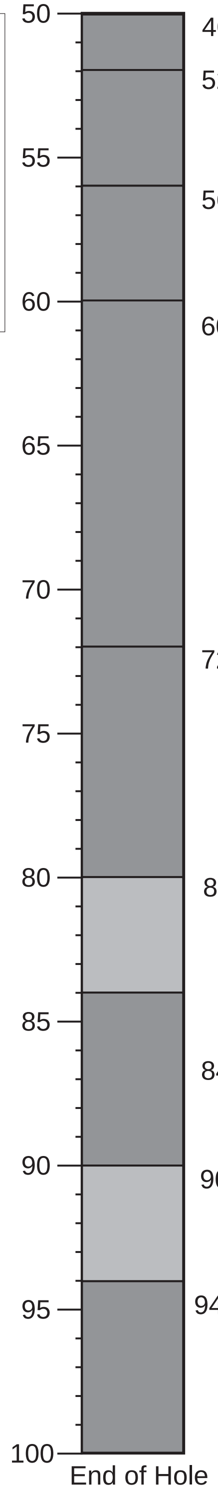
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66927° N
Longitude: 119.52492° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-01
Date drilled: 9/28/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





40-52' **Clayey, Gravelly Sand (SC);** with cobbles; as above.

52-56' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/4); 50% sand, fine to medium, quartzose; 30% clasts to 4", slightly to moderately weathered, trace highly weathered coarse grained granitics; 20% clay.

56-60' **Clayey Sand with Gravel (SC);** trace cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand, lesser coarse; 25% interstitial clay; 25% clasts to 7", most less than 3", slightly to highly weathered, increase in coarse grained grayish brown to reddish brown granitics.

60-72' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/6); 45% sand, fine to coarse, arkosic; 35% clasts to 4", mostly moderately to highly weathered coarse grained granitics, lesser slightly weathered dark greenish gray aphanitic mafics and porphyritic basalt; 20% clay.

Clasts decreased to 30%, sand increased slightly to 50% from 66' to 72' depth.

72-80' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 50% sand, fine to coarse, lesser coarse; 35% clasts to 5", slightly to highly weathered, increasingly highly weathered granitics; 15% clay.

Clay content increased to 20%, sand decreased to 45% from 76' to 80' depth.

80-84' **Gravelly Sand with Clay (SW-SC);** trace cobbles; dark yellowish brown (10YR 4/4); 55% fine to coarse sand; 35% clasts to 4", moderately to highly weathered, most clasts break readily under strong hammer blow; light gray to reddish brown granitics are pervasively stained with iron oxide, trace slightly weathered dark gray aphanitic mafics; 10% clay; very micaceous. High water production. Inferred thin sandy clay layers.

84-90' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 30% clasts to 4", moderately to highly weathered; 20% clay.

90-94' **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 40% clasts to 6", mostly moderately to highly weathered, trace slightly weathered; 10% clay. High water production.

94-100' **Clayey, Gravelly Sand (SC);** yellowish brown (10YR 5/4); 50% fine to coarse sand; 30% gravel to 3", moderately to highly weathered; 20% clay.

First water was observed at 28' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

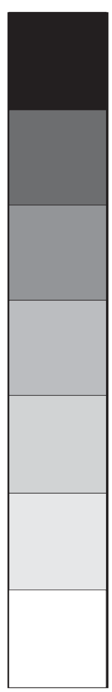
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66905° N
Longitude: 119.52306° W
Elevation: 333 feet (topo)

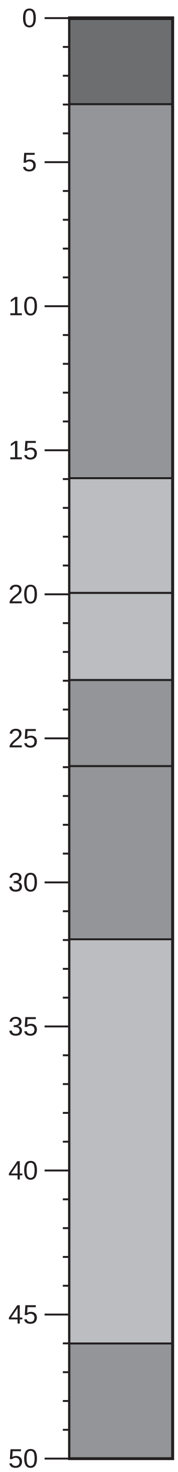
Log of boring: SJ-10-02

Date drilled: 10/2/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-3' **Sandy Silt (ML);** dark yellowish brown (10YR 3/4); 70% soft silt; 30% fine grained sand; dry.

3-16' **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

16-20' **Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 90% fine grained sand; 10% clay; micaceous; moist.

20-23' **Sand with Clay and Gravel (SP-SC);** dark yellowish brown (10YR 4/4); 70% sand, fine to medium; 20% gravel to 2", slightly to moderately weathered; 10% clay; micaceous; becomes wet at 20' depth.

23-26' **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/4); 45% fine to coarse sand; 35% clasts to 4", slightly to moderately weathered; 20% clay; micaceous.

26-32' **Clayey, Sandy Gravel (GC);** with cobbles; dark yellowish brown (10YR 4/4); 50% clasts to 5", slightly weathered dark greenish gray aphanitic mafics and slightly to moderately weathered granitics, most clasts resistant to strong hammer blow; 35% fine to coarse sand; 15% clay.

32-46' **Gravelly Sand with Clay (SP-SC);** with cobbles; yellowish brown (10YR 5/4); 50% sand, mostly fine to medium, lesser coarse; 40% clasts to 4", slightly to moderately weathered light gray granitics and dark greenish gray aphanitic mafic clasts; 10% clay.

46-55' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 55% fine to coarse sand, arkosic; 30% clasts to 4", mostly slightly to moderately weathered with lesser highly weathered coarse grained granitics, slight increase in granitic fraction; 10% clay.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

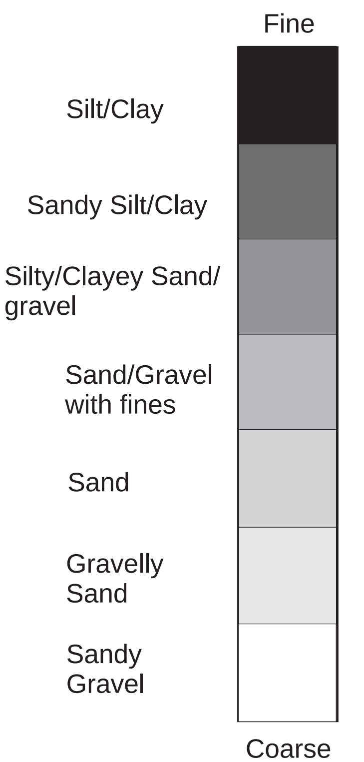
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

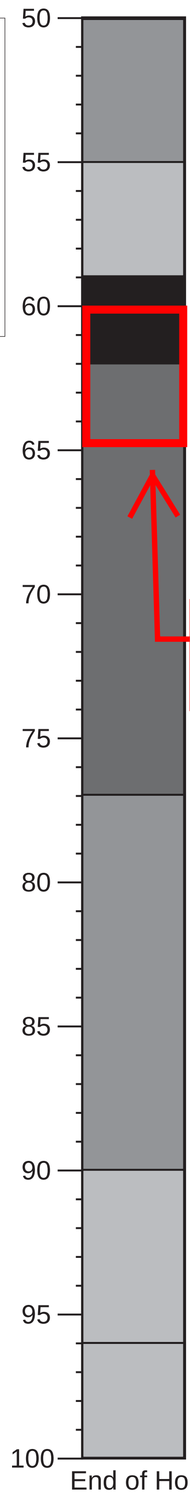
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66905° N
Longitude: 119.52306° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-02
Date drilled: 10/2/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





46-55’ **Clayey, Gravelly Sand (SC);** with cobbles; as above.

Thin sandy clay lens at 54’ depth.

55-59’ **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 40% clasts to 6”, slightly to highly weathered, mostly moderately to highly weathered granitics and lesser fine grained greenish gray mafics; 10% clay.

59-62’ **Clay (CL);** yellowish brown (10YR 5/6); medium consistency.

62-77’ **Sandy Clay (CL);** yellowish brown (10YR 5/4); 60% soft clay; 40% fine sand; micaceous.

Tetra Tech BASg:
gradation,
Atterberg Limits

77-90’ **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/4); 50% fine to coarse arkosic sand; 35% clasts to 4”, mostly moderately to highly weathered, trace slightly weathered, clasts predominantly coarse equigranular granitics, weakly resistant to strong hammer blows; 15% clay. High water production.

Color change to dark yellowish brown (10YR 4/4) from 82’ to 90’ depth.

90-96’ **Sand with Gravel and Clay (SW-SC);** trace cobbles; dark yellowish brown (10YR 4/4); 70% fine to coarse sand; 20% clasts to 4”, moderately to highly weathered, pervasive iron oxide staining; 10% clay; micaceous. High water production.

96-100’ **Gravelly Sand with Clay (SW-SC);** trace cobbles; dark yellowish brown (10YR 4/6); 60% fine to coarse arkosic sand; 30% clasts to 4”, moderately to highly weathered; 10% clay; micaceous.

First water was observed at 20’ depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

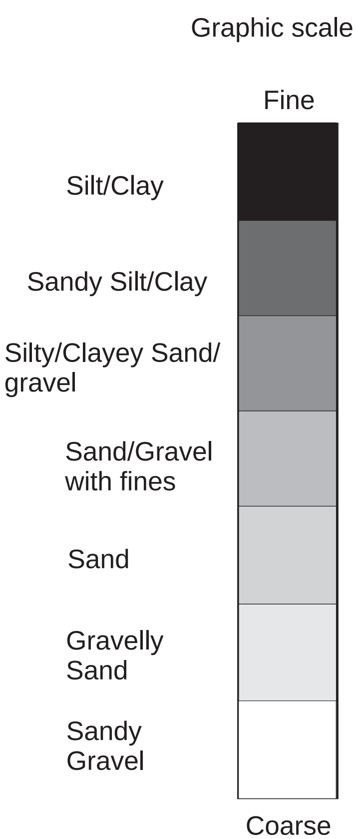
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

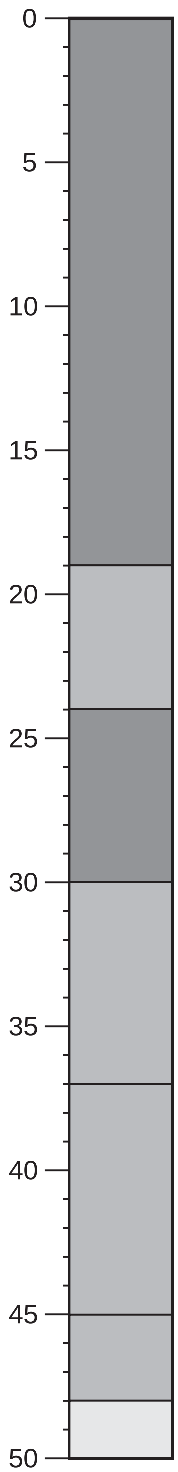
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66661° N
Longitude: 119.52494° W
Elevation: 334 feet (topo)

Log of boring: SJ-10-03

Date drilled: 9/28/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-19' **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Becomes moist at 10' depth.

Thin clay lens at 18' depth.

19-24' **Gravelly Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 60% sand, mostly fine to medium, lesser coarse; 30% gravel to 2", slightly to moderately weathered light gray granitics and dark greenish gray aphanitic mafic clasts; 10% clay; micaceous; moist.

24-30' **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 30% clasts to 5", slightly to moderately weathered; 20% clay; micaceous; moist.

30-37' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% sand, fine to coarse; 35% clasts to 5", mostly slightly to moderately weathered, trace highly weathered coarse grained granitics; 10% clay; wet. High water production.

37-45' **Sandy Gravel with Clay (GW-GC);** trace cobbles; dark yellowish brown (10YR 4/4); 60% clasts to 4", slightly weathered dark greenish gray aphanitic mafics and slightly to moderately weathered granitics, trace highly weathered iron oxide stained coarse grained granitics; 30% fine to coarse sand; 10% clay. High water production.

Slight increase in cobbles from 42' to 45' depth.

45-48' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% sand, fine to coarse; 35% clasts to 5", slightly to moderately weathered; 10% clay.

48-50' **Gravelly Sand (SW);** with cobbles; yellowish brown (10YR 5/4); 60% sand, fine to coarse, clean; 40% clasts to 5", mostly slightly to moderately weathered, trace highly weathered.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

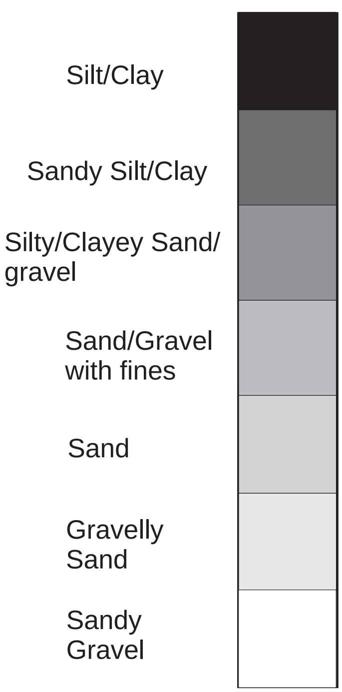
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66661° N
Longitude: 119.52494° W
Elevation: 334 feet (topo)

Log of boring: SJ-10-03
Date drilled: 9/28/10
Total Depth: 100 feet

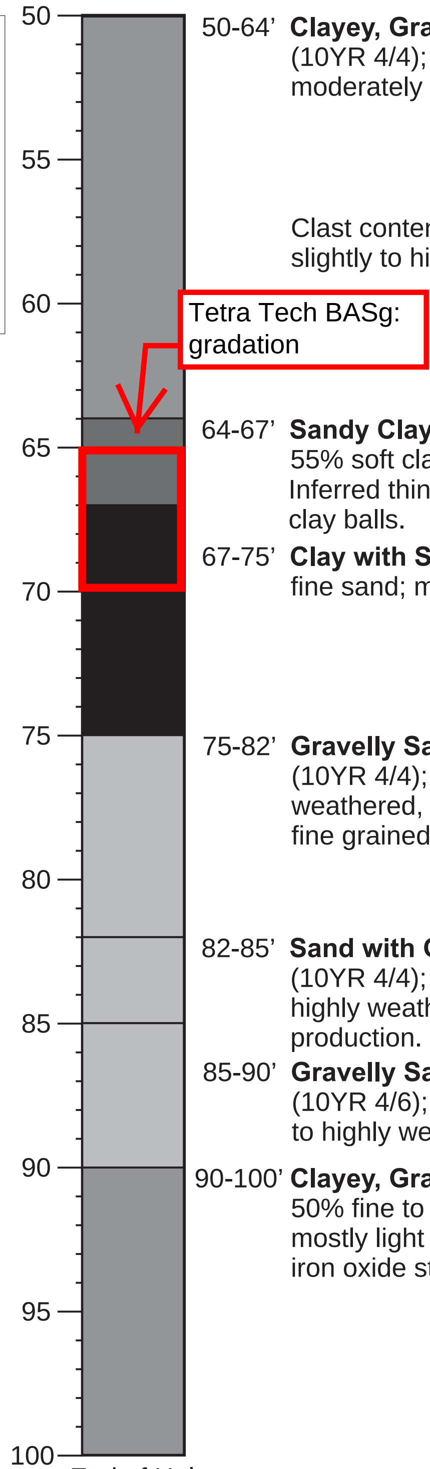
Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale

Fine



Coarse



50-64' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 30% clasts to 6", mostly slightly to moderately weathered, trace highly weathered; 20% clay.

Clast content increased 35%, clay decreased to 15%, and clasts become slightly to highly weathered from 57' to 64' depth.

64-67' **Sandy Clay with Gravel (CL);** trace cobbles; yellowish brown (10YR 5/6); 55% soft clay; 30% fine sand; 15% clasts to 4", slightly to highly weathered. Inferred thin clay lenses with strong reddish brown mottling as evidenced in clay balls.

67-75' **Clay with Sand (CL);** dark yellowish brown (10YR 3/6); 85% soft clay; 15% fine sand; micaceous.

75-82' **Gravelly Sand with Clay (SW-SC);** trace cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 40% clasts to 4", slightly to highly weathered, mostly moderately to highly weathered granitics and lesser fine grained greenish gray mafics; 10% clay. High water production.

82-85' **Sand with Gravel and Clay (SW-SC);** trace cobbles; dark yellowish brown (10YR 4/4); 70% fine to coarse sand; 20% clasts to 4", moderately to highly weathered, pervasive iron oxide staining; 10% clay. High water production.

85-90' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/6); 55% fine to coarse arkosic sand; 35% clasts to 5", moderately to highly weathered; 10% clay; micaceous.

90-100' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 35% clasts to 5", moderately to highly weathered, mostly light gray to reddish brown coarse grained granitics, with pervasive iron oxide staining; 15% clay. High water production.

End of Hole

First water was observed at 30' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

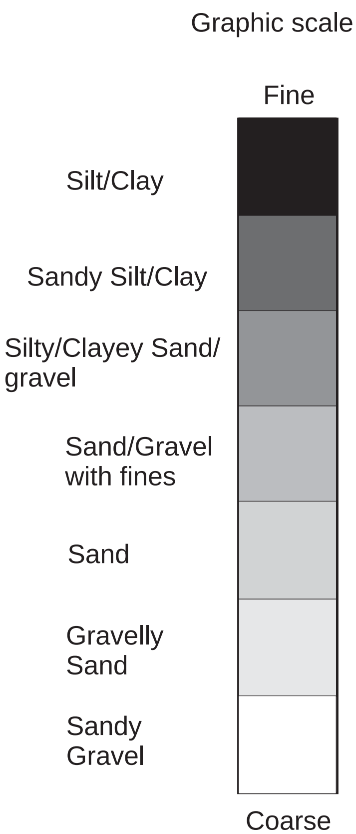
Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

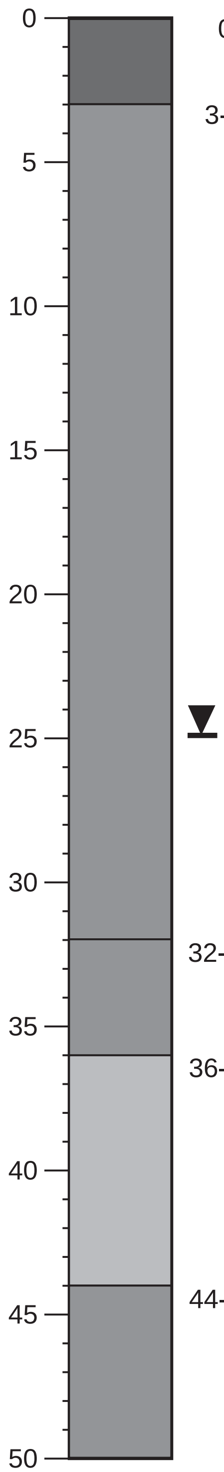
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66676° N
Longitude: 119.52203° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-04
Date drilled: 9/27/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-3' **Sandy Silt (ML);** dark yellowish brown (10YR 3/4); 70% soft silt; 30% fine grained sand; dry.

3-32' **Silty Sand (SM);** trace gravel; dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Becomes moist from 14' to 25' depth.

Becomes wet at 25' depth.

32-36' **Clayey Sand (SC);** dark yellowish brown (10YR 4/4); 70% fine to coarse sand; 30% clay; wet.

36-44' **Gravelly Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 60% sand, mostly fine to medium, lesser coarse; 30% gravel to 3", slightly to moderately weathered light gray granitics and dark greenish gray aphanitic mafic clasts with lesser black porphyritic basalt, fragmental quartz, and trace quartzite, clasts are generally resistant to strong hammer blows; 10% clay.

44-50' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine to coarse sand; 35% clasts to 4", mostly slightly to moderately weathered, trace highly weathered coarse grained granitics; 15% clay. High water production.

Thin clay lens at 50' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

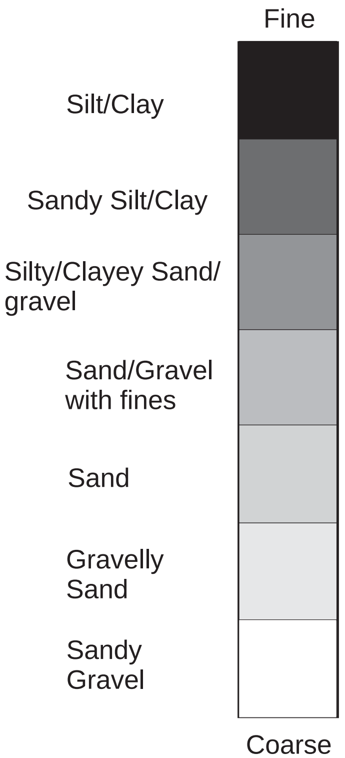
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66676° N
Longitude: 119.52203° W
Elevation: 333 feet (topo)

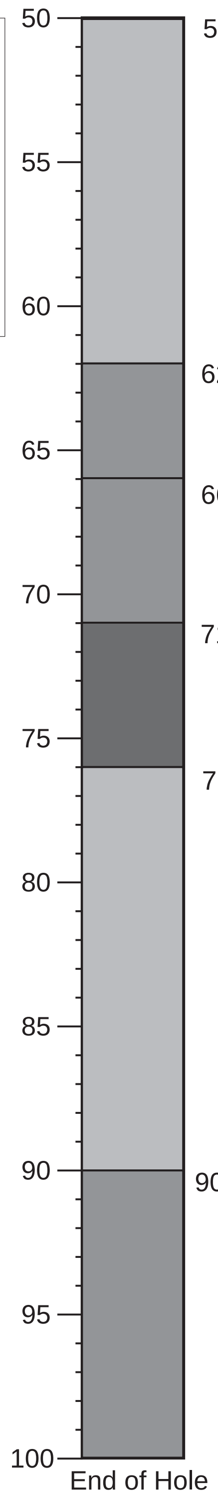
Log of boring: SJ-10-04

Date drilled: 9/27/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





50-62’ **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/6); 60% fine to coarse sand; 30% clasts to 4”, slightly to moderately weathered, trace highly weathered; 10% clay.

Cobbles increased in size up to 7”. Clasts become increasingly weathered, with abundant coarse grained granitic clasts moderately to highly weathered from 55’ to 62’ depth.

62-66’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/6); 45% sand, mostly fine to coarse, lesser coarse; 30% clasts to 5”, slightly to highly weathered; 25% clay; inferred thin clay lenses evidenced by observed clay balls.

66-71’ **Clayey Sand with Gravel (SC);** trace cobbles; dark yellowish brown (10YR 4/6); 45% fine to medium sand; 35% clasts to 6”, slightly to highly weathered, lesser slightly weathered, mostly coarse grained granitics; 20% clay.

71-76’ **Sandy Clay with Gravel (CL);** yellowish brown (10YR 5/4); 50% soft clay; 30% sand, mostly fine grained; 20% gravel to 3”, moderately to highly weathered.

76-90’ **Gravelly Sand with Clay (SW-SC);** dark yellowish brown (10YR 4/6); 60% fine to coarse arkosic sand; 30% gravel to 3”, moderately to highly weathered; 10% clay.

Increased degree of weathering below 80’ depth (mostly highly weathered).

90-100’ **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 55% fine to coarse sand, arkosic; 30% clasts to 5”, mostly moderately to highly weathered, trace slightly weathered dark greenish gray mafics; 15% clay. High water production.

First water was observed at 25’ depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

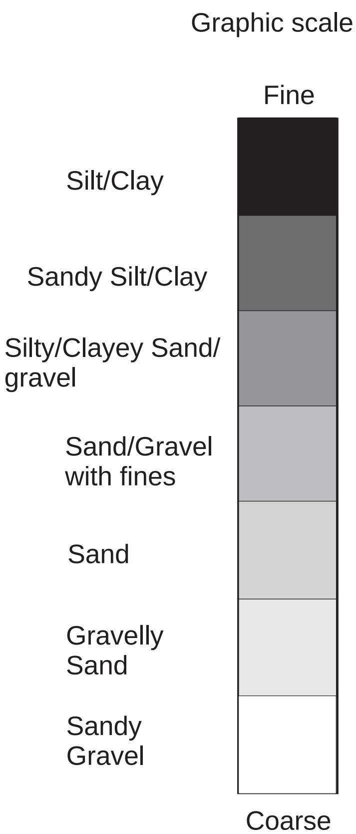
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

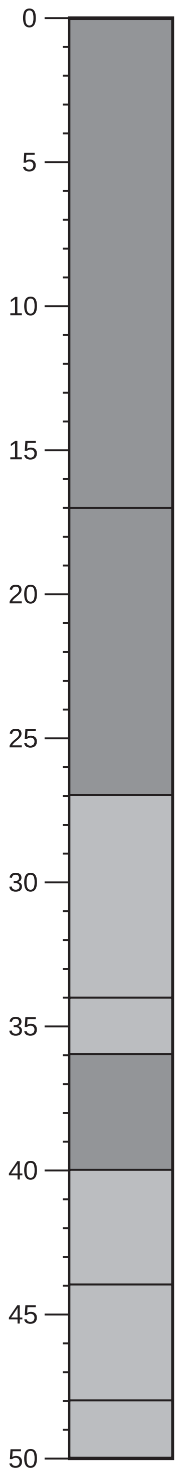
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66321° N
Longitude: 119.52500° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-05

Date drilled: 9/29/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-17' **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

17-27' **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 55% sand, mostly fine to medium, lesser coarse, quartzose; 30% gravel to 2", slightly to moderately weathered; 15% clay; micaceous; moist.

27-34' **Gravelly Sand with Clay (SP-SC);** yellowish brown (10YR 5/4); 55% sand, mostly fine to medium, lesser coarse; 35% gravel to 3", light gray granitics and dark greenish gray aphanitic mafic clasts are resistant to strong hammer blows, slightly to moderately weathered; 10% clay; moist. Becomes wet at 30' depth.

34-36' **Sand with Gravel and Clay (SP-SC);** yellowish brown (10YR 5/4); 70% sand, fine to medium; 20% gravel to 2"; 10% clay.

36-40' **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 35% gravel to 3", slightly to moderately weathered, clasts generally resistant to strong hammer blows; 15% clay.

40-44' **Sandy Gravel with Clay (GW-GC);** with cobbles; dark yellowish brown (10YR 4/4); 55% clasts to 4", slightly to moderately weathered; 35% sand, fine to coarse; 10% clay. High water production.

44-48' **Sand with Gravel and Clay (SW-SC);** yellowish brown (10YR 5/4); 75% sand, fine to coarse; 15% gravel to 2"; 10% clay.

48-54' **Sandy Gravel with Clay (GW-GC);** with cobbles; dark yellowish brown (10YR 4/4); 55% clasts to 4", slightly to moderately weathered; 35% sand, fine to coarse; 10% clay. High water production.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

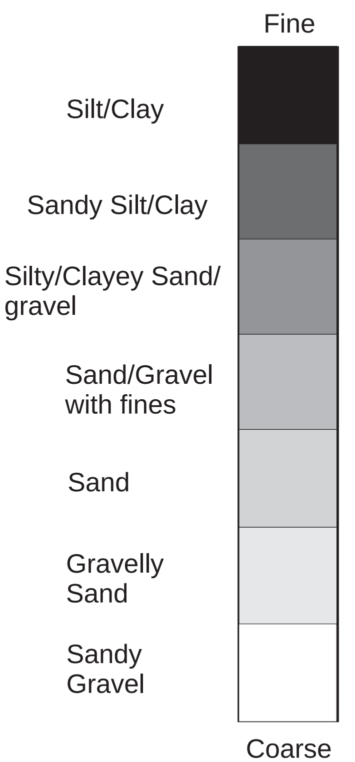
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

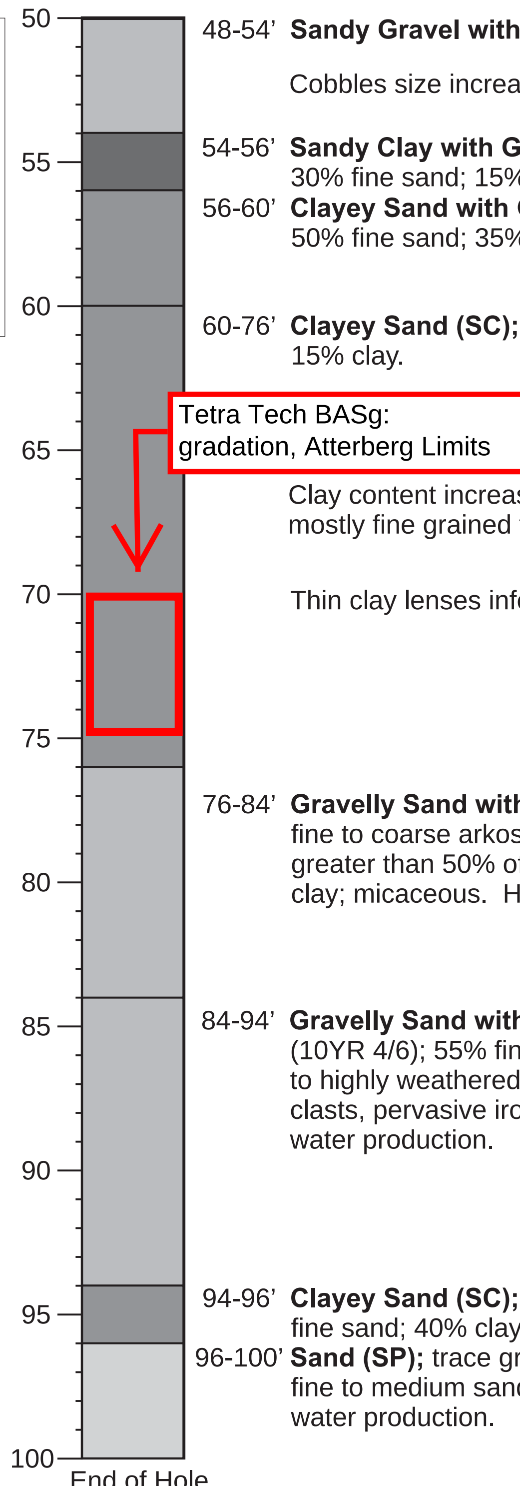
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66321° N
Longitude: 119.52500° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-05
Date drilled: 9/29/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





48-54' **Sandy Gravel with Clay (GW-GC);** with cobbles; as above.

Cobbles size increased up to 6", from 52' to 54' depth.

54-56' **Sandy Clay with Gravel (CL);** yellowish brown (10YR 5/6); 55% soft clay; 30% fine sand; 15% gravel to 3"; micaceous.

56-60' **Clayey Sand with Gravel (SC);** with cobbles; yellowish brown (10YR 5/6); 50% fine sand; 35% clay; 15% clasts to 6", slightly to highly weathered.

60-76' **Clayey Sand (SC);** yellowish brown (10YR 5/6); 85% fine to medium sand; 15% clay.

Clay content increased to 25%, sand decreased to 75% and becomes mostly fine grained from 66' to 76' depth.

Thin clay lenses inferred from 70' to 76' depth.

76-84' **Gravelly Sand with Clay (SW-SC);** dark yellowish brown (10YR 4/6); 55% fine to coarse arkosic sand; 35% gravel to 3", slightly to highly weathered, greater than 50% of clasts break readily with strong hammer blow; 10% clay; micaceous. High water production.

84-94' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/6); 55% fine to coarse arkosic sand; 35% clasts to 5", moderately to highly weathered coarse grained granitics and dark gray schistose clasts, pervasive iron oxide on granitic clasts; 10% clay; micaceous. High water production.

94-96' **Clayey Sand (SC);** trace gravel; dark yellowish brown (10YR 4/4); 50% fine sand; 40% clay; 10% gravel to 3".

96-100' **Sand (SP);** trace gravel and clay; dark yellowish brown (10YR 4/6); 95% fine to medium sand, arkosic; 5% gravel to 3"; slightly micaceous. High water production.

First water was observed at 30' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

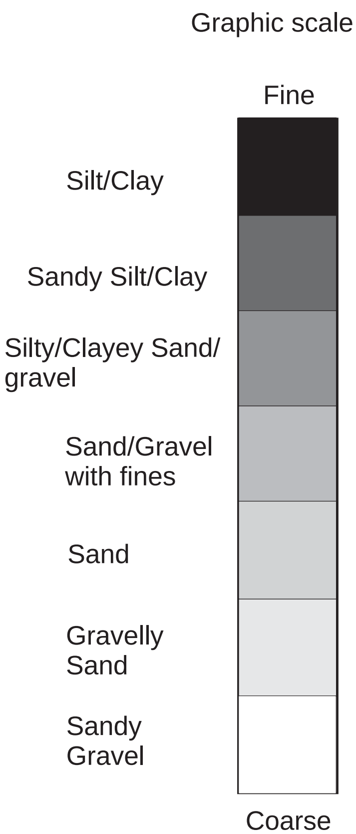
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

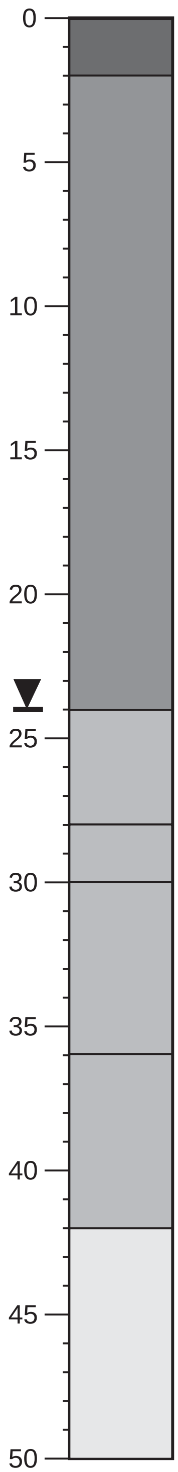
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66307° N
Longitude: 119.52216° W
Elevation: 332 feet (topo)

Log of boring: SJ-10-06

Date drilled: 9/27/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-2' **Sandy Silt (ML);** dark brown (10YR 3/3); 60% soft silt; 40% fine sand; dry.

2-24' **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Becomes moist at 14' depth.

24-28' **Sand with Silt (SP-SM);** yellowish brown (10YR 5/4); 90% fine to medium sand, quartzose; 10% silt; micaceous; wet.

28-30' **Sand with Gravel and Clay (SW-SC);** yellowish brown (10YR 5/4); 70% sand, fine to coarse; 20% gravel to 3", slightly to moderately weathered; 10% clay.

30-36' **Sand with Clay (SP-SC);** trace gravel; grayish brown (10YR 5/2); 90% sand, fine to medium, lesser coarse, quartzose; 10% clay; micaceous.

36-42' **Gravelly Sand with Clay (SW-SC);** dark yellowish brown (10YR 4/4); 55% sand, fine to coarse; 35% gravel to 3", mostly slightly to moderately weathered light gray granitics and dark greenish gray aphanitic mafics with trace fragmental quartz and light brown quartzite, trace highly weathered coarse grained equigranular granitics with pervasive iron oxide staining; 10% clay.

42-58' **Gravelly Sand (SW);** with cobbles; dark yellowish brown (10YR 4/4); 60% sand, fine to coarse; 40% clasts to 5", mostly slightly to moderately weathered, trace highly weathered.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

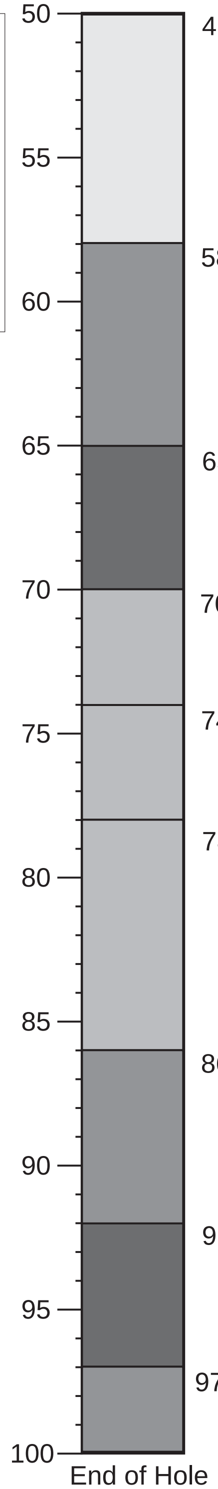
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66307° N
Longitude: 119.52216° W
Elevation: 332 feet (topo)

Log of boring: SJ-10-06

Date drilled: 9/27/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale



42-58' **Gravelly Sand (SW);** with cobbles; as above.

Becomes yellowish brown (10YR 5/6) with increased weathering on light gray to reddish brown coarse grained granitic clasts from 54' to 58' depth.

58-65' **Clayey Sand with Gravel (SC);** yellowish brown (10YR 5/6); 50% fine to medium sand; 30% clay; 20% gravel to 3", slightly to highly weathered.

65-70' **Sandy Clay (CL);** dark yellowish brown (10YR 4/6); 60% soft clay; 40% fine sand.

70-74' **Sand with Clay (SP-SC);** trace gravel; yellowish brown (10YR 5/6); 85% sand, fine to medium, lesser coarse; 10% clay; 5% gravel to 2".

74-78' **Gravelly Sand with Clay (SP-SC);** yellowish brown (10YR 5/6); 55% sand, fine to medium, lesser coarse; 35% gravel to 3", moderately to highly weathered, most clasts break readily with strong hammer blow, pervasive iron oxide staining; 10% clay.

78-86' **Sand with Gravel and Clay (SP-SC);** yellowish brown (10YR 5/6); 65% fine to medium sand; 25% gravel to 3", moderately to highly weathered; 10% clay.

86-92' **Clayey Sand (SC);** trace gravel; dark yellowish brown (10YR 4/4); 60% sand, mostly fine, lesser medium grained; 40% soft interstitial clay.

92-97' **Sandy Clay (CL);** yellowish brown (10YR 5/6); 55% stiff clay; 45% fine sand.

97-100' **Clayey Sand (SC);** trace gravel and cobbles; yellowish brown (10YR 5/4) 80% fine to medium sand, arkosic; 15% clay; 5% clasts to 5", moderately to highly weathered. High water production.

First water was observed at 24' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

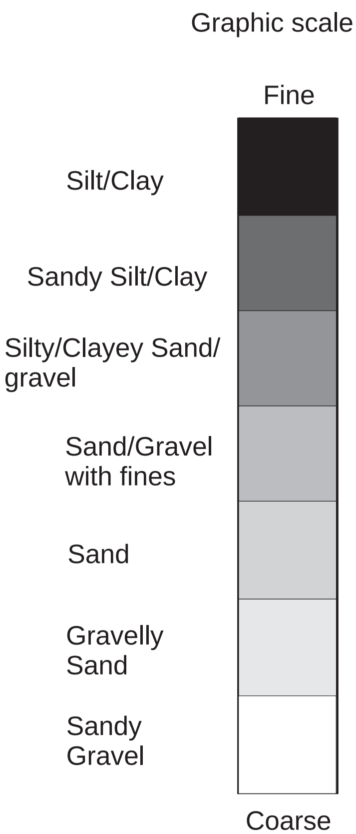
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

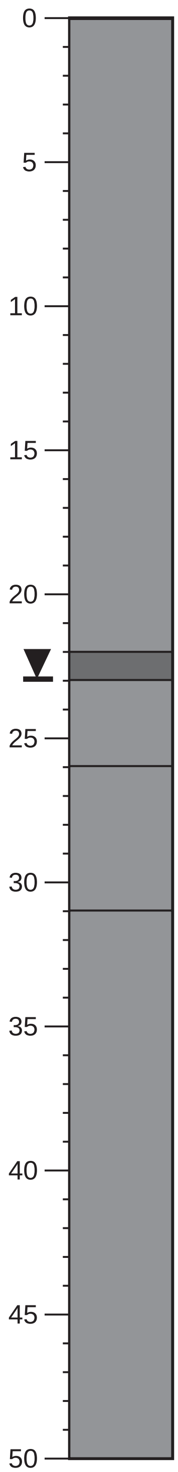
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66802° N
Longitude: 119.51848° W
Elevation: 334 feet (topo)

Log of boring: SJ-10-07

Date drilled: 9/30/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-22’ **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

22-23’ **Sandy Clay (CL);** dark yellowish brown (10YR 3/4); 70% soft clay; 30% fine sand; moist.

23-26’ **Clayey Sand with Gravel (SC);** dark yellowish brown (10YR 3/6); 50% fine to medium sand; 30% disseminated clay; 20% gravel to 3”, slightly to moderately weathered; becomes wet at 23 feet depth.

26-31’ **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 45% sand, fine to medium, lesser coarse; 30% clasts to 6”, slightly to moderately weathered light gray granitics and dark gray aphanitic mafics with trace fragmental quartz and light brown quartzite; 25% clay.

31-53’ **Clayey, Sandy Gravel (GC);** with cobbles; dark yellowish brown (10YR 4/4); 45% clasts to 4”, slightly to moderately weathered, most clasts resistant to strong hammer blow; 35% sand, fine to medium, lesser coarse; 20% sticky clay. Color change to yellowish brown (10YR 5/6) from 33’ to 53’ depth.

Increase in cobbles and increase in size, up to 6” from 47’ to 53’ depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

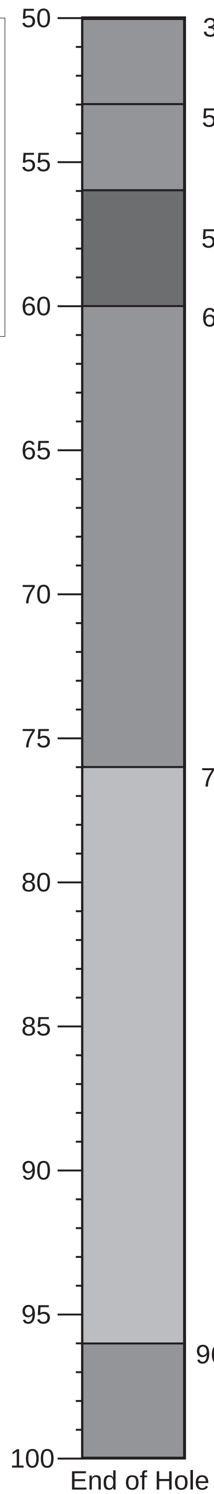
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66802° N
Longitude: 119.51848° W
Elevation: 334 feet (topo)

Log of boring: SJ-10-07

Date drilled: 9/30/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.



31-53' **Clayey, Sandy Gravel (GC);** with cobbles; as above.

53-56' **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 45% sand, mostly fine to medium, lesser coarse; 30% clasts to 4", slightly to moderately weathered, trace highly weathered coarse grained granitics; 25% clay.

56-60' **Sandy Clay (CL);** yellowish brown (10YR 5/6); 65% sticky clay; 35% fine sand.

60-76' **Clayey Sand (SC);** yellowish brown (10YR 5/4); 60% fine sand; 40% stiff clay, interstitial clay with thin discrete clay (10YR 5/6) lenses.

76-96' **Gravelly Sand with Clay (SW-SC);** trace cobbles; yellowish brown (10YR 5/6); 60% fine to coarse sand, arkosic; 30% clasts to 4", moderately to highly weathered, most clasts break readily under strong hammer blow; light gray to reddish brown granitics are pervasively stained with iron oxide, trace slightly weathered dark gray aphanitic mafics; 10% clay; micaceous.

Increase in cobble content from 82' to 96' depth.

Clast content increased to 40%, sand decreased to 50% from 88' to 96' depth.

96-100' **Clayey Sand (SC);** grayish brown (10YR 5/2); 60% sand, fine to medium; 40% sticky clay.

First water was observed at 23' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

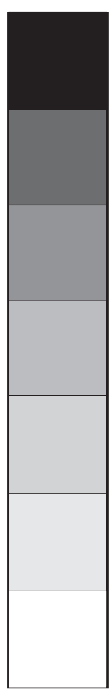
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66795° N
Longitude: 119.51366° W
Elevation: 333 feet (topo)

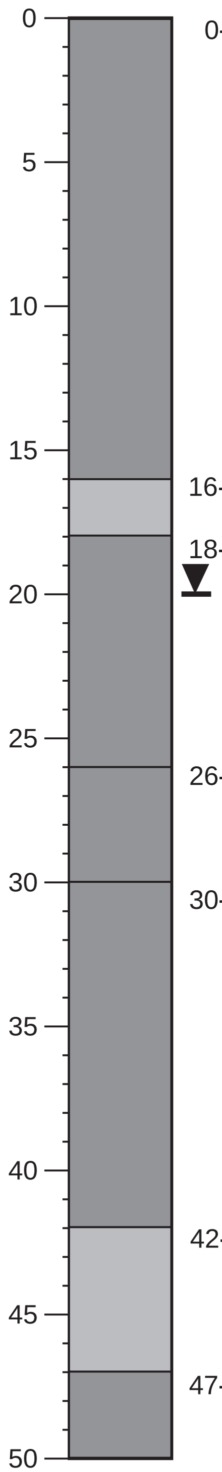
Log of boring: SJ-10-08

Date drilled: 10/1/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-16’ **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

16-18’ **Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 90% fine grained sand; 10% clay; micaceous; moist.

18-26’ **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 55% mostly fine to medium sand, lesser coarse; 30% gravel to 2”, slightly to moderately weathered greenish gray aphanitic mafics and light gray granitics with lesser quartzite and fragmental quartz; 15% clay; micaceous; moist. Becomes wet at 20’ depth.

With cobbles up to 5”, from 22’ to 26’ depth.

26-30’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/6); 55% sand, fine to coarse grained, quartzose; 30% clasts to 4”, slightly to moderately weathered, most clasts resistant to strong hammer blow; 15% clay.

30-42’ **Clayey, Sandy Gravel (GC);** with cobbles; yellowish brown (10YR 5/4); 50% clasts to 4”, slightly to moderately weathered granitics and lesser aphanitic mafics, with trace fragmental quartz, light gray quartzite and black porphyritic basalt; 35% fine to coarse sand; 15% clay.

42-47’ **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 50% fine to coarse sand; 40% clasts to 5”, slightly to moderately weathered, trace highly weathered; 10% clay.

47-56’ **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/6); 55% mostly fine to medium sand, lesser coarse; 30% clasts to 5”, slightly to moderately weathered, trace highly weathered; 15% clay.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

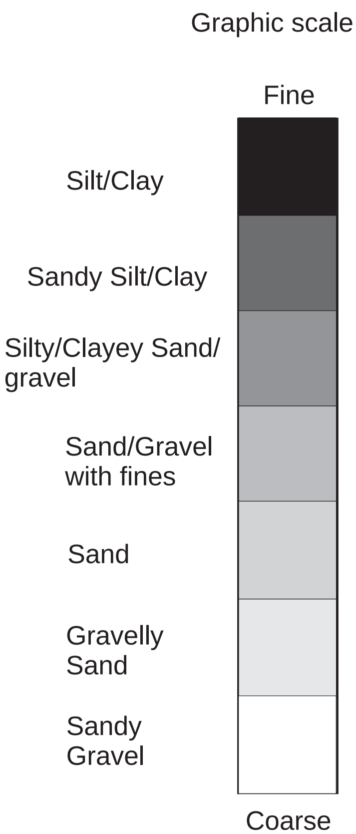
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

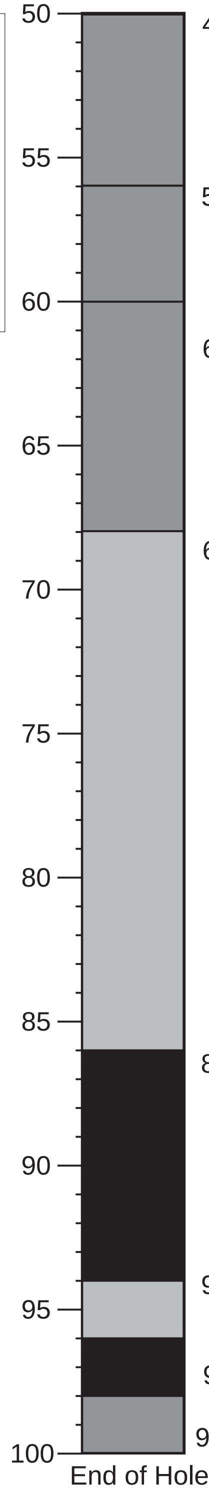
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66795° N
Longitude: 119.51366° W
Elevation: 333 feet (topo)

Log of boring: SJ-10-08

Date drilled: 10/1/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





47-56' **Clayey, Gravelly Sand (SC);** with cobbles; as above.

56-60' **Clayey, Gravelly Sand (SC);** with cobbles; dark grayish brown (10YR 4/2); 45% sand, mostly fine to medium, lesser coarse, arkosic; 35% clasts to 5", slightly to highly weathered, increase in highly weathered light gray coarse grained granitics with pervasive iron oxide staining; trace slightly foliated weakly resistant clasts; 20% clay.

60-68' **Clayey, Sandy Gravel (GC);** trace cobbles; yellowish brown (10YR 5/4); 50% clasts to 5", slightly to highly weathered, clasts are mostly variegated light gray and reddish brown coarse-grained granitics and lesser dark gray aphanitic mafics that are generally slightly weathered; 35% fine to medium sand; 15% clay. High water production.

68-86' **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/4); 50% fine to coarse sand; 40% clasts to 5", slightly to highly weathered, mostly moderately to highly weathered granitics and lesser fine grained greenish gray mafics and light brown quartzite; 10% clay.

86-94' **Clay with Sand (CL);** dark grayish brown (10YR 4/2); 80% stiff clay, slightly plastic; 20% fine sand; micaceous.

94-96' **Sandy Gravel with Clay (GW-GC);** trace cobbles; yellowish brown (10YR 5/4); 50% clasts to 5", moderately to highly weathered; 40% sand, mostly fine to medium, lesser coarse; 10% clay.

96-98' **Clay with Sand (CL);** dark grayish brown (10YR 4/2); 80% stiff clay, slightly plastic; 20% fine sand; micaceous.

98-100' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/4); 45% fine to coarse sand; 35% clasts to 4", 20% clay.

First water was observed at 20' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

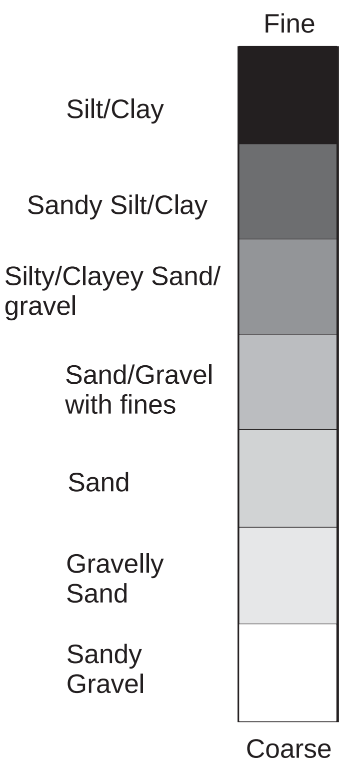
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66470° N
Longitude: 119.51845° W
Elevation: 332 feet (topo)

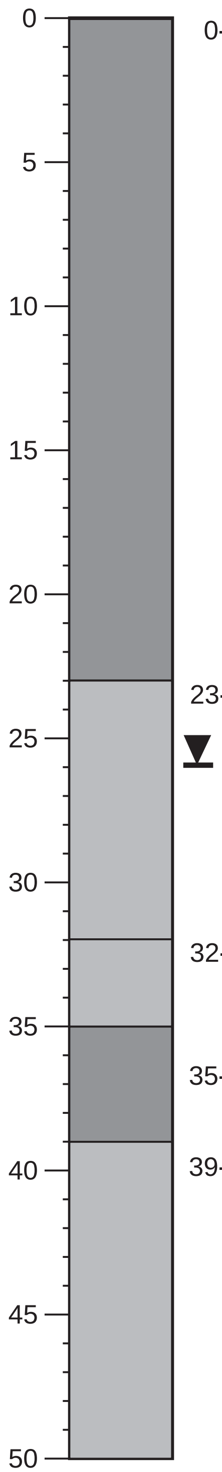
Log of boring: SJ-10-09

Date drilled: 9/30/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





0-23’ **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Becomes moist at 10’ depth.

23-32’ **Gravelly Sand with Clay (SP-SC);** dark yellowish brown (10YR 4/4); 55% sand, fine to medium, lesser coarse; 35% gravel to 3”, slightly to moderately weathered light gray granitics and dark gray aphanitic mafics with trace fragmental quartz and light brown quartzite, granitics are iron oxide stained on clast rims; 10% clay; moist. Becomes wet at 26’ depth. Trace cobbles to 4” from 28’ to 32’ depth.

32-35’ **Sandy Gravel with Clay (GW-GC);** with cobbles; dark yellowish brown (10YR 4/4); 50% clasts to 5”, slightly to moderately weathered, trace highly weathered, most clasts resistant to strong hammer blows; 40% fine to coarse sand; 10% clay.

35-39’ **Clayey, Gravelly Sand (SC);** with cobbles; yellowish brown (10YR 5/6); 45% fine to coarse sand; 35% clasts to 6”, slightly to moderately weathered; 20% clay.

39-55’ **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/6); 55% fine to coarse sand; 35% clasts to 5”, slightly to moderately weathered, trace highly weathered coarse grained granitics; 10% clay; micaceous.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

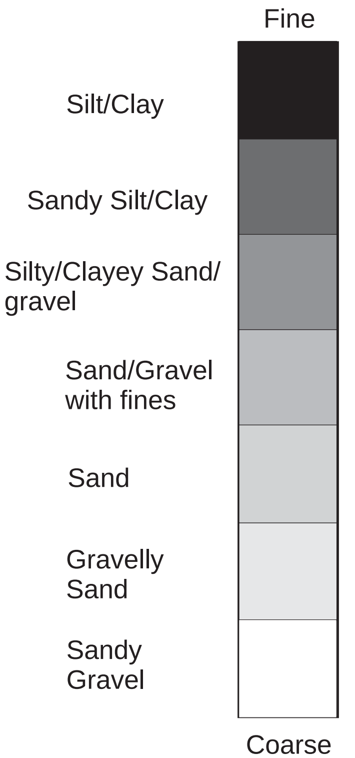
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

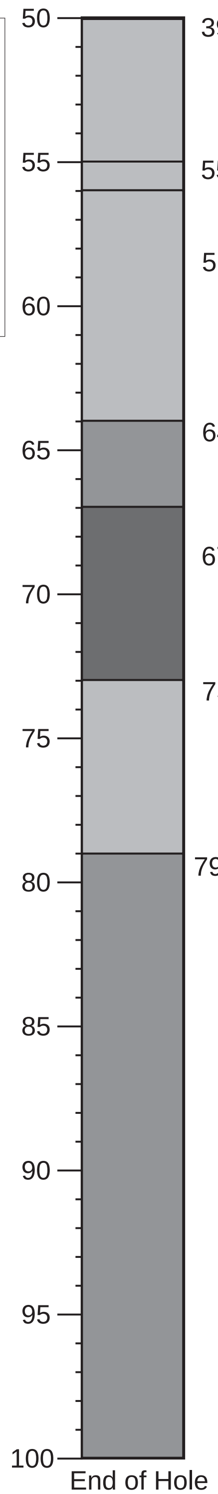
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66470° N
Longitude: 119.51845° W
Elevation: 332 feet (topo)

Log of boring: SJ-10-09
Date drilled: 9/30/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





39-55' **Gravelly Sand with Clay (SW-SC);** with cobbles; as above.

55-56' **Sand with Gravel and Clay (SP-SC);** yellowish brown (10YR 5/6); 70% sand, mostly fine to medium, lesser coarse; 20% slightly to moderately weathered gravel to 2"; 10% clay.

56-64' **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/6); 60% fine to coarse sand; 30% clasts to 5", slightly to highly weathered, lesser highly weathered; 10% clay.

64-67' **Clayey, Gravelly Sand (SC);** trace cobbles; yellowish brown (10YR 5/6); 50% sand, mostly fine to coarse, lesser fine; 35% clasts to 4", slightly weathered dark greenish gray mafics and quartzite, and moderately to highly weathered granitics; 15% clay. High water production.

67-73' **Sandy Clay (CL);** dark yellowish brown (10YR 3/6), mottled yellowish brown (10YR 5/6); 70% stiff clay; 30% fine sand; inferred thin discrete plastic clay lenses.

73-79' **Gravelly Sand with Clay (SW-SC);** yellowish brown (10YR 5/4); 55% sand, fine to coarse; 35% gravel to 3", mostly moderately to highly weathered, lesser slightly weathered, less mafics than shallower depths; 10% clay.

79-100' **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 45% fine to coarse sand; 35% clasts to 5", most clasts break readily with strong hammer blow, moderately to highly weathered; 20% clay.

Cobbles decrease in amounts and in size from 90' to 100' depth.

First water was observed at 26' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

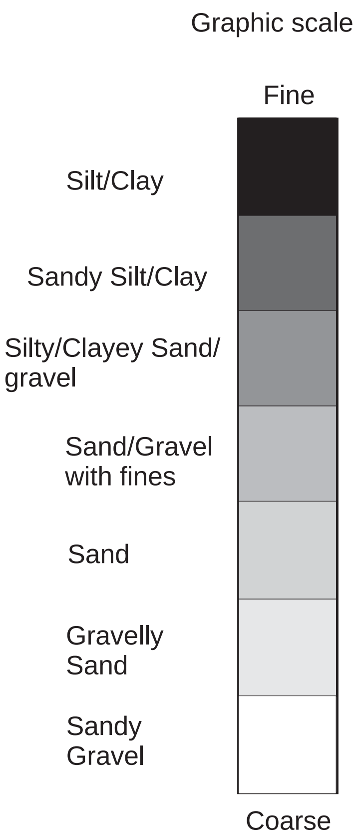
Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

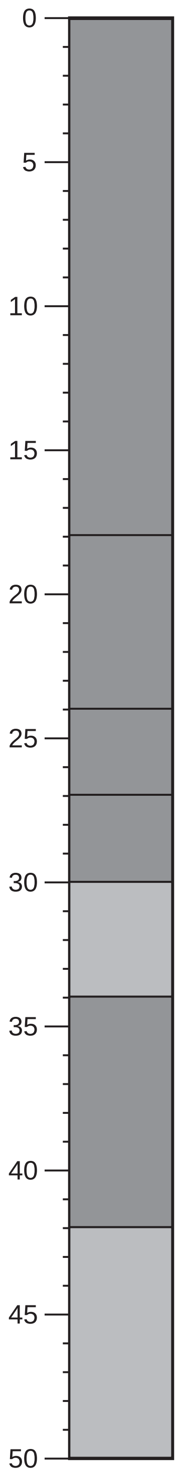
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66460° N
Longitude: 119.51369° W
Elevation: 332 feet (topo)

Log of boring: SJ-10-10
Date drilled: 10/1/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-18 **Silty Sand (SM);** dark yellowish brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Sand becomes fine to medium grained and moist from 12’ depth.

18-24’ **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 45% sand, mostly fine to medium, lesser coarse; 35% gravel to 3”, slightly to moderately weathered light gray granitics and dark greenish gray aphanitic mafics with trace quartzite; 20% clay; becomes wet at 20’ depth.

24-27’ **Clayey, Gravelly Sand (SC);** with cobbles; dark yellowish brown (10YR 4/4); 45% fine to coarse sand; 30% clasts to 5”, slightly to moderately weathered; 25% clay.

27-30’ **Clayey, Sandy Gravel (GC);** trace cobbles; dark yellowish brown (10YR 4/4); 50% clasts to 5”, slightly weathered dark greenish gray aphanitic mafics and slightly to moderately weathered granitics; 35% fine to coarse sand; 15% clay.

30-34’ **Sandy Gravel with Clay (GW-GC);** trace cobbles; dark yellowish brown (10YR 4/4); 50% clasts to 5”; 40% fine to coarse sand; 10% clay.

34-42’ **Clayey, Gravelly Sand (SC);** trace cobbles; dark yellowish brown (10YR 4/6); 50% fine to coarse sand; 35% clasts to 5”, mostly slightly to moderately weathered, trace highly weathered coarse grained granitics with pervasive iron oxide staining on clast rims and in fractures, trace moderately weathered grayish brown schistose clasts; 15% clay.

42-53’ **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/6); 50% fine to coarse sand; 40% clasts to 8”, mostly slightly to moderately weathered and resistant to strong hammer blows; 10% clay. high water production.

Color change to yellowish brown (10YR 5/6) from 46 to 53’ depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

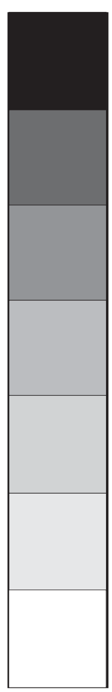
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

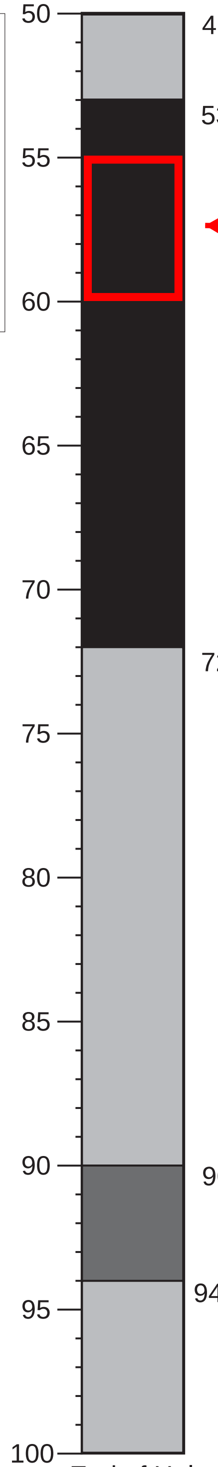
Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66460° N
Longitude: 119.51369° W
Elevation: 332 feet (from topo)

Log of boring: SJ-10-10
Date drilled: 10/1/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.

Graphic scale





42-53' **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/6); as above.

53-72' **Clay (CL);** yellowish brown (10YR 5/6); stiff, slightly plastic.

Tetra Tech BASg: gradation, shear, Atterberg Limits, maximum density

Interbedded with thin sandy layers from 62' to 72' depth.

Becomes dark yellowish brown (10YR 4/6) from 63' to 72' depth.

72-90' **Gravelly Sand with Clay (SP-SC);** with cobbles; yellowish brown (10YR 5/6); 60% fine to medium sand; 30% clasts to 4", mostly highly weathered light gray coarse grained granitics with pervasive iron oxide staining, clasts break readily with strong hammer blow; 10% clay; very micaceous.

Increase in gravel content to 40%, sand content decreased to 50% from 80' to 90' depth.

Clay lenses to 4" thick observed between 85' and 90' depth.

90-94' **Sandy Clay with Gravel (CL);** yellowish brown (10YR 5/6); 55% clay, very stiff; 30% fine sand; 15% gravel to 3".

94-100' **Sand with Gravel and Clay (SP-SC);** trace cobbles; grayish brown (10YR 5/2); 70% fine to medium sand; 20% clasts to 4", moderately to highly weathered; 10% clay. High water production.

End of Hole

First water was observed at 20' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

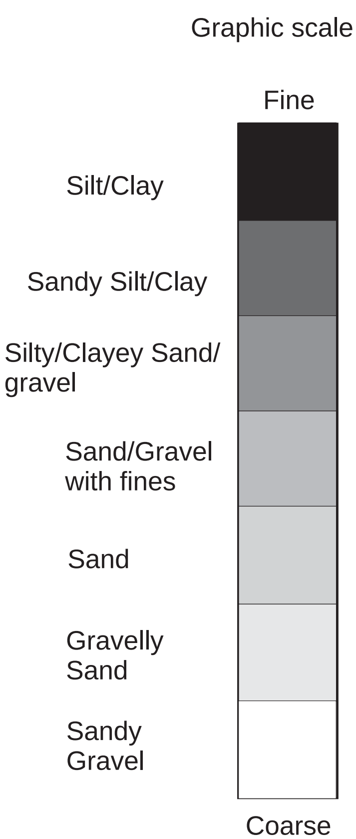
Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

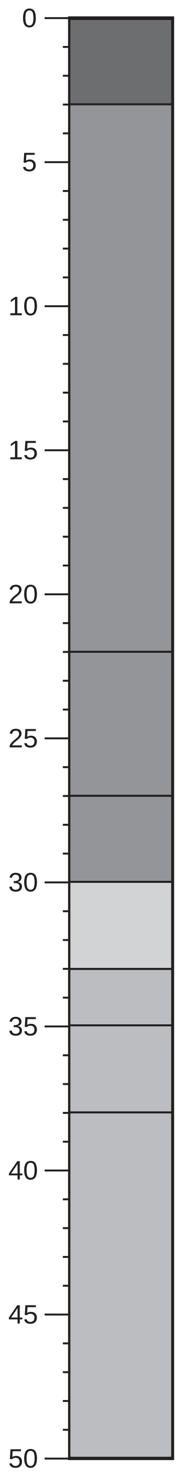
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66278° N
Longitude: 119.51583° W
Elevation: 330 feet (topo)

Log of boring: SJ-10-11
Date drilled: 9/29/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





0-3' **Sandy Silt (ML);** dark yellowish brown (10YR 3/4); 70% soft silt; 30% fine grained sand; dry.

3-22' **Silty Sand (SM);** dark brown (10YR 3/3); 70% fine grained sand; 30% soft silt; dry.

Becomes wet at 18' depth.

22-27' **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 45% mostly fine to medium sand, lesser coarse, quartzose; 35% gravel to 3", slightly to moderately weathered, most clasts resistant to strong hammer blow, light gray granitics and dark greenish gray mafics with lesser amounts of porphyritic basalt, fragmental quartz, and quartzite; 20% clay; wet.

27-30' **Clayey, Gravelly Sand (SC);** with cobbles, dark yellowish brown (10YR 4/4); 45% fine to medium sand; 35% clasts to 5", slightly to moderately weathered; 20% clay.

30-33' **Sand with Gravel (SW);** with cobbles; brown (10YR 4/3); 80% clean sand, fine to coarse; 20% clasts to 5", slightly to moderately weathered; micaceous.

33-35' **Gravelly Sand with Clay (SW-SC);** dark yellowish brown (10YR 4/4); 60% fine to coarse sand; 30% gravel to 3"; 10% clay.

35-38' **Sandy Gravel with Clay (GW-GC);** with cobbles; yellowish brown (10YR 5/4); 50% clasts to 5", slightly to moderately weathered granitics and lesser dark gray mafics; 40% fine to medium sand; 10% clay.

38-50' **Gravelly Sand with Clay (SW-SC);** with cobbles; yellowish brown (10YR 5/4); 50% fine to coarse sand; 40% clasts to 4", slightly to moderately weathered, trace highly weathered coarse grained granitics; 10% clay; micaceous. High water production.

Clasts content decreased to 30%, sand increased to 60% from 46' to 50' depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

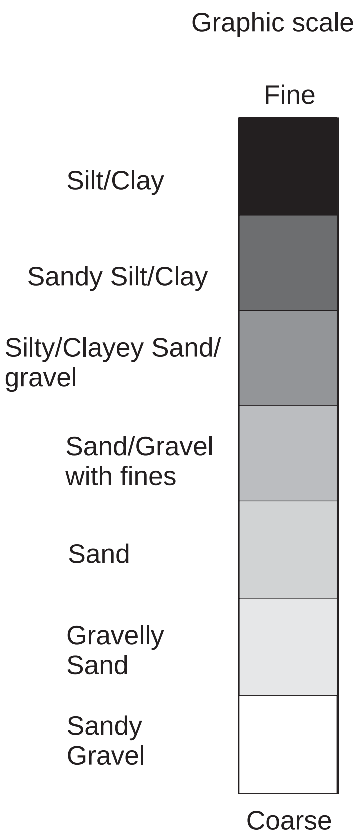
CHG

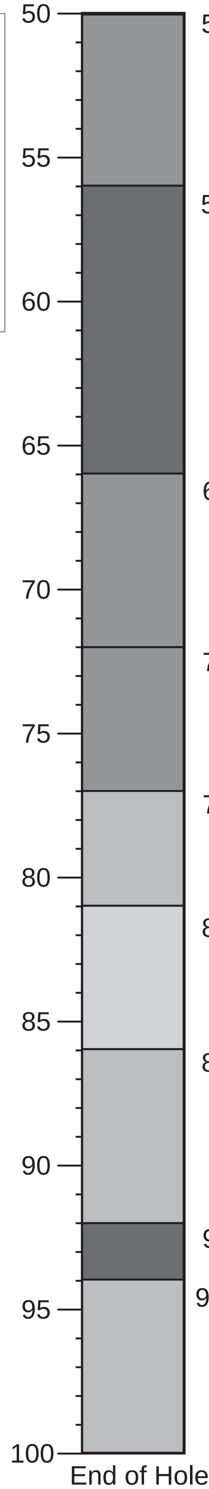
Project: Samantha Jean Project, Running Luck Ranch
Fresno County, California

Client: Running Luck Ranch
Site: East Goodfellow Road
Latitude: 36.66278° N
Longitude: 119.51583° W
Elevation: 330 feet (topo)

Log of boring: SJ-10-11
Date drilled: 9/29/10
Total Depth: 100 feet

Notes:
1) All sand angular to subrounded unless otherwise noted.
2) All gravel and cobbles subrounded to rounded unless otherwise noted.
3) All percentages based on visual estimates.





50-56’ **Clayey, Gravelly Sand (SC);** yellowish brown (10YR 5/4); 50% sand, fine to medium, lesser coarse; 35% gravel to 3”, slightly weathered dark greenish gray mafics and moderately to highly weathered coarse-grained granitics with pervasive iron oxide staining; 15% clay.

56-66’ **Sandy Clay (CL);** yellowish brown (10YR 5/6); 70% stiff clay; 30% fine sand; micaceous.

Inferred alternating layers of plastic clay and and sandy clay from 60’ to 66’ depth.

66-72’ **Clayey Sand (SC);** dark yellowish brown (10YR 3/6); 70% fine sand; 30% clay; micaceous.

72-77’ **Clayey, Gravelly Sand (SC);** dark yellowish brown (10YR 4/4); 45% fine to coarse sand, arkosic; 30% gravel to 3”, slightly to highly weathered, mostly moderately to highly weathered; 25% clay. Inferred discrete clay lenses within interval.

77-81’ **Gravelly Sand with Clay (SP-SC);** grayish brown (10YR 5/2); 60% medium to coarse sand, lesser fine; 30% gravel to 3”, moderately to highly weathered, most clasts break readily under strong hammer blow; 10% clay; micaceous.

81-86’ **Sand with Gravel (SW);** grayish brown (10YR 5/2); 80% fine to coarse sand, clean; 20% gravel to 2”, moderately to highly weathered.

86-92’ **Gravelly Sand with Clay (SW-SC);** with cobbles; dark yellowish brown (10YR 4/4); 55% fine to coarse sand; 35% clasts to 5”, moderately to highly weathered coarse grained granitics and lesser slightly foliated clasts; 10% clay.

92-94’ **Sandy Clay (CL);** dark yellowish brown (10YR 4/4); 70% stiff clay; 30% fine sand.

94-100’ **Sand with Gravel and Clay (SP-SC);** with cobbles; dark yellowish brown (10YR 4/4); 75% sand, fine to medium, lesser coarse; 15% clasts to 6”, mostly highly weathered; 10% clay.

First water was observed at 18’ depth.

Driller: Layne Christensen Co.
Rig: Foremost AP 1000 drilling rig
Method: 10-3/4-inch diameter percussion hammer

Geologist : D. Williams
Cleath-Harris Geologists, Inc.
San Luis Obispo, California

CHG

TABLE 5.1 Unified Soil Classification System

Major divisions	Subdivisions	USCS symbol	Typical names	Laboratory classification criteria	
Coarse-grained soils (More than 50% retained on No. 200 sieve)	**Gravels** (More than 50% of coarse fraction retained on no. 4 sieve)	GW	Well-graded gravels or gravel-sand mixtures, little or no fines	Less than 5% fines*	$C_u \geq 4$ and $1 \leq C_c \leq 3$
		GP	Poorly graded gravels or gravelly sands, little or no fines	Less than 5% fines*	Does not meet C_u and/or C_c criteria listed above
		GM	Silty gravels, gravel-sand-silt mixtures	More than 12% fines*	Minus no. 40 soil plots below the *A* line
		GC	Clayey gravels, gravel-sand-clay mixtures	More than 12% fines*	Minus no. 40 soil plots on or above the *A* line
	Sands (50% or more of coarse fraction passes no. 4 sieve)	SW	Well-graded sands or gravelly sands, little or no fines	Less than 5% fines*	$C_u \geq 6$ and $1 \leq C_c \leq 3$
		SP	Poorly graded sands or gravelly sands, little or no fines	Less than 5% fines*	Does not meet C_u and/or C_c criteria listed above
		SM	Silty sands, sand-silt mixtures	More than 12% fines*	Minus no. 40 soil plots below the *A* line
		SC	Clayey sands, sand-clay mixtures	More than 12% fines*	Minus no. 40 soil plots on or above *A* line
Fine-grained soils (50% or more passes no. 200 sieve)	**Silts and clays** (Liquid limit less than 50)	ML	Inorganic silts, rock flour, silts of low plasticity	Inorganic soil	PI < 4 or plots below *A* line
		CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, etc.	Inorganic soil	PI > 7 and plots on or above *A* line†
		OL	Organic silts and organic clays of low plasticity	Organic soil	LL (oven-dried)/LL (not dried) < 0.75
	Silts and clays (Liquid limit 50 or more)	MH	Inorganic silts, micaceous silts, silts of high plasticity	Inorganic soil	Plots below *A* line
		CH	Inorganic highly plastic clays, fat clays, silty clays, etc.	Inorganic soil	Plots on or above *A* line
		OH	Organic silts and organic clays of high plasticity	Organic soil	LL (oven dried) / LL (not dried) < 0.75
Peat	Highly organic	PT	Peat and other highly organic soils	Primarily organic matter, dark in color, and organic odor	

**Fines* are those soil particles that pass the no. 200 sieve. For gravels with 5 to 12 percent fines, use of dual symbols required (i.e., GW-GM, GW-GC, GP-GM, or GP-GC). For sands with 5 to 12 percent fines, use of dual symbols required (i.e., SW-SM, SW-SC, SP-SM, or SP-SC).

† If $4 \leq PI \leq 7$ and plots above *A* line, then dual symbol (i.e., CL-ML) is required.

ROCKS

Table 4-4.—Weathering descriptors

Descriptors: Alpha-numeric descriptor	Descriptors: Descriptive term	Diagnostic features: Chemical weathering—Discoloration and/or oxidation: Body of rock	Diagnostic features: Chemical weathering—Discoloration and/or oxidation: Fracture surfaces†	Diagnostic features: Mechanical weathering - Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Diagnostic features: Texture and solutioning: Texture	Diagnostic features: Texture and solutioning: Solutioning	General characteristics (strength, excavation, etc.)§
W1	Fresh.	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change.	No solutioning.	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
W2	Slightly weathered to fresh.*						
W3	Slightly weathered.	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
W4	Moderately to slightly weathered.*						
W5	Moderately weathered.	Discoloration or oxidation extends from fractures, usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstone or shales.
W6	Intensely to moderately weathered.*						
W7	Intensely weathered.	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
W8	Very intensely weathered.						
W9	Decomposed.	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Note: This chart and its horizontal categories are more readily applied to rocks with feldspars and mafic minerals. Weathering in various sedimentary rocks, particularly limestones and poorly indurated sediments, will not always fit the categories established. This chart and weathering categories may have to be modified for particular site conditions or alteration such as hydrothermal effects; however, the basic framework and similar descriptors are to be used.

* Combination descriptors are permissible where equal distribution of both weathering characteristics are present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, dual descriptors should not be used where significant, identifiable zones can be delineated. When given as a range, only two adjacent terms may be combined (i.e., decomposed to lightly weathered or moderately weathered to fresh) are not acceptable.

† Does not include directional weathering along shears or faults and their associated features. For example, a shear zone that carried weathering to great depths into a fresh rock mass would not require the rock mass to be classified as weathered.

§ These are generalizations and should not be used as diagnostic features for weathering or excavation classification. These characteristics vary to a large extent based on naturally weak materials or cementation and type of excavation.

Consistency of fine grained material (Excerpted from Soil Testing Manual, Robert Day, McGraw-Hill, 2001)

Very soft. The clay is easily penetrated several centimeters by the thumb. The clay oozes out between the fingers when squeezed in the hand.

Soft. The clay is easily penetrated 2.5 cm (1 inch) by the thumb. The clay can be molded by slight finger pressure.

Medium. The clay can be penetrated about 1 cm (0.4 inches) by the thumb with moderate effort. The clay can be molded by strong finger pressure.

Stiff. The clay can be indented about 0.5 cm (0.2 inches) by the thumb with great effort.

Very stiff. The clay cannot be indented by the thumb, but can be readily indented with the thumbnail.

Hard. With great difficulty, the clay can only be indented with the thumbnail.

Excerpted from U.S. Bureau of Reclamation Engineering Field Manual (1989). Chapter 3

Angularity

Angularity is a descriptor for coarse-grained materials only. The angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, are described as angular, subangular, subrounded, or rounded as indicated by the criteria in table 3-8. A range of angularity may be stated, such as: sub-rounded to rounded.

Angular Particles have sharp edges and relatively planar sides with unpolished surfaces.

Subangular Particles are similar to angular description but have rounded edges.

Subrounded Particles have nearly planar sides but well rounded corners and edges.

Rounded Particles have smoothly curved sides and no edges.

Moisture Conditions

Describe the moisture condition as dry, moist, or wet, as indicated by the criteria in table 3-10.

Dry: Absence of moisture, dusty, dry to the touch.

Moist: Damp but no visible water.

Wet: Visible free water, usually soil is below water table.

APPENDIX B

LABORATORY TESTING:

TETRA TECH BAS GEOSCIENCE
CLEATH-HARRIS GEOLOGISTS, INC.

Appendix B
Results of Laboratory Testing – Tetra Tech BAS GeoScience

Samples recovered from soil borings advanced on the site in 2010 under the direction of Cleath-Harris Geologists, Inc. (2010a, 2010b) were provided for field review by Tt-BASg staff. Selected samples were retained and tested to evaluate Atterberg limits, grain size distribution, dry density and optimum moisture relationships and shear strength properties. A brief description of the tests performed along with the results is presented below.

Atterberg Limits Tests
The Liquid Limit, Plastic Limit, and Plasticity Index of four soil samples were evaluated in general accordance with ASTM D4318. The results of this test are presented in the table below.

Cleath-Harris Geologists, Inc. Boring No.	Sample Depth (ft)	Soil Type USCS	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
RL-11-01	79.5-82	CL	38	22	16
SJ-10-02	60-65	ML	30	23	7
SJ-10-05	70-75	SM	23	19	4
SJ-10-10	55-60	ML	36	27	9

Particle Size Analysis
Particle size analyses of nine selected soil samples were performed in general accordance with ASTM D422. The results of the analyses are presented on the following pages.

Dry Density and Moisture Relationships
Dry density and moisture content of four selected soil samples were evaluated in general accordance with ASTM D1557 methods. The test method was modified to include the evaluation of one point per sample as a means of estimating the maximum dry density and the optimum moisture content. The results of the analyses are presented on the following pages.

Direct Shear Tests
Direct shear tests were performed on four soil samples remolded to approximately 90 percent of the estimated maximum dry density and near then estimated optimum moisture content. The samples were tested under three different normal loads at a constant strain rate of 0.0042 inches per minute in general accordance with ASTM D3080. The samples were inundated during shearing to represent potentially adverse field conditions. Shearing of the specimens was continued until the shear stress became essentially constant or until a deformation of approximately 10 percent of the original diameter had been reached. The results of the direct shear tests are presented on the following pages.

Appendix B
Results of Laboratory Testing – Tetra Tech BAS GeoScience

Samples recovered from soil borings advanced on the site in 2010 under the direction of Cleath-Harris Geologists, Inc. (2010a, 2010b) were provided for field review by Tt-BASg staff. Selected samples were retained and tested to evaluate Atterberg limits, grain size distribution, dry density and optimum moisture relationships and shear strength properties. A brief description of the tests performed along with the results is presented below.

Atterberg Limits Tests

The Liquid Limit, Plastic Limit, and Plasticity Index of four soil samples were evaluated in general accordance with ASTM D4318. The results of this test are presented in the table below.

Cleath-Harris Geologists, Inc. Boring No.	Sample Depth (ft)	Soil Type USCS	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
RL-11-01	79.5-82	CL	38	22	16
SJ-10-02	60-65	ML	30	23	7
SJ-10-05	70-75	SM	23	19	4
SJ-10-10	55-60	ML	36	27	9

Particle Size Analysis

Particle size analyses of nine selected soil samples were performed in general accordance with ASTM D422. The results of the analyses are presented on the following pages.

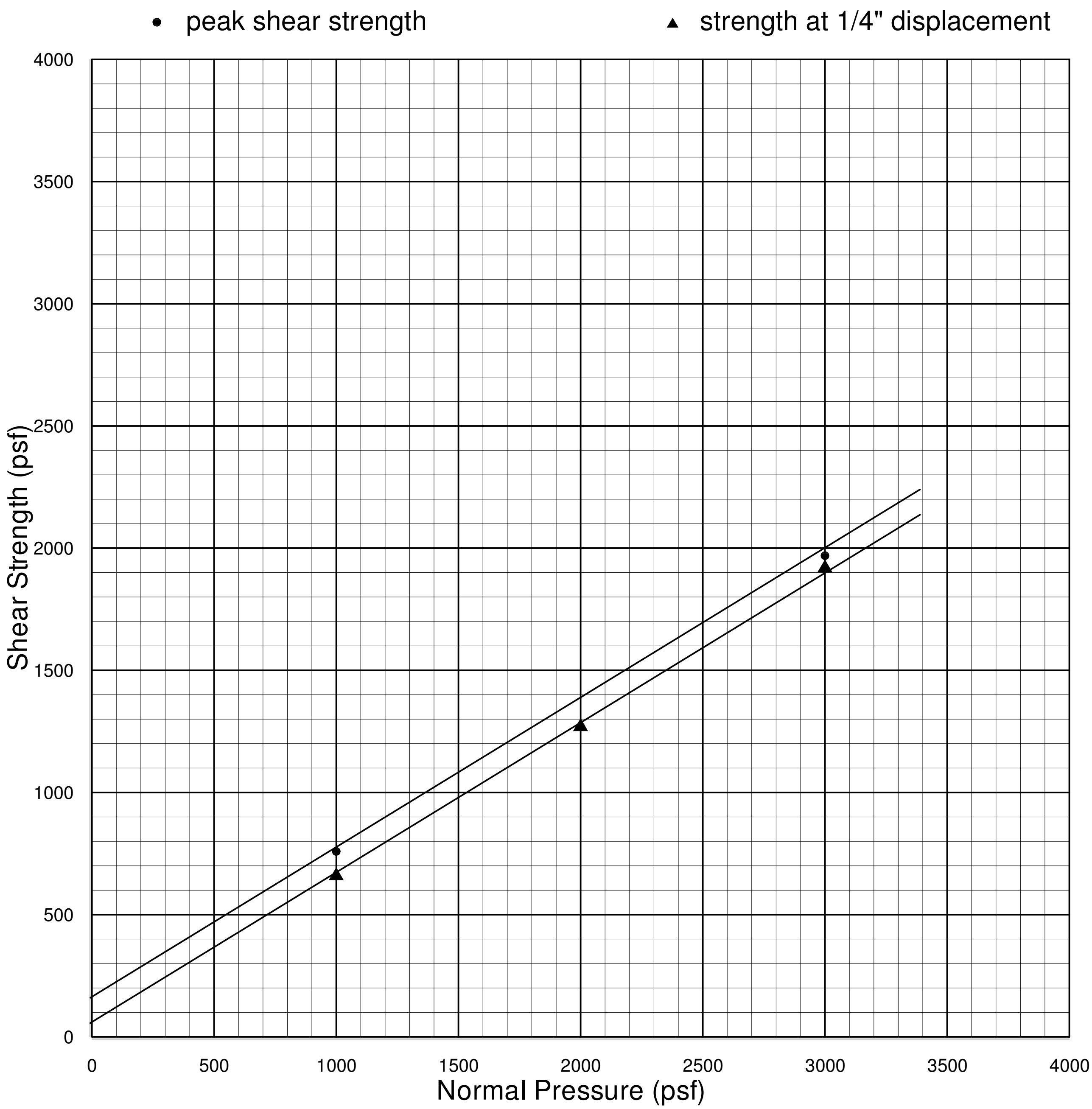
Dry Density and Moisture Relationships

Dry density and moisture content of four selected soil samples were evaluated in general accordance with ASTM D1557 methods. The test method was modified to include the evaluation of one point per sample as a means of estimating the maximum dry density and the optimum moisture content. The results of the analyses are presented on the following pages.

Direct Shear Tests

Direct shear tests were performed on four soil samples remolded to approximately 90 percent of the estimated maximum dry density and near then estimated optimum moisture content. The samples were tested under three different normal loads at a constant strain rate of 0.0042 inches per minute in general accordance with ASTM D3080. The samples were inundated during shearing to represent potentially adverse field conditions. Shearing of the specimens was continued until the shear stress became essentially constant or until a deformation of approximately 10 percent of the original diameter had been reached. The results of the direct shear tests are presented on the following pages.

DIRECT SHEAR TEST - ASTM D-3080

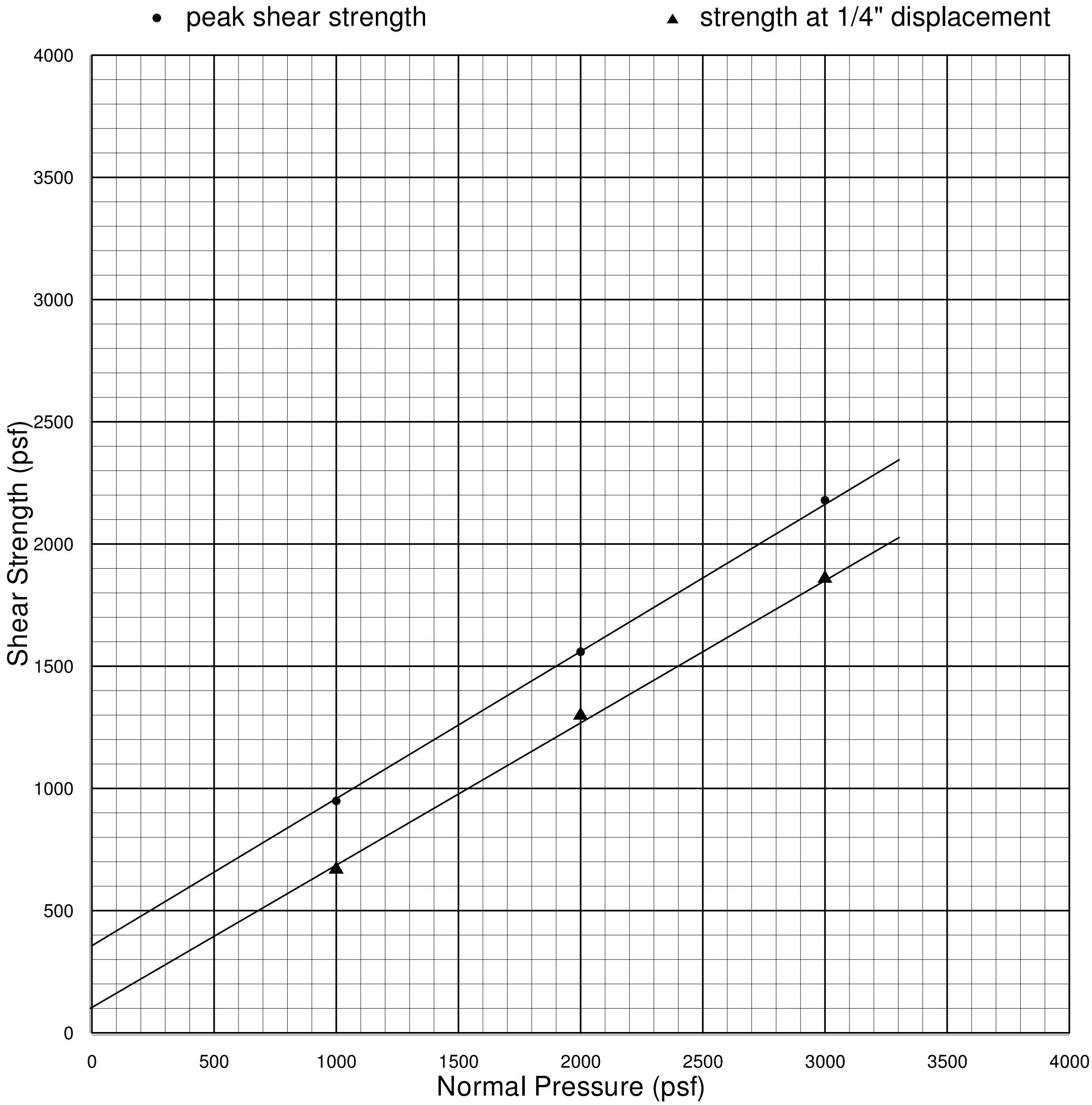


Strain Rate: 0.0042 in. / min.

Sample	**Type**	**Description**	**Dry Density (pcf)**	**Initial W.C (%)**	**Final W.C. (%)**
RL 11-01 @9.5'-12'	Remolded & Saturated	Silty Sand	105.0 (85% Max. Density)	10.0	19.5

Normal Pressure (psf)	Peak Shear Strength (psf)	Ultimate Shear Strength (psf)
1000	760 @ 0.0350"	660
2000	1270 @ 0.2300"	1270
3000	1970 @ 0.2400"	1920
	C = 150 psf	C = 50 psf
	ϕ = 32 deg.	ϕ = 32 deg.

DIRECT SHEAR TEST - ASTM D-3080

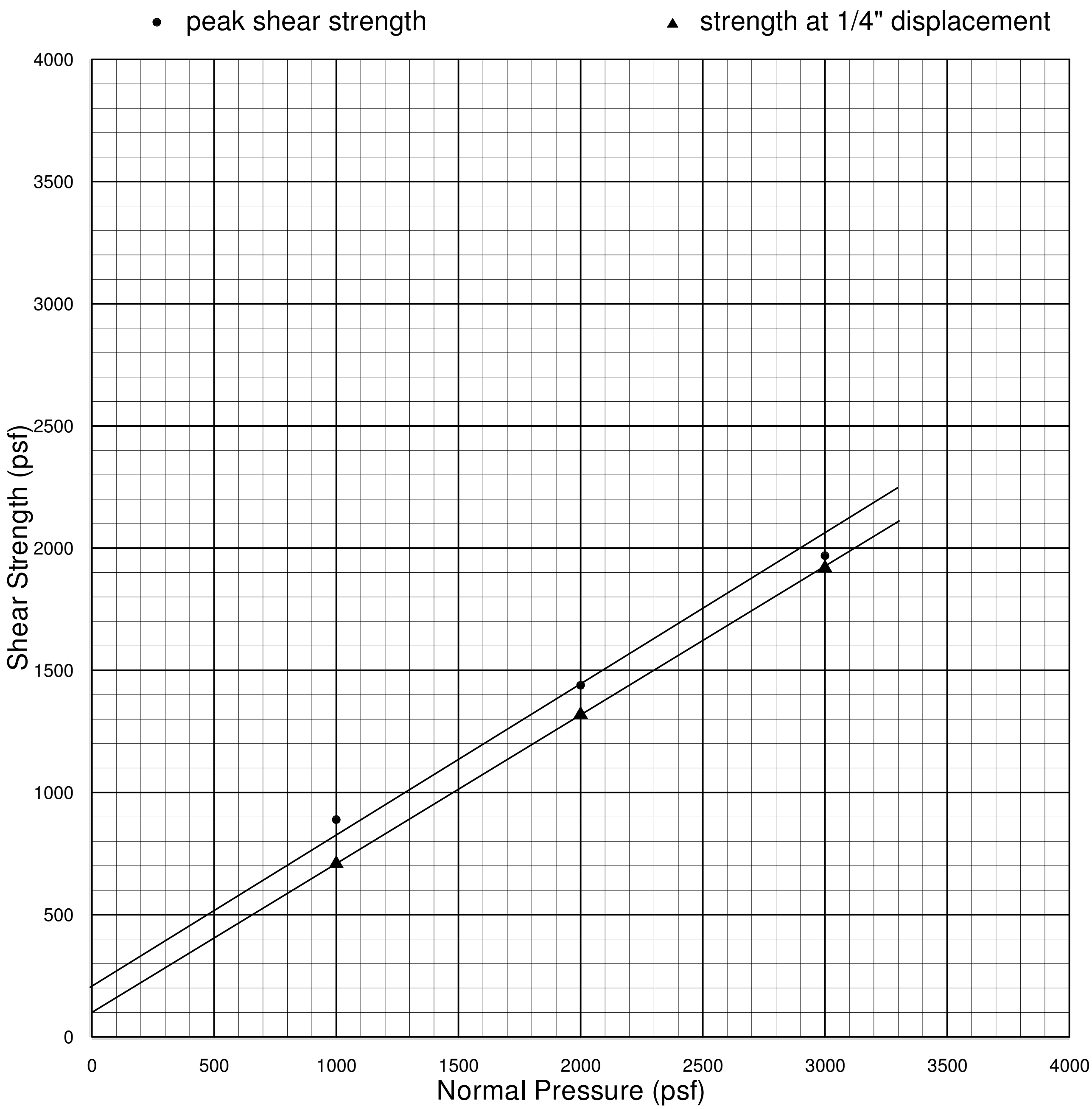


Strain Rate: 0.0042 in. / min.

Sample	**Type**	**Description**	**Dry Density (pcf)**	**Initial W.C (%)**	**Final W.C. (%)**
RL 11-01 @79.5'-82'	Remolded & Saturated	Sandy Clay	111.6 (90% Max. Density)	13.0	17.8

Normal Pressure (psf)	Peak Shear Strength (psf)	Ultimate Shear Strength (psf)
1000	950 @ 0.0350"	670
2000	1560 @ 0.0600"	1300
3000	2180 @ 0.0550"	1860
	C = 350 psf	C = 100 psf
	ϕ = 31 deg.	ϕ = 31 deg.

DIRECT SHEAR TEST - ASTM D-3080

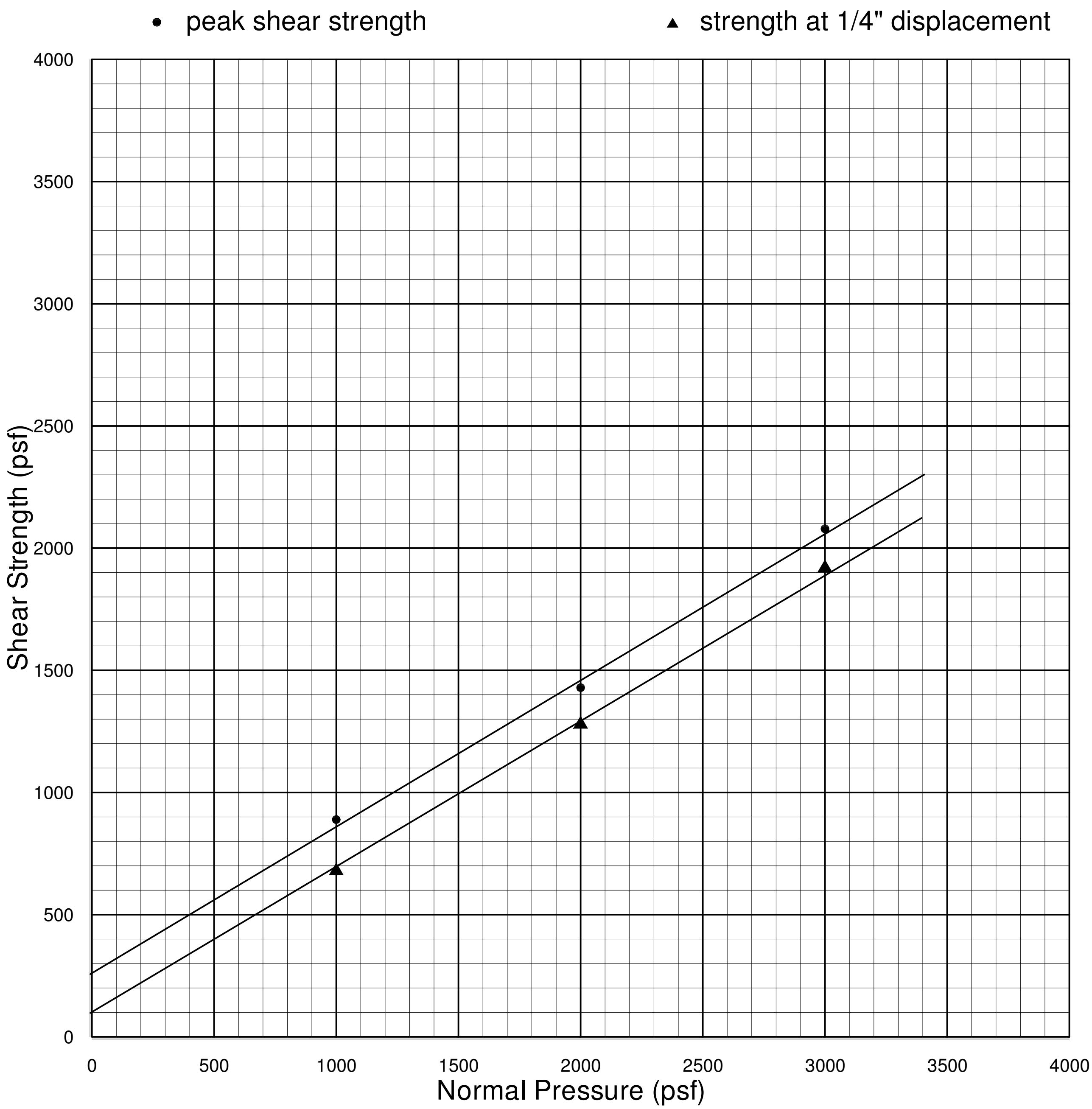


Strain Rate: 0.0042 in. / min.

Sample	Type	Description	Dry Density (pcf)	Initial W.C (%)	Final W.C. (%)
RL 11-02 @67'-69.5'	Remolded & Saturated	Silty Sand	113.9 (90% Max. Density)	10.7	15.4

Normal Pressure (psf)	Peak Shear Strength (psf)	Ultimate Shear Strength (psf)
1000	890 @ 0.0350"	710
2000	1440 @ 0.0350"	1320
3000	1970 @ 0.1450"	1920
	C = 200 psf	C = 100 psf
	ϕ = 31 deg.	ϕ = 31 deg.

DIRECT SHEAR TEST - ASTM D-3080



Strain Rate: 0.0042 in. / min.

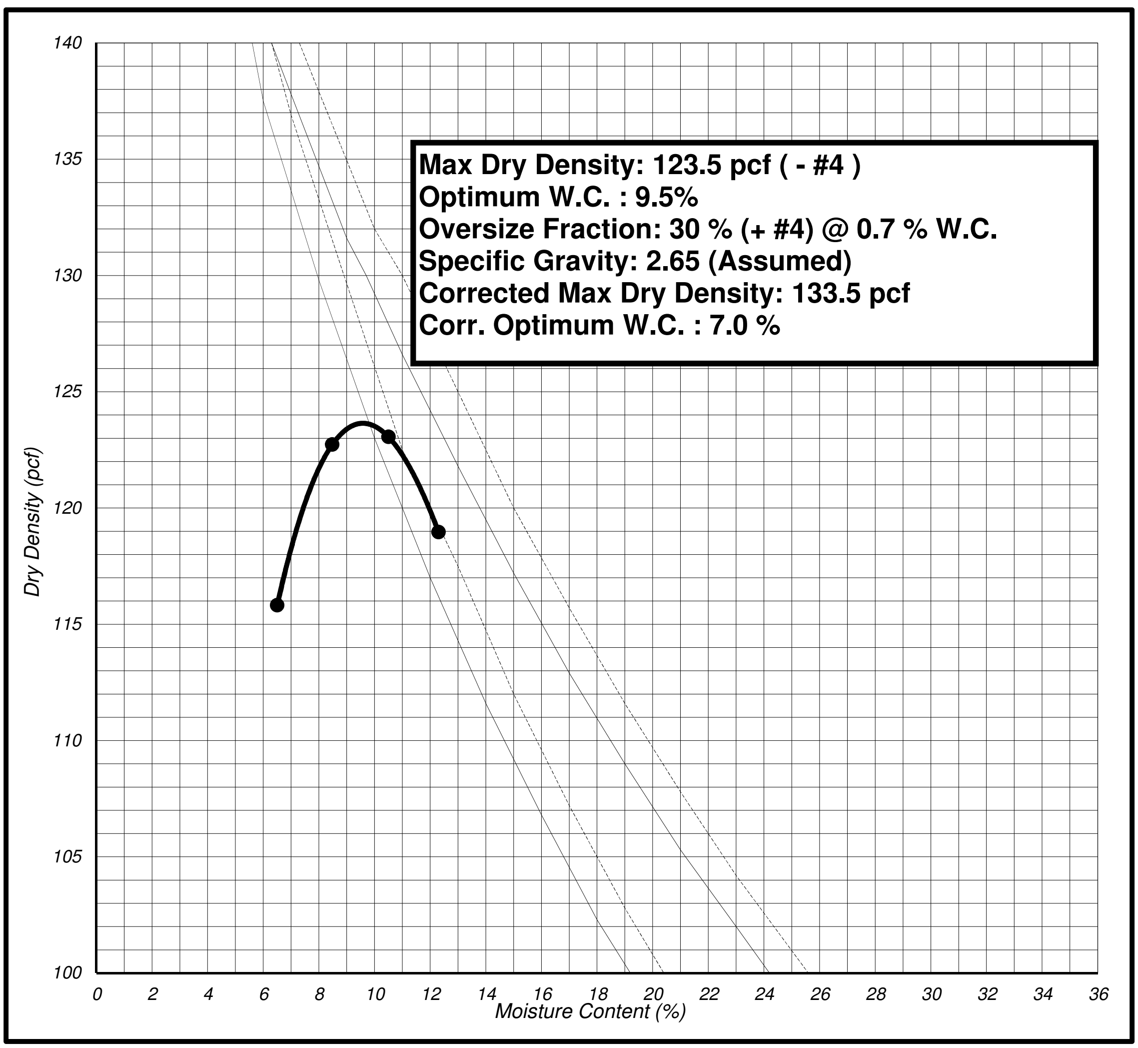
Sample	**Type**	**Description**	**Dry Density (pcf)**	**Initial W.C (%)**	**Final W.C. (%)**
SJ 10-10 @55'-60'	Remolded & Saturated	Silt	97.7 (90% Max. Density)	15.0	27.4

Normal Pressure (psf)	Peak Shear Strength (psf)	Ultimate Shear Strength (psf)
1000	890 @ 0.0350"	680
2000	1430 @ 0.0550"	1280
3000	2080 @ 0.0500"	1920
	C = 150 psf	C = 100 psf
	ϕ = 31 deg.	ϕ = 31 deg.

MAXIMUM DENSITY TEST ASTM D1557

Job Name	TetraTech BAS # RSG 13-01E	**Date:**	6/10/2013
Job No.		**By:**	LD
Boring/Sample No.	RL-11-01 @ 9.5' - 12'		
Description:	Brown, F.M. Silty Sand w. Gravel		

Method: **A**	Mold Volume (cf): **0.0333**	Blows: **25**		Layers: **5**	
Specimen	A	B	C	D	E
Total Wet Weight (lbs)	**8.33**				
Weight of Mold (lbs)	3.89				
Wet Weight of Soil (lbs)	4.44				
Wet Density (pcf)	133.1				
Moisture Can No.					
Dry Weight					
Moisture Content (%)	**8.5**				
Dry Density (pcf)	122.7				

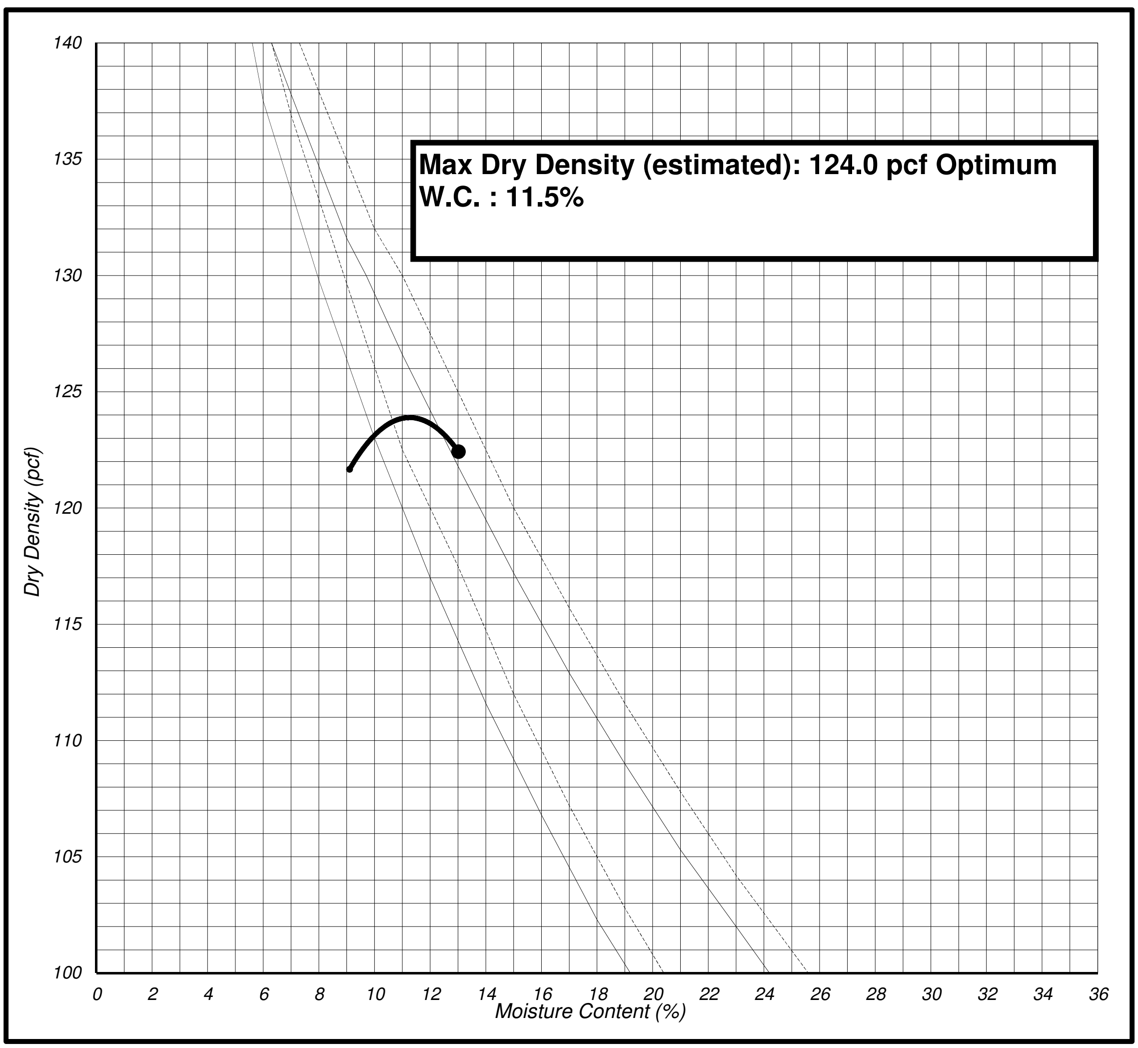


Geo-Logic ASSOCIATES

MAXIMUM DENSITY TEST ASTM D1557

Job Name	TetraTech BAS # RSG 13-01E	**Date:**	6/11/2013
Job No.	2013-0047	**By:**	LD
Boring/Sample No.	RL-11-01 @ 79.5' - 82'		
Description:	Brown, F.M. Sandy Clay		

Method: **A**	Mold Volume (cf): **0.0333**		Blows: **25**		Layers: **5**
Specimen	A	B	C	D	E
Total Wet Weight (lbs)	**8.50**				
Weight of Mold (lbs)	3.89				
Wet Weight of Soil (lbs)	4.61				
Wet Density (pcf)	138.4				
Moisture Can No.					
Dry Weight					
Moisture Content (%)	**13.0**				
Dry Density (pcf)	122.4				

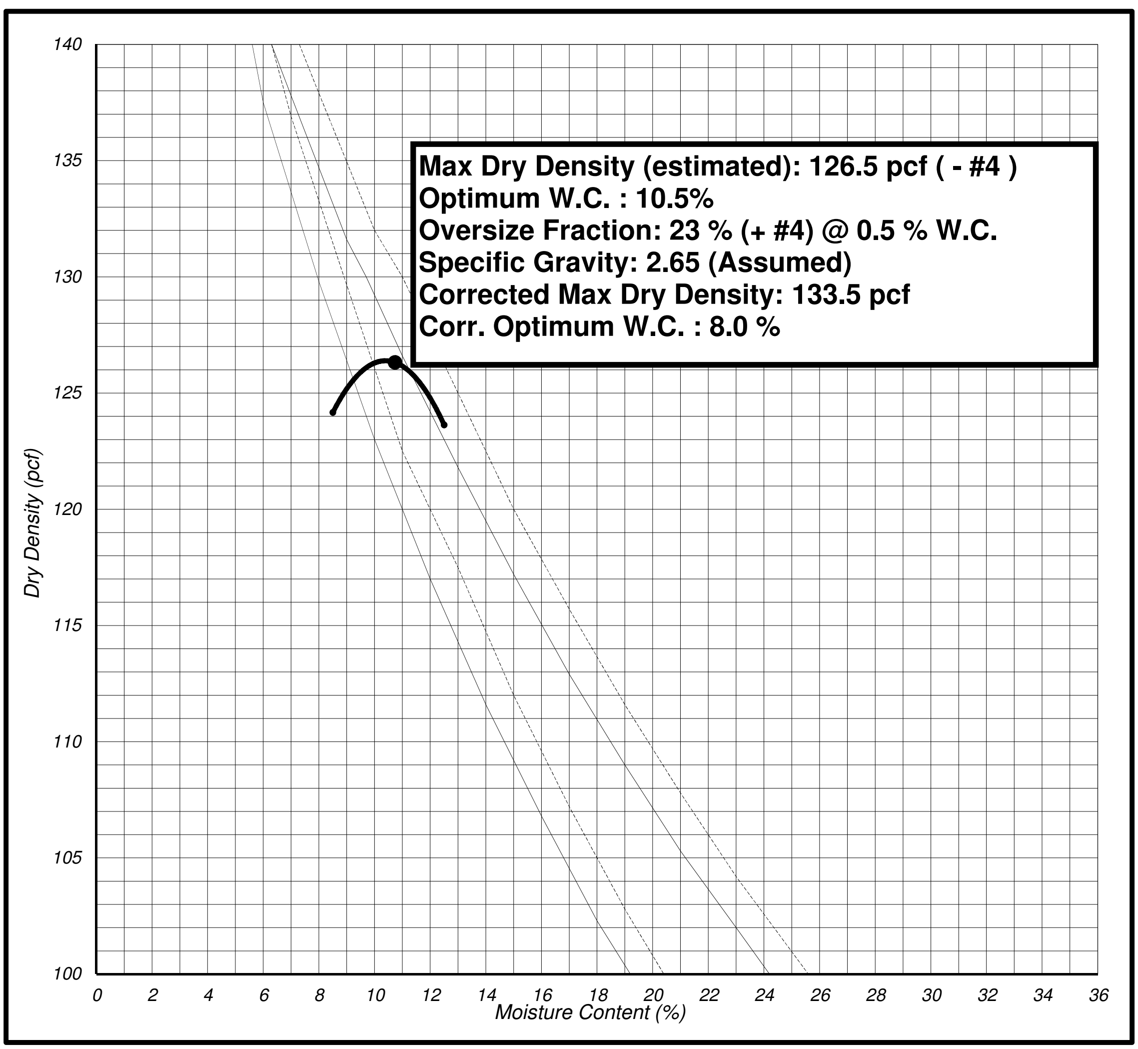


Geo-Logic ASSOCIATES

ONE POINT DENSITY TEST ASTM D1557

Job Name	TetraTech BAS # RSG 13-01E	**Date:**	6/10/2013
Job No.	2013-0047	**By:**	LD
Boring/Sample No.	RL-11-02 @ 67' - 69.5'		
Description:	Brown, F.M. Silty Sand w. Gravel		

Method: **A**	Mold Volume (cf): **0.0333**	Blows: **25**		Layers: **5**	
Specimen	A	B	C	D	E
Total Wet Weight (lbs)	**8.55**				
Weight of Mold (lbs)	3.89				
Wet Weight of Soil (lbs)	4.66				
Wet Density (pcf)	139.9				
Moisture Can No.					
Dry Weight					
Moisture Content (%)	**10.7**				
Dry Density (pcf)	126.3				

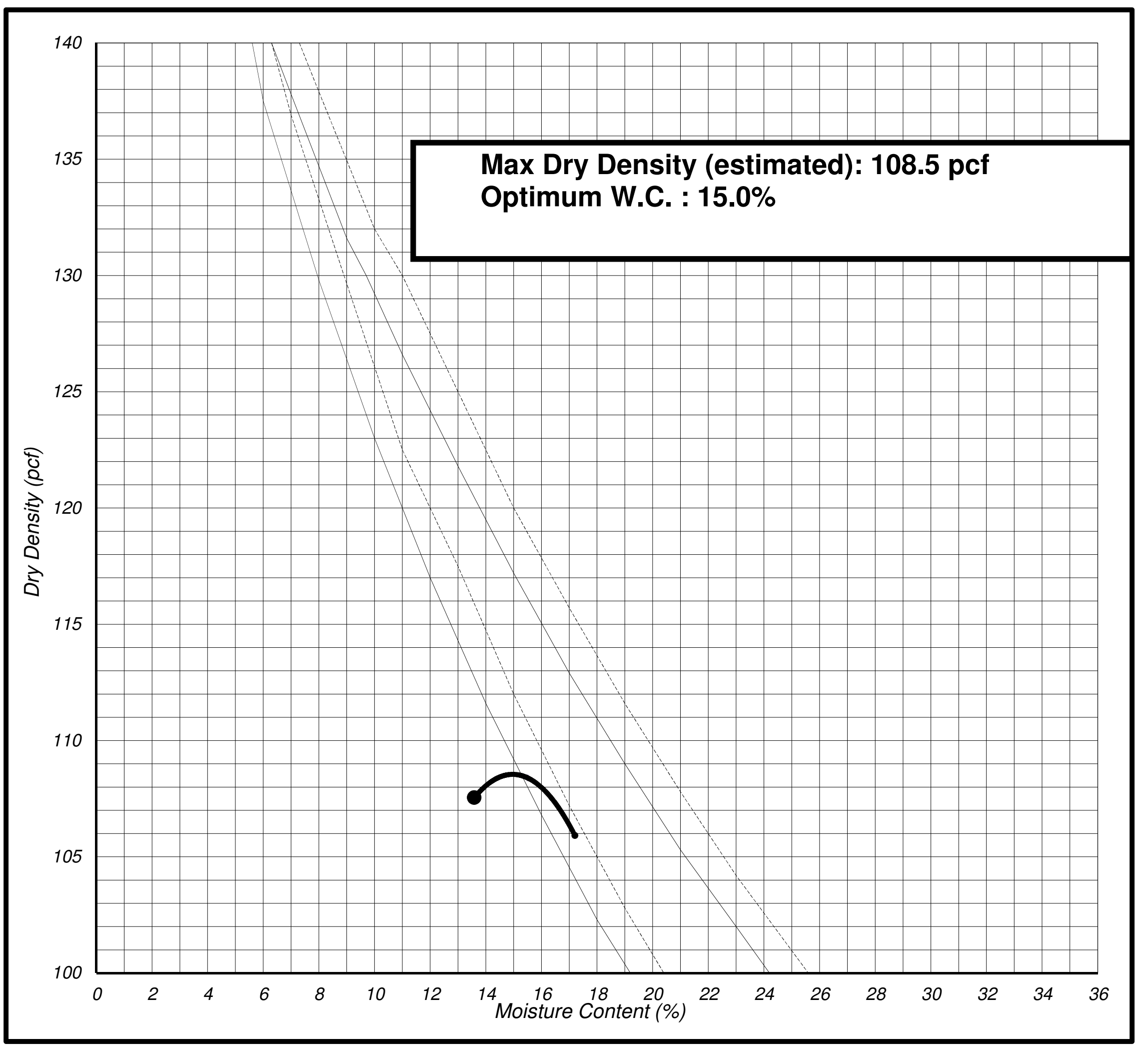


Geo-Logic ASSOCIATES

ONE POINT DENSITY TEST ASTM D1557

Job Name	TetraTech BAS # RSG 13-01E	**Date:**	6/11/2013
Job No.	2013-0047	**By:**	LD
Boring/Sample No.	SJ 10-10 @ 55' - 60'		
Description:	Brown, Silt		

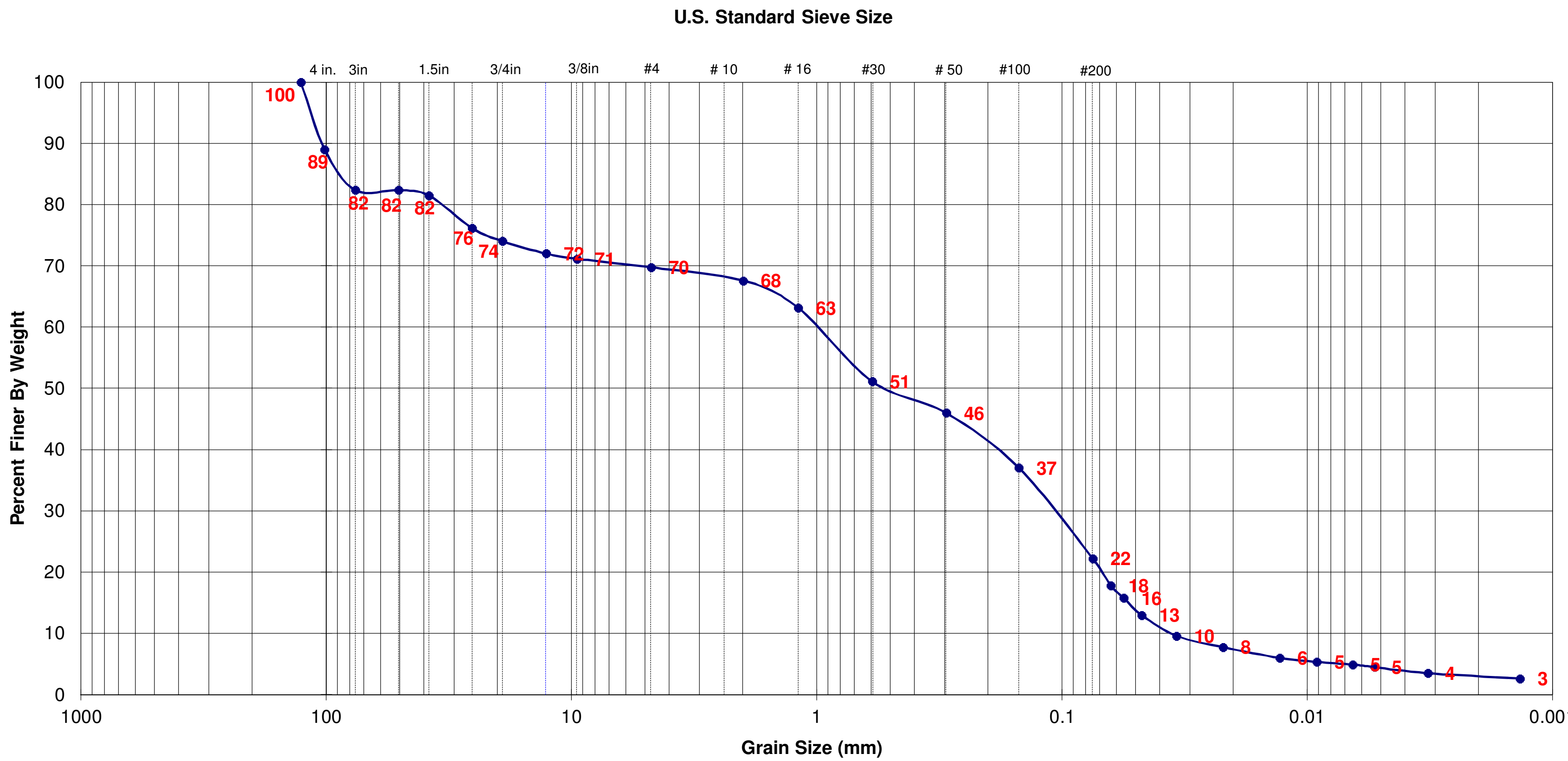
Method: **A**	Mold Volume (cf): **0.0333**	Blows: **25**		Layers: **5**	
Specimen	A	B	C	D	E
Total Wet Weight (lbs)	**7.96**				
Weight of Mold (lbs)	3.89				
Wet Weight of Soil (lbs)	4.07				
Wet Density (pcf)	122.2				
Moisture Can No.					
Dry Weight					
Moisture Content (%)	**13.6**				
Dry Density (pcf)	107.5				



Geo-Logic ASSOCIATES

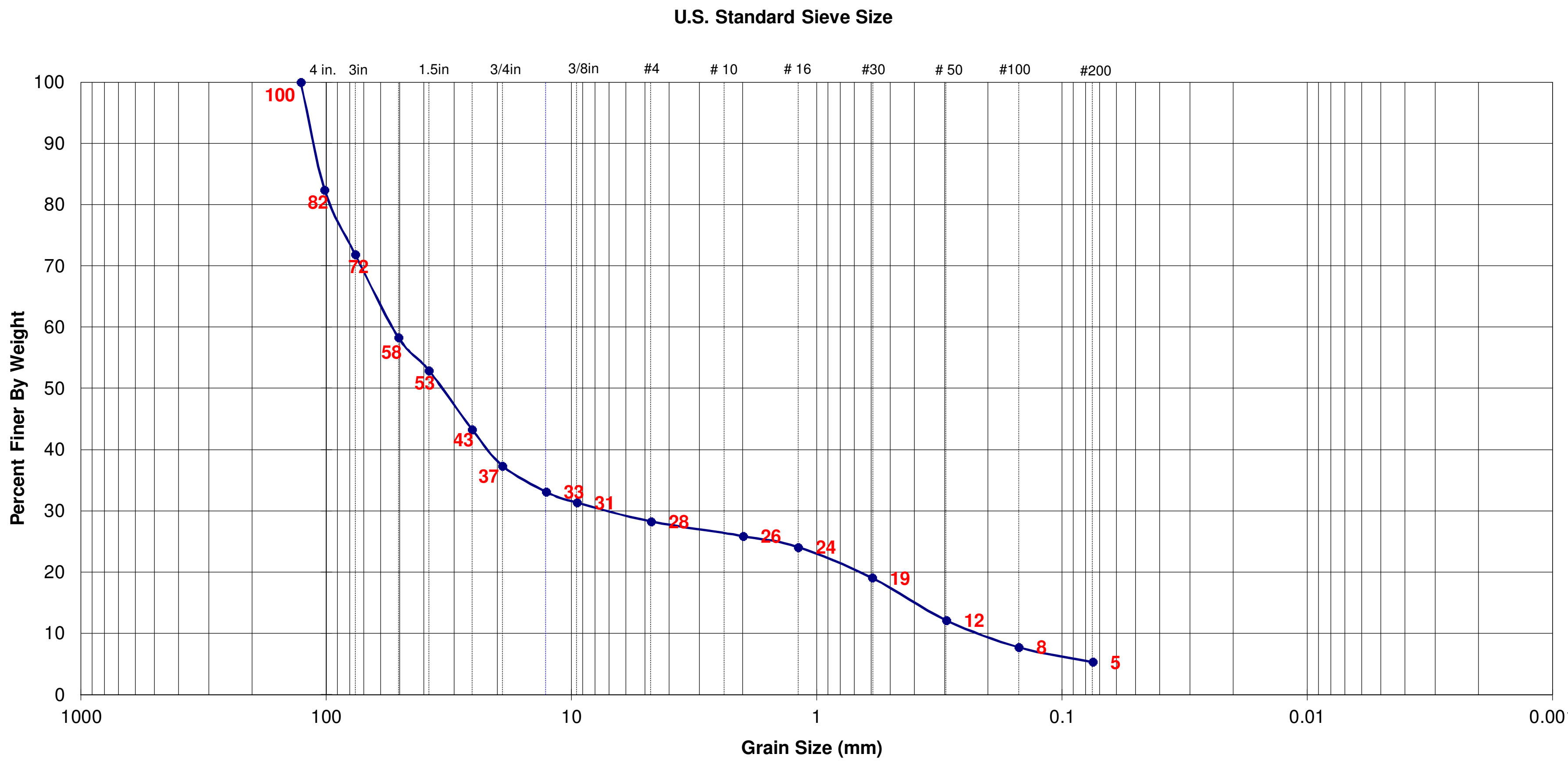
GRAIN SIZE ANALYSIS - ASTM D 422

Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
RL-11-01 @ 9.5' - 12'									SM	Silty Sand w. Gravel

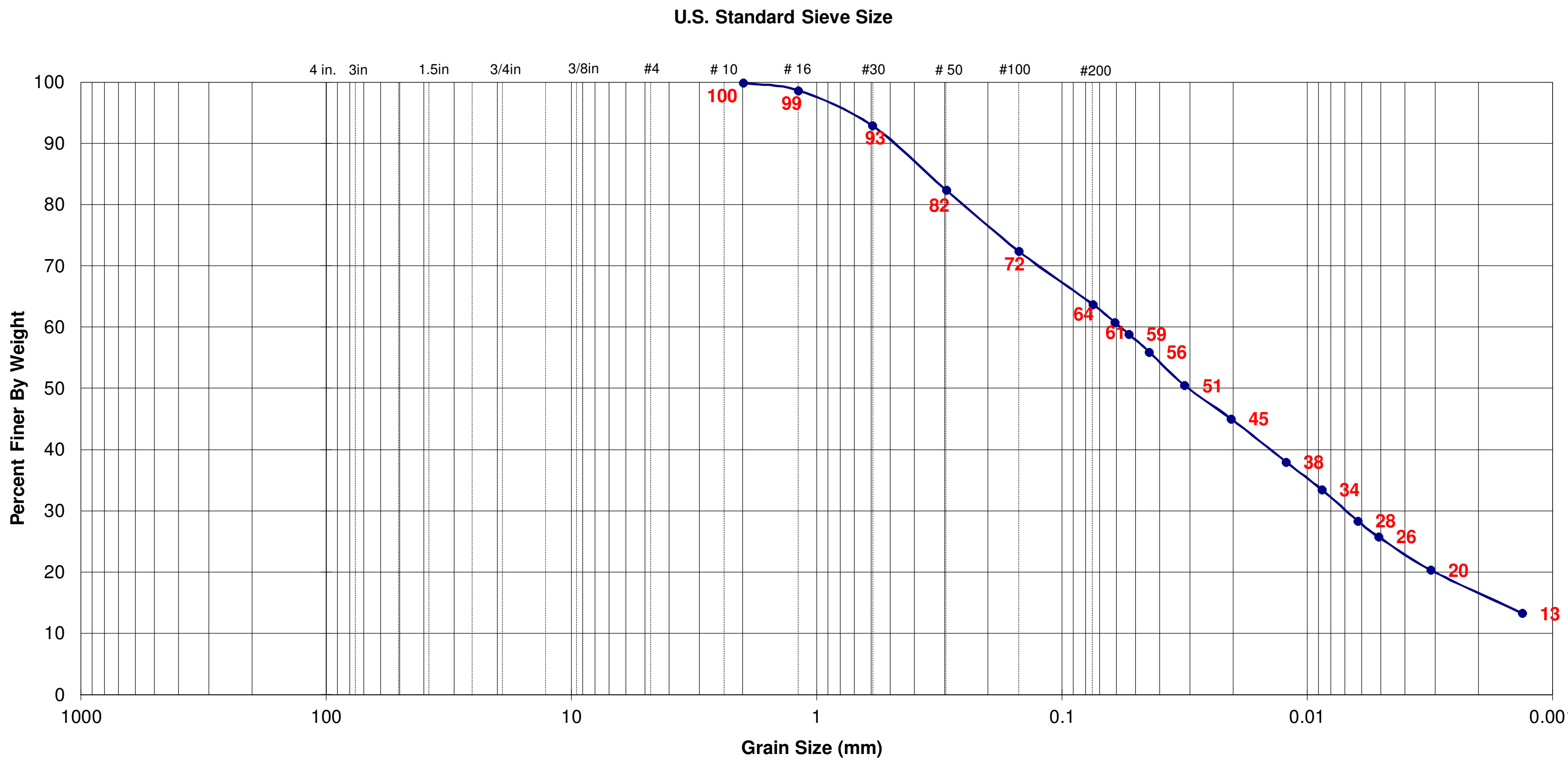
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
RL-11-01 @ 22' - 24.5'									GP	Poorly Graded Gravel w. Sand

Geo-Logic ASSOCIATES

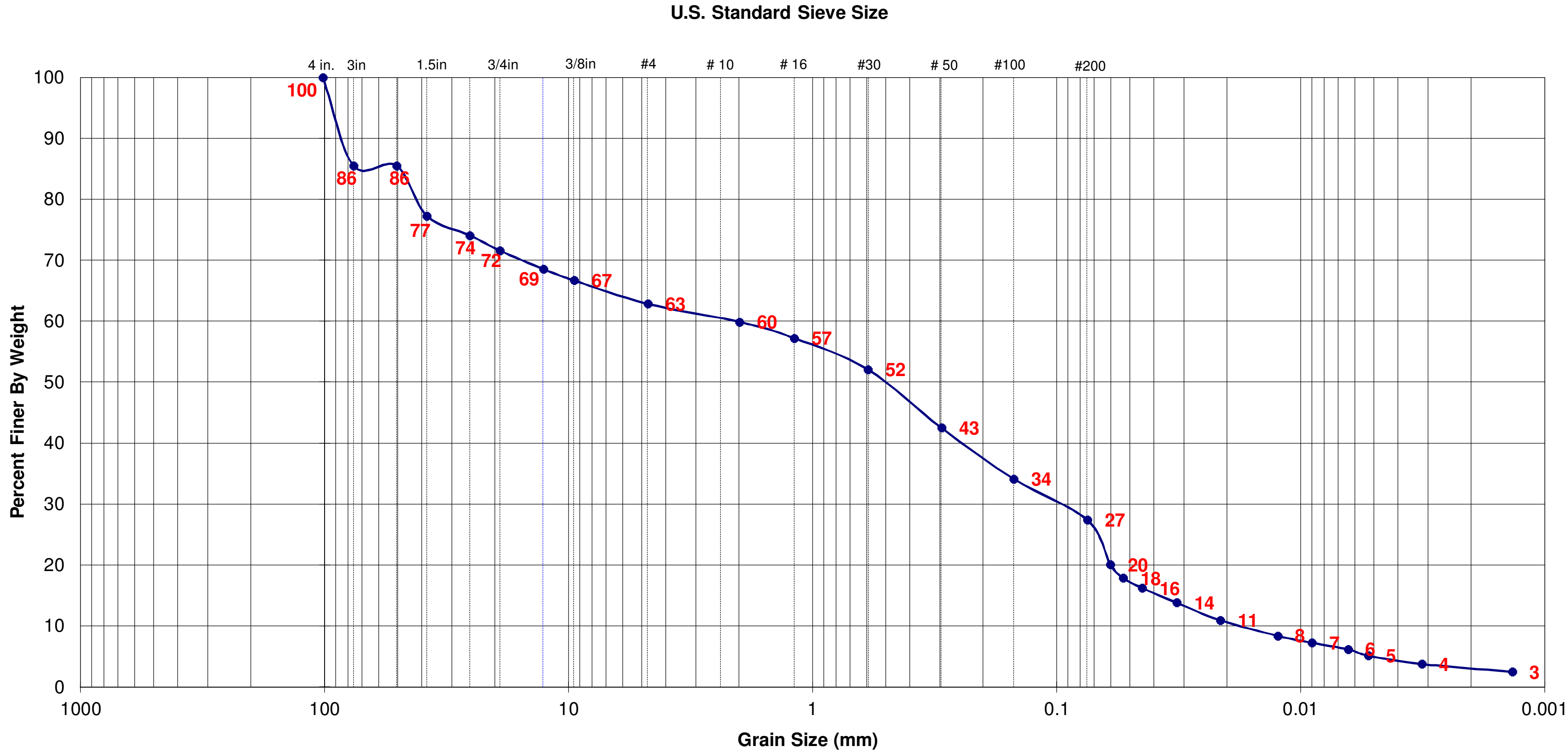
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
RL-11-01 @ 79.5' - 82'						38	22	16	CL	Sandy Clay

Geo-Logic ASSOCIATES

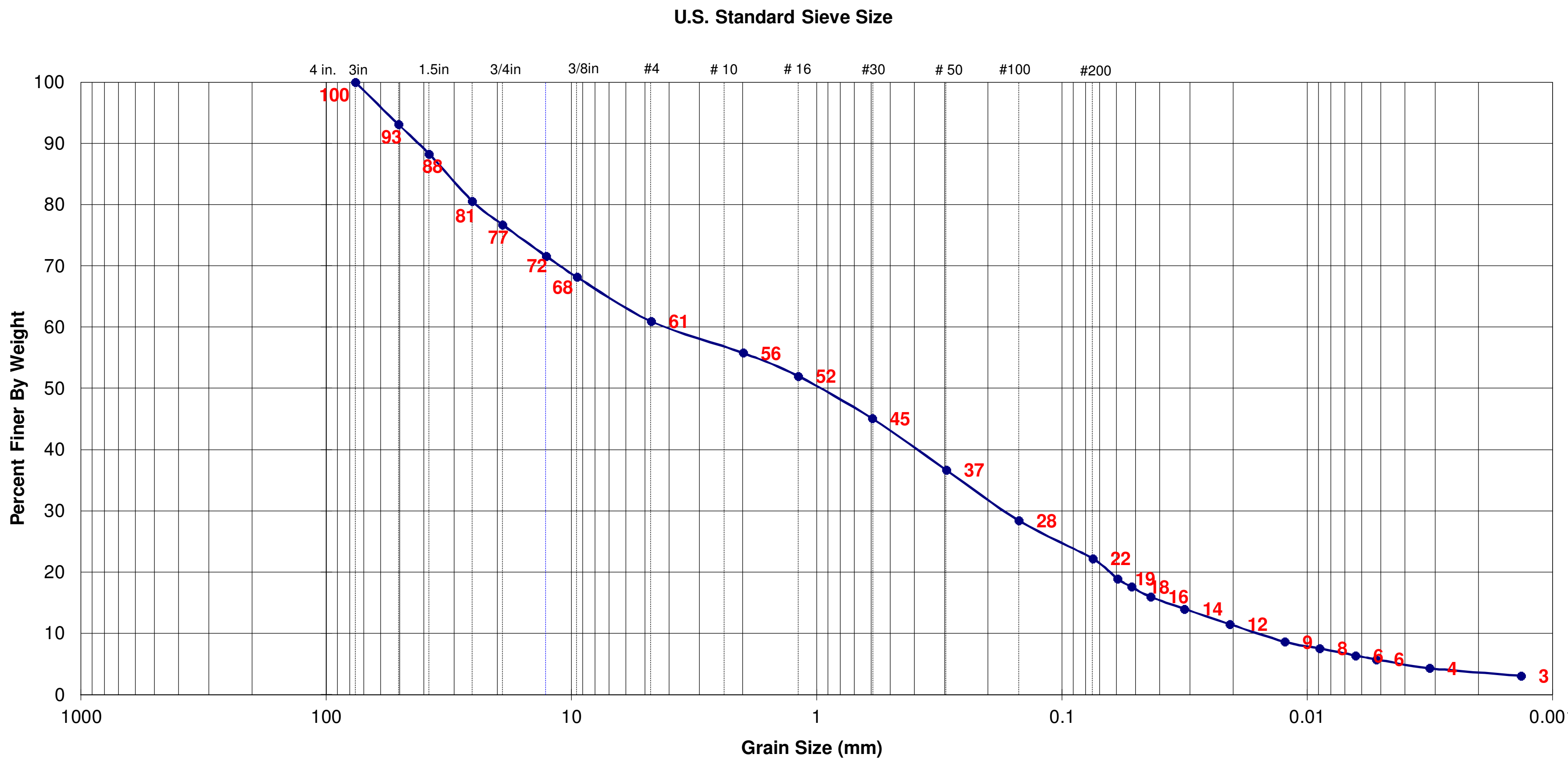
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
RL-11-03 @ 42' - 44.5'									SM	Silty Sand w. Gravel

Geo-Logic ASSOCIATES

Date: 6/5/13

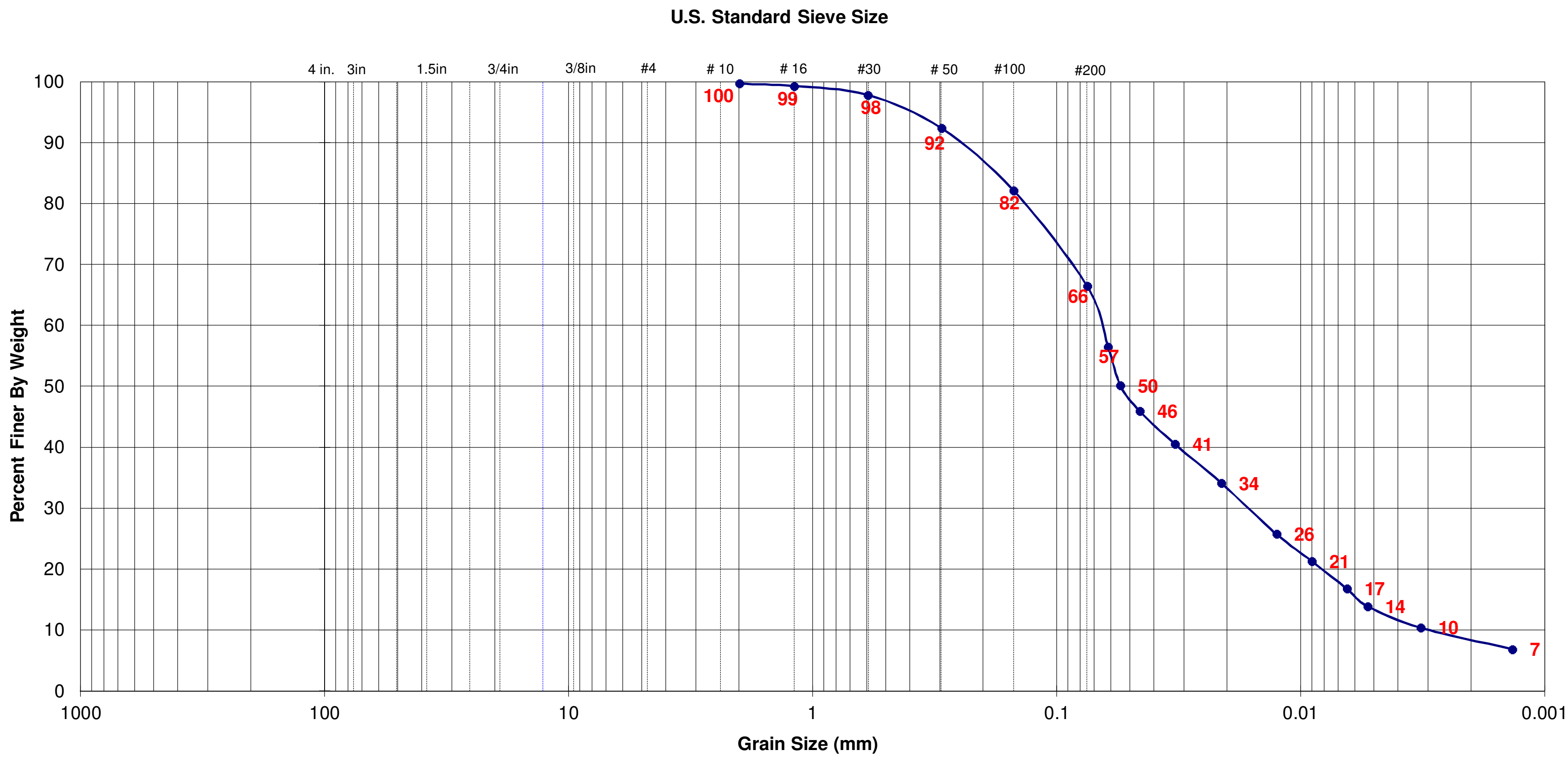


Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
RL-11-03 @ 72' - 74.5'									SM	Silty Sand w. Gravel

Geo-Logic ASSOCIATES

GRAIN SIZE ANALYSIS - ASTM D 422

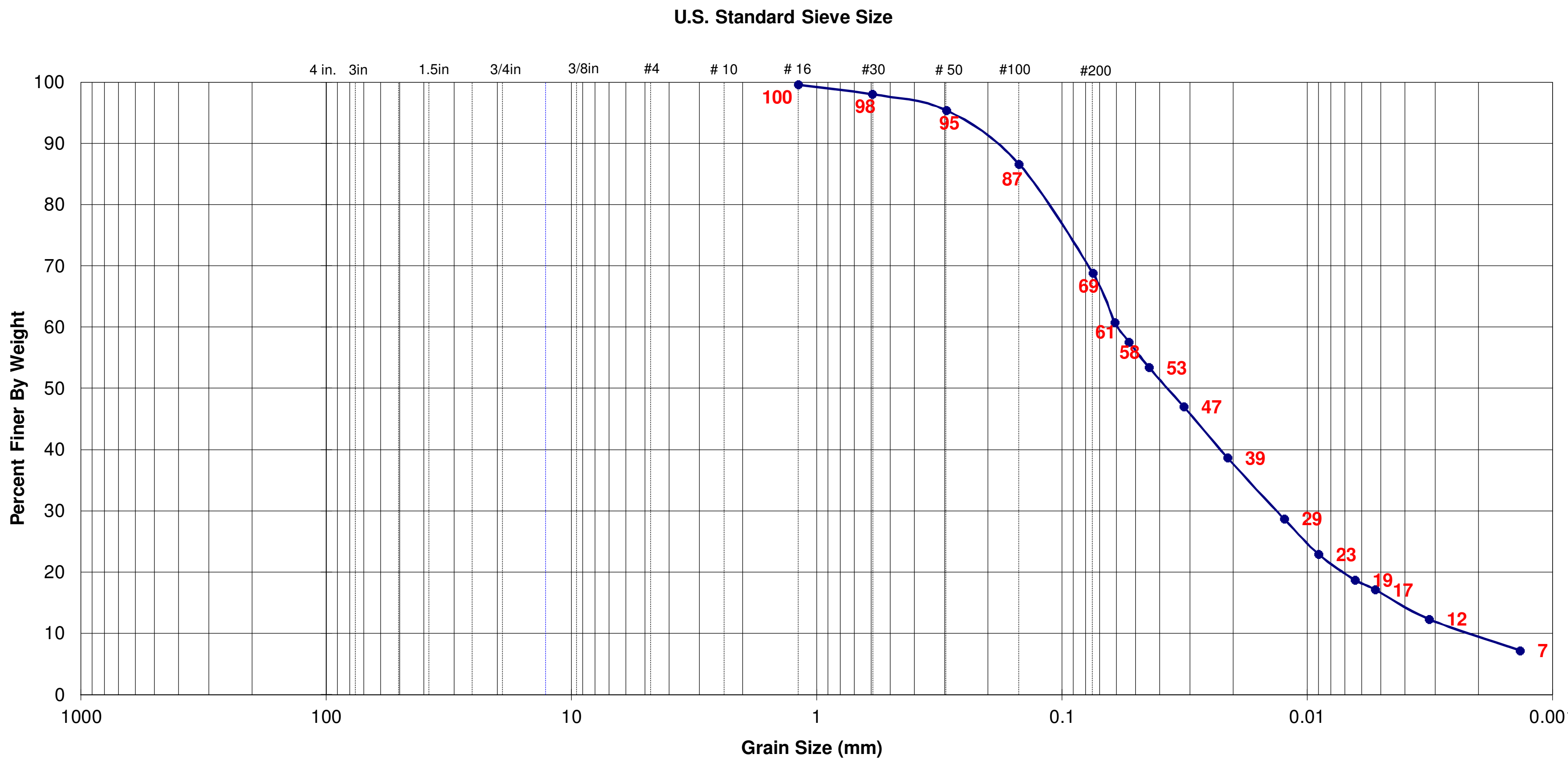
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
SJ-10-02 @ 60' - 65'						30	23	7	ML	Sandy Silt

Geo-Logic ASSOCIATES

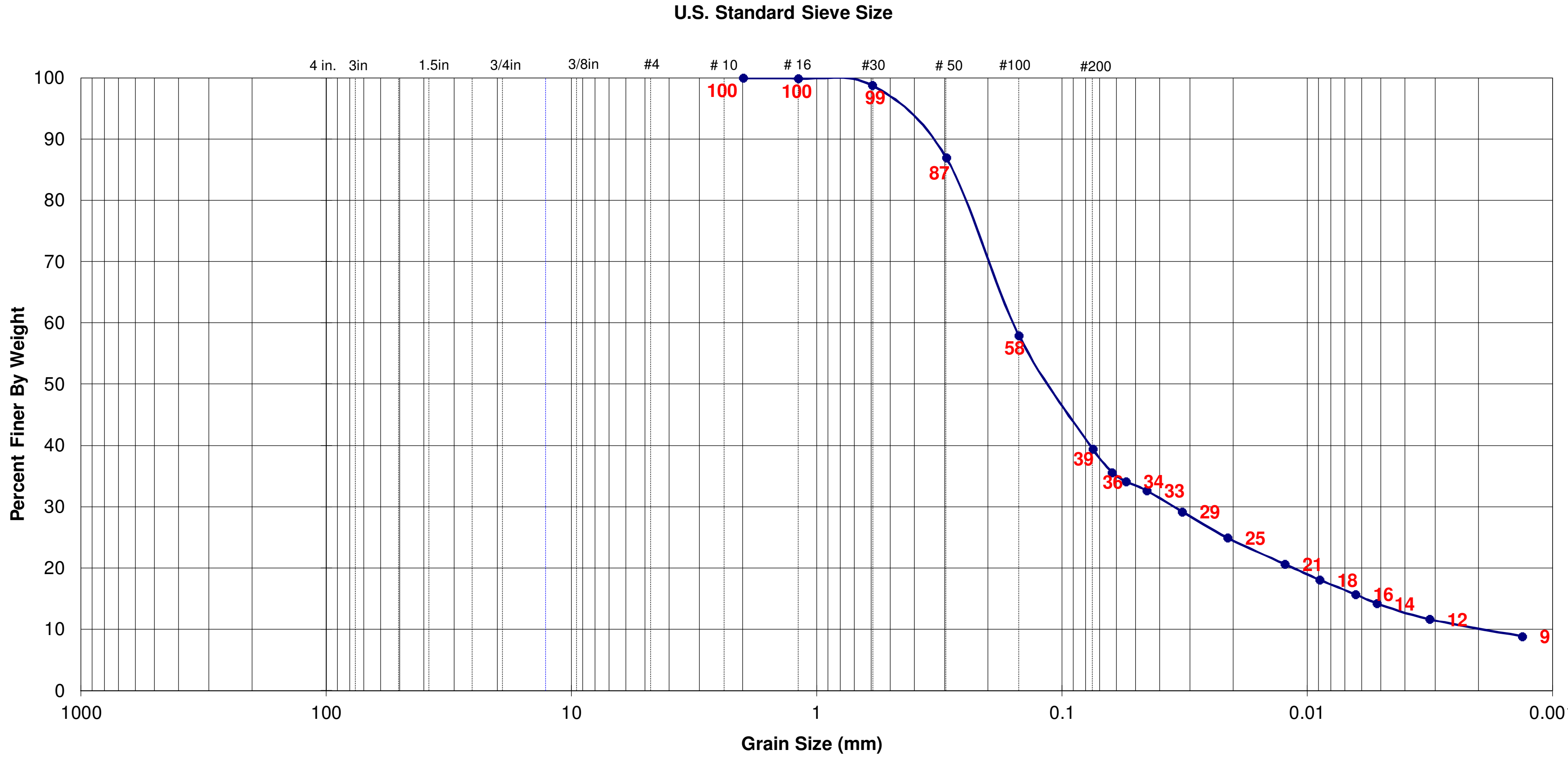
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
SJ-10-03 @ 65'- 70'									ML	Sandy Silt

Geo-Logic ASSOCIATES

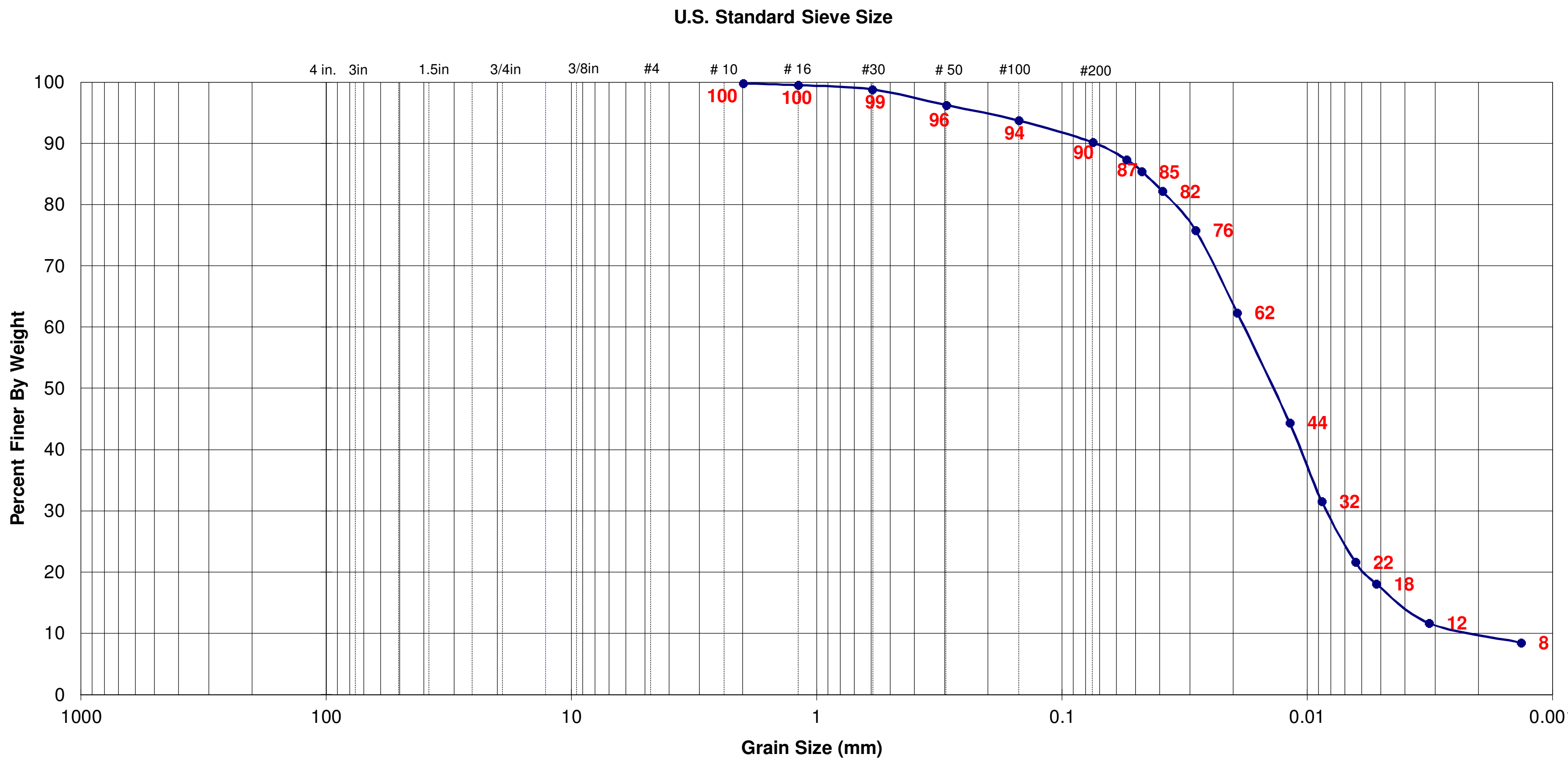
Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
SJ-10-05 @ 70' - 75'						23	19	4	SM	Silty Sand

Geo-Logic ASSOCIATES

Date: 6/5/13



Boring / Sample No.	Initial Dry Density (pcf)	Initial Moist. (%)	Test Dry Density (pcf)	Test Moist. (%)	Permeabilty, k (cm/sec)	LL	PL	PI	Unified Soil Class.	Description
SJ-10-10 @ 55' - 60'						36	27	9	ML	Silt

Geo-Logic ASSOCIATES

Appendix B
Results of Laboratory Testing – Cleath-Harris Geologists, Inc.

Cleath-Harris Geologists, Inc. (2010a, 2010b) conducted laboratory testing of selected soil samples, including the evaluation of: particle size, Sand Equivalence, Durability Index, L.A. Rattler, Absorption and Soundness. Reported test methods employed are presented below. Reported results are presented on the following pages.

Particle Size Analysis – ASTM C136

Sand Equivalence – ASTM 2419

Durability Index – ASTM 3744

L.A. Rattler - ASTM C131

Absorption – ASTM C127, ASTM C128

Soundness – ASTM C88

Specific Gravity - ASTM C127

Summary of Laboratory Results for UPPER Sand and Gravel Interval,
Riverbend Drilling Project

TEST HOLE		RL-11-01			RL-11-02		RL-11-03		**AVERAGE**
Grading	Depth >	12.0 - 17.0	24.5 - 29.5	34.5 - 39.5	19.5 - 24.5	29.5 - 34.5	17.0 - 22.0	34.5 - 39.5	
	Screen Size								
	5"	100	100	100	100	100	100	100	100
	4"	100	90	100	100	91	100	91	96
	3"	100	88	88	95	83	98	89	92
	2"	88	80	71	80	75	83	84	80
	1 1/2"	74	70	65	64	70	75	77	71
	1"	58	58	56	50	60	60	67	58
	3/4"	53	54	52	44	56	52	59	53
	1/2"	46	48	47	37	51	43	50	46
	3/8"	44	45	45	34	48	39	47	43
	No. 4	40	40	42	30	43	35	41	39
	No. 8	38	37	40	28	37	31	36	35
	No. 16	34	35	37	26	31	28	33	32
	No. 30	21	28	31	19	25	20	27	24
	No. 50	9	12	19	9	18	13	19	14
	No. 100	5	8	13	5	13	10	13	10
	No. 200	3	5	9.1	3	9	7	9	6
Sand Equivalent		82	70	25	71	25	29	30	47
Washed SE			96	85	82	96	87	88	88
Durability, Df		83	78	37	73	79	58	75	69
Double Durability (Fine)				82			84		
Durability, Dc		87	87	76	82	82	87	78	83
Soundness Coarse			0.8		1.9			6.3	
Soundness Fine			7.2		13.0			4.4	
Specific Gravity Soil		2.72	2.69	2.68	2.69	2.68	2.72	2.71	2.70
Specific Gravity (Washed Fine)									
Bulk Specific Gravity (Dry)		2.61	2.58	2.57	2.60	2.59	2.62	2.610	2.60
Apparent Specific Gravity		2.64	2.61	2.59	2.63	2.62	2.65	2.640	2.63
Bulk Specific Gravity (SSD)		2.68	2.66	2.64	2.68	2.67	2.70	2.680	2.67
Absorption (Fine)		0.90	1.10	1.00	1.30	1.20	1.20	1.00	1.10
Specific Gravity (Coarse)									
Bulk Specific Gravity (Dry)		2.61	2.61	2.61	2.63	2.64	2.60	2.600	2.61
Apparent Specific Gravity		2.64	2.64	2.64	2.66	2.67	2.62	2.630	2.64
Bulk Specific Gravity (SSD)		2.69	2.70	2.69	2.71	2.72	2.67	2.690	2.70
Absorption (Coarse)		1.10	1.30	1.10	1.10	1.20	1.00	1.30	1.16
LA Rattler	Gradation	A	A	(1)	A	A	B	B	
100 Rev		10.0	10.0	11.0	9.0	9.0	10.0	13.0	10.3
500 Rev		35.0	35.0	27.0	36.0	36.0	31.0	31.0	33.0

Summary of Laboratory Results for TRANSITION Interval,
Riverbend Drilling Project

TEST HOLE		RL-11-01		RL-11-02		RL-11-03	**AVERAGE**
Grading	Depth >	44.5 - 49.5		44.5 - 49.5		44.5 - 49.5	
	Screen Size						
	5"	100		100		100	100
	4"	100		100		100	100
	3"	97		95		92	95
	2"	83		87		87	86
	1 1/2"	76		83		82	80
	1"	69		68		76	71
	3/4"	66		62		71	66
	1/2"	60		55		66	60
	3/8"	57		52		64	58
	No. 4	53		47		59	53
	No. 8	48		42		55	48
	No. 16	43		36		50	43
	No. 30	37		29		42	36
	No. 50	28		21		29	26
	No. 100	21		15		22	19
	No. 200	16		11		17	15
Sand Equivalent		25		25		27	26
Washed SE		94		91		92	92
Durability, Df		81		70		58	70
Double Durability (Fine)						84	
Durability, Dc		76		74		70	73
Soundness Coarse				5.0			
Soundness Fine				16.8			
Specific Gravity Soil		2.69		2.69		2.67	2.68
Specific Gravity (Washed Fine)							
Bulk Specific Gravity (Dry)		2.60		2.58		2.52	2.57
Apparent Specific Gravity		2.63		2.61		2.55	2.60
Bulk Specific Gravity (SSD)		2.67		2.66		2.58	2.64
Absorption (Fine)		1.00		1.20		0.90	1.03
Specific Gravity (Coarse)							
Bulk Specific Gravity (Dry)		2.58		2.58		2.55	2.57
Apparent Specific Gravity		2.62		2.61		2.59	2.61
Bulk Specific Gravity (SSD)		2.69		2.69		2.67	2.68
Absorption (Coarse)		1.50		1.70		1.70	1.63
LA Rattler	Gradation	(1)				A	
100 Rev		11.0				13.0	12.0
500 Rev		27.0				40.0	33.5

Summary of Laboratory Results for MIDDLE Sand and Gravel Interval,
Riverbend Drilling Project

TEST HOLE		RL-11-01		RL-11-02		RL-11-03		AVERAGE
Grading	Depth >	59.5 - 64.5		57.0 - 62.0		59.5 - 64.5		
	Screen Size							
	5"	100		100		100		100
	4"	100		94		100		98
	3"	98		88		92		93
	2"	94		87		86		89
	1 1/2"	90		82		81		84
	1"	85		73		74		77
	3/4"	82		69		69		73
	1/2"	78		63		62		68
	3/8"	76		59		59		65
	No. 4	72		54		54		60
	No. 8	67		48		51		55
	No. 16	61		44		47		51
	No. 30	50		35		38		41
	No. 50	37		24		29		30
	No. 100	28		14		23		22
	No. 200	20		7		17		15
Sand Equivalent		20		20		21		20
Washed SE		93		87		94		91
Durability, Df		68		59		70		66
Double Durability (Fine)				83				
Durability, Dc		71		73		76		73
Soundness Coarse		5.3						
Soundness Fine		7.4						
Specific Gravity Soil		2.69		2.72		2.68		2.70
Specific Gravity (Washed Fine)								
Bulk Specific Gravity (Dry)		2.57		2.60		2.57		2.58
Apparent Specific Gravity		2.61		2.64		2.60		2.62
Bulk Specific Gravity (SSD)		2.67		2.69		2.64		2.67
Absorption (Fine)		1.40		1.30		1.00		1.23
Specific Gravity (Coarse)								
Bulk Specific Gravity (Dry)		2.58		2.58		2.57		2.58
Apparent Specific Gravity		2.62		2.63		2.61		2.62
Bulk Specific Gravity (SSD)		2.72		2.70		2.68		2.70
Absorption (Coarse)		2.10		1.70		1.50		1.77
LA Rattler	Gradation	(1)		(1)		(1)		
100 Rev		13.0		13.0		13.0		13.0
500 Rev		27.0		31.0		30.0		29.3

Summary of Laboratory Results for LOWER Sand and Gravel Interval,
Riverbend Drilling Project

TEST HOLE		RL-11-01		RL-11-02		RL-11-03		AVERAGE
Grading	Depth >	82.0 - 87.0		74.5 - 79.5		74.5 - 79.5		
	Screen Size							
	5"	100		100		100		100
	4"	100		100		100		100
	3"	100		100		100		100
	2"	95		94		96		95
	1 1/2"	90		87		92		90
	1"	84		80		84		83
	3/4"	80		76		77		78
	1/2"	74		70		70		71
	3/8"	72		68		67		69
	No. 4	66		63		62		64
	No. 8	61		58		56		58
	No. 16	56		53		51		53
	No. 30	45		45		44		45
	No. 50	35		35		35		35
	No. 100	28		25		27		27
	No. 200	23		17		21		20
Sand Equivalent		21		19		22		21
Washed SE		80		88		92		87
Durability, Df		57		74		67		66
Double Durability (Fine)		92						
Durability, Dc		76		70		73		73
Soundness Coarse						4.6		
Soundness Fine						8.5		
Specific Gravity Soil		2.66		2.7		2.69		2.68
Specific Gravity (Washed Fine)								
Bulk Specific Gravity (Dry)		2.57		2.58		2.58		2.58
Apparent Specific Gravity		2.61		2.60		2.60		2.60
Bulk Specific Gravity (SSD)		2.68		2.64		2.64		2.65
Absorption (Fine)		1.50		0.90		0.90		1.10
Specific Gravity (Coarse)								
Bulk Specific Gravity (Dry)		2.56		2.56		2.54		2.55
Apparent Specific Gravity		2.60		2.59		2.58		2.59
Bulk Specific Gravity (SSD)		2.68		2.65		2.66		2.66
Absorption (Coarse)		1.70		1.40		1.50		1.53
LA Rattler	Gradation	(1)		(1)		(1)		
100 Rev		13.0		13.0		13.0		13.0
500 Rev		27.0		31.0		30.0		29.3

C.H.J. Incorporated

Laboratory Test Results Summary

Project: Sanger Test Hole RL-11-01

Job No.: 11381-7

Depth, Ft.:	12 to 17		24.5 to 29.5		34.5 to 39.5		44.5 to 49.5		59.5 to 64.5		82 to 87	
Sieve Analysis; CT202, % Passing												
5" (125 mm)			100									
4" (100 mm)			90		100		100		100			
3" (75 mm)	100		88		88		97		98		100	
2" (50 mm)	88		80		71		83		94		95	
1 1/2" (37.5 mm)	74		70		65		76		90		90	
1" (25 mm)	58		58		56		69		85		84	
3/4" (19mm)	53		54		52		66		82		80	
1/2" (12.5 mm)	46		48		47		60		78		74	
3/8" (9.5 mm)	44		45		45		57		76		72	
No. 4 (4.75 mm)	40	100	40	100	42	100	53	100	72	100	66	100
No. 8 (2.38 mm)	38	93	37	93	40	95	48	91	67	93	61	93
No. 16 (1.18 mm)	34	84	35	87	37	90	43	83	61	85	56	86
No. 30 (600 micro)	21	52	28	69	31	73	37	70	50	70	45	69
No. 50 (300 micro)	9	23	12	31	19	45	28	53	37	52	35	53
No. 100 (150 micro)	5	12	8	18	13	31	21	40	28	39	28	43
No. 200 (75 micro)	3.0	7.4	4.8	12	9.1	22	16	30	20	28	23	35
Sand Equivalent, CT 217		82		70		25		25		20		21
Sand Equivalent (washed), CT 217		----		96		85		94		93		80
Durability Index, (fine) CT 229		83		78		37		81		68		57
Double Durability Index, (fine) CT 229		----		----		82		----		----		92
Durability Index, (coarse) CT 229	87		87		76		76		71		76	
Sodium Sulfate Soundness; C 88, % Loss 5 Cycles	----	----	0.8	7.2	----	----	----	----	5.3	7.4	----	----
Specific Gravity Soil, CT 209		2.72		2.69		2.68		2.69		2.69		2.66
Specific Gravity (coarse) , C 127; Specific Gravity (fine washed), C 128												
Bulk Dry	2.61	2.61	2.61	2.58	2.61	2.57	2.58	2.60	2.58	2.57	2.56	2.57
Bulk SSD	2.64	2.64	2.64	2.61	2.64	2.59	2.62	2.63	2.62	2.61	2.60	2.61
Apparent	2.69	2.68	2.70	2.66	2.69	2.64	2.69	2.67	2.72	2.67	2.68	2.68
Absorption, %	1.1	0.9	1.3	1.1	1.1	1.0	1.5	1.0	2.1	1.4	1.7	1.5
Potential Alkali Silica Reactivity, C 289 (chemical method)												
SC, mmol/L	----	----	6.0	115.5	----	----	----	----	----	----	----	----
RC, mmol/L	----	----	120	105	----	----	----	----	----	----	----	----
Considered; I = Innocuous, PD = Potentially Deleterious, D = Deleterious	----	----	I	PD	----	----	----	----	----	----	----	----
Los Angeles Abrasion; C 131, C 535	12' to 29.5' combined				34.5' to 49.5' combined				59.5' to 87' combined			
Grading	A		A		1		1		1		1	
% Loss 100 Revolutions	10		10		----		----		----		----	
% Loss 500 Revolutions	35		35		----		----		----		----	
% Loss 200 Revolutions	----		----		11		11		13		13	
% Loss 1000 Revolutions	----		----		27		27		27		27	
Organic Impurities, C 40; LS = Lighter than Standard (Satisfactory) DS = Darker than Standard (unsatisfactory)		LS		LS		LS		LS		LS		LS

*NT = Not tested insufficient material.

C.H.J. Incorporated

Laboratory Test Results Summary

Project: Sanger Test Hole RL-11-02

Job No.: 11381-7

Depth, Ft.:	19.5 to 24.5		29.5 to 34.5		44.5 to 49.5		57 to 62		74.5 to 79.5	
Sieve Analysis; CT202, % Passing										
5" (125 mm)			100				100			
4" (100 mm)	100		91		100		94			
3" (75 mm)	95		83		95		88		100	
2" (50 mm)	80		75		87		87		94	
1 1/2" (37.5 mm)	64		70		83		82		87	
1" (25 mm)	50		60		68		73		80	
3/4" (19mm)	44		56		62		69		76	
1/2" (12.5 mm)	37		51		55		63		70	
3/8" (9.5 mm)	34		48		52		59		68	
No. 4 (4.75 mm)	30	100	43	100	47	100	54	100	63	100
No. 8 (2.38 mm)	28	91	37	86	42	90	48	90	58	92
No. 16 (1.18 mm)	26	85	31	74	36	78	44	81	53	83
No. 30 (600 micro)	19	63	25	59	29	62	35	66	45	71
No. 50 (300 micro)	9	29	18	43	21	44	24	45	35	55
No. 100 (150 micro)	5	15	13	31	15	32	14	25	25	39
No. 200 (75 micro)	2.7	9.0	9.1	21	11	23	6.7	12	17	27
Sand Equivalent, CT 217		71		25		25		20		19
Sand Equivalent (washed), CT 217		92		96		91		87		88
Durability Index, (fine) CT 229		73		79		70		59		74
Double Durability Index, (fine) CT 229		----		----		----		83		----
Durability Index, (coarse) CT 229	82		82		74		73		70	
Sodium Sulfate Soundness; C 88, % Loss 5 Cycles	1.9	13.0	----	----	5.0	16.8	----	----	----	----
Specific Gravity Soil, CT 209		2.69		2.68		2.69		2.72		2.68
Specific Gravity (coarse) , C 127; Specific Gravity (fine washed), C 128										
Bulk Dry	2.63	2.60	2.64	2.59	2.58	2.58	2.58	2.60	2.56	2.58
Bulk SSD	2.66	2.63	2.67	2.62	2.61	2.61	2.63	2.64	2.59	2.60
Apparent	2.71	2.68	2.72	2.67	2.69	2.66	2.70	2.69	2.65	2.64
Absorption, %	1.1	1.3	1.2	1.2	1.7	1.2	1.7	1.3	1.4	0.9
Potential Alkali Silica Reactivity, C 289 (chemical method)										
SC, mmol/L	294.4	29.0	----	----	----	----	----	----	----	----
RC, mmol/L	135	150	----	----	----	----	----	----	----	----
Considered; I = Innocuous, PD = Potentially Deleterious, D = Deleterious	PD	I	----	----	----	----	----	----	----	----
Los Angeles Abrasion; C 131, C 535	19.5' to 34.5' combined						57' to 79.5' combined			
Grading	A		A		*NT		1		1	
% Loss 100 Revolutions	9		9		*NT		----		----	
% Loss 500 Revolutions	36		36		*NT		----		----	
% Loss 200 Revolutions	----		----		*NT		13		13	
% Loss 1000 Revolutions	----		----		*NT		31		31	
Organic Impurities, C 40; LS = Lighter than Standard (Satisfactory) DS = Darker than Standard (unsatisfactory)		LS		LS		LS		LS		LS

*NT = Not tested insufficient material.

C.H.J. Incorporated

Laboratory Test Results Summary

Project: Sanger Test Hole RL-11-03

Job No.: 11381-7

Depth, Ft.:	17 to 22		34.5 to 39.5		44.5 to 49.5		59.5 to 64.5		74.5 to 79.5	
Sieve Analysis; CT202, % Passing										
5" (125 mm)			100							
4" (100 mm)	100		91		100		100			
3" (75 mm)	98		89		92		92		100	
2" (50 mm)	83		84		87		86		96	
1 1/2" (37.5 mm)	75		77		82		81		92	
1" (25 mm)	60		67		76		74		84	
3/4" (19mm)	52		59		71		69		77	
1/2" (12.5 mm)	43		50		66		62		70	
3/8" (9.5 mm)	39		47		64		59		67	
No. 4 (4.75 mm)	35	100	41	100	59	100	54	100	62	100
No. 8 (2.38 mm)	31	90	36	89	55	93	51	93	56	91
No. 16 (1.18 mm)	28	81	33	81	50	85	47	86	51	83
No. 30 (600 micro)	20	59	27	66	42	70	38	71	44	71
No. 50 (300 micro)	13	38	19	46	29	50	29	54	35	57
No. 100 (150 micro)	10	27	13	31	22	37	23	42	27	44
No. 200 (75 micro)	6.9	20	8.9	22	17	29	17	32	21	34
Sand Equivalent, CT 217		29		30		27		21		22
Sand Equivalent (washed), CT 217		87		88		92		94		92
Durability Index, (fine) CT 229		58		75		58		70		67
Double Durability Index, (fine) CT 229		84		----		84		----		----
Durability Index, (coarse) CT 229	87		78		70		76		73	
Sodium Sulfate Soundness; C 88, % Loss 5 Cycles	----	----	6.3	4.4	----	----	----	----	4.6	8.5
Specific Gravity Soil, CT 209		2.72		2.71		2.67		2.68		2.69
Specific Gravity (coarse) , C 127; Specific Gravity (fine washed), C 128										
Bulk Dry	2.60	2.62	2.60	2.61	2.55	2.52	2.57	2.57	2.54	2.58
Bulk SSD	2.62	2.65	2.63	2.64	2.59	2.55	2.61	2.60	2.58	2.60
Apparent	2.67	2.70	2.69	2.68	2.67	2.58	2.68	2.64	2.66	2.64
Absorption, %	1.0	1.2	1.3	1.0	1.7	0.9	1.5	1.0	1.5	0.9
Potential Alkali Silica Reactivity, C 289 (chemical method)										
SC, mmol/L	----	----	33.0	59.6	----	----	----	----	----	----
RC, mmol/L	----	----	85.0	220.0	----	----	----	----	----	----
Considered; I = Innocuous, PD = Potentially Deleterious, D = Deleterious	----	----	I	I	----	----	----	----	----	----
Los Angeles Abrasion; C 131, C 535			34.5' to 49.5' combined				59.5' to 79.5' combined			
Grading	B		A		A		1		1	
% Loss 100 Revolutions	10		13		13		----		----	
% Loss 500 Revolutions	31		40		40		----		----	
% Loss 200 Revolutions	----		----		----		13		13	
% Loss 1000 Revolutions	----		----		----		30		30	
Organic Impurities, C 40; LS = Lighter than Standard (Satisfactory) DS = Darker than Standard (unsatisfactory)		LS		LS		LS		LS		LS

*NT = Not tested insufficient material.

Summary of Laboratory Results for UPPER Sand and Gravel Interval, Samantha Jean-Luck Ranch Project

TEST HOLE	SJ-10-01		SJ-10-02		SJ-10-03		SJ-10-04		SJ-10-05		SJ-10-06		SJ-10-07		SJ-10-08		SJ-10-09		SJ-10-10		SJ-10-11		Average
Grading Depth >	20-25'	40-45'	20-25'	40-45'	20-25'	40-45'	35-40'	45-50'	20-25'	40-45'	25-30'	45-50'	20-25'	40-45'	20-25'	40-45'	20-25'	40-45'	20-25'	40-45'	20-25'	40-45'	
Screen Size																							
3 1/2"	100	100	100	100	100	100	100	100	100	100	100	100		100	100	100	100	100	90	58		100	97.4
3"	100	100	100	91	100	100	100	100	100	100	100	100	O	100	100	100	100	89	90	58	O	82	95.5
2 1/2"	100	100	100	86	100	100	100	100	100	100	100	100	V	100	94	100	100	89	90	55	V	82	94.8
2"	91	75	94	74	100	100	100	93	100	92	100	97	E	100	80	96	95	89	88	46	E	67	88.9
1 1/2"	79	69	89	66	98	71	100	85	97	75	100	93	R	60	72	91	85	88	75	42	R	65	80.0
1"	68	60	79	56	91	57	99	78	78	53	100	80	B	47	61	84	69	81	61	38	B	57	69.9
3/4"	62	57	68	53	85	49	97	76	69	43	100	70	U	40	55	76	60	76	54	36	U	51	63.9
1/2"	56	53	59	49	77	40	94	70	60	36	99	62	R	35	51	70	51	72	50	32	R	46	58.1
3/8"	52	50	55	47	73	35	93	67	56	32	99	59	D	32	50	66	46	70	48	29	D	42	55.1
No. 4	47	46	50	44	65	28	91	63	51	26	99	53	E	28	47	60	41	66	44	24	E	36	50.5
No. 8	43	44	46	41	59	24	90	59	49	24	99	51	N	26	46	55	37	62	42	21	N	33	47.6
No. 16	38	42	44	39	54	22	89	56	48	22	99	48		25	43	50	34	59	39	18		28	44.9
No. 30	28	32	37	32	41	18	82	34	41	18	87	37		21	35	33	28	36	34	13		22	35.5
No. 50	20	20	26	14	30	12	57	11	22	12	54	25		15	21	17	23	13	29	8		15	22.2
No. 100	15	13	19	5	23	9	35	5	12	7	33	18		11	13	9	20	7	23	4		8	14.5
No. 200	9.8	8.6	14.7	2.2	17.2	6.4	16.1	1.8	7.7	4.9	21.5	14.0		7.8	7.8	5.9	15.3	4.3	16.0	1.8		3.9	9.4
Sand Equivalent	35	29	28	81	33	24	31	25	44	54	33	75	O	27	36	62	19	76	17	77	O	86	
Washed SE	89	98	82	81	87	92	87	91	86	87	88	75	V	91	82	95	77	75	78	93	V	86	86
													E								E		
Durability, Df	74	80	65	76	47	79	72	79	69	75	77	84	R	88	76	81	62	82	36	89	R	73	73
Double Durability (Fine)					67								B						70		B		
													U								U		
Durability, Dc	92	90	87	90	94	90	*	85	93	89	*	90	R	93	90	90	85	87	89	87	R	87	89
													D								D		
Soundness													E								E		
													N								N		
Specific Gravity (Unwashed Fine)																							
Bulk Specific Gravity (Dry)	2.535	2.577	2.613	2.619	2.553	2.426	2.620	2.551	2.565	2.565	2.623	2.555		2.379	2.608	2.527	2.539	2.524	2.571	2.630		2.620	
Apparent Specific Gravity	2.680	2.695	2.677	2.646	2.679	2.578	2.662	2.676	2.677	2.677	2.658	2.639		2.497	2.690	2.668	2.664	2.639	2.698	2.715		2.743	2.663
Bulk Specific Gravity (SSD)	2.589	2.621	2.637	2.629	2.600	2.485	2.636	2.636	2.607	2.607	2.636	2.587		2.426	2.639	2.580	2.586	2.567	2.618	2.661		2.665	
Absorption (Fine)	2.12	1.71	0.91	0.38	1.83	2.42	0.60	1.83	1.63	1.63	0.50	1.26		1.99	1.17	2.08	1.90	1.73	1.83	1.19		1.71	1.52
Specific Gravity (Washed Fine)													O								O		
Bulk Specific Gravity (Dry)	2.609	2.603	2.618	2.640	2.590	2.603	2.608	2.564	2.686	2.586	2.572	2.570	V	2.563	2.620	2.578	2.583	2.563	2.615	2.610	V	2.641	
Apparent Specific Gravity	2.650	2.656	2.683	2.660	2.654	2.676	2.660	2.648	2.699	2.675	2.662	2.646	E	2.637	2.689	2.669	2.664	2.647	2.705	2.702	E	2.671	2.668
Bulk Specific Gravity (SSD)	2.625	2.623	2.642	2.647	2.614	2.630	2.627	2.596	2.691	2.619	2.606	2.599	R	2.591	2.646	2.612	2.614	2.595	2.648	2.644	R	2.652	
Absorption (Fine)	0.58	0.77	0.93	0.28	0.93	1.05	0.75	1.24	0.18	1.30	1.32	1.11	B	1.09	0.99	1.32	1.17	1.24	1.27	1.30	B	0.42	0.96
													U								U		
Specific Gravity (Coarse)													R								R		
Bulk Specific Gravity (Dry)	2.610	2.612	2.603	2.595	2.488	2.566	2.627	2.570	2.523	2.560	*	2.614	D	2.607	2.603	2.603	2.539	2.520	2.608	2.583	D	2.590	
Apparent Specific Gravity	2.660	2.663	2.672	2.677	2.686	2.676	2.694	2.702	2.683	2.694	*	2.684	E	2.627	2.656	2.684	2.668	2.665	2.680	2.680	E	2.690	2.676
Bulk Specific Gravity (SSD)	2.628	2.631	2.629	2.626	2.562	2.613	2.652	2.619	2.583	2.609	*	2.640	N	2.632	2.623	2.633	2.587	2.574	2.635	2.620	N	2.630	
Absorption (Coarse)	0.72	0.72	0.99	1.19	2.96	1.81	0.94	1.91	2.36	1.95	*	0.99		0.93	0.76	1.15	1.91	2.16	1.03	1.40		1.35	1.43
LA Rattler Gradation	(2)	(2)	(A)	(A)	(A)	(A)			(A)	(A)	*	(A)		(A)	(A)	(A)	(A)	(A)	(A)	(A)		(A)	
100 Rev	6.5	4.8	8.7	7.0	10.7	7.4	*	*	8.3	8.6	*	10.9		9.1	4.7	6.6	8.7	8.8	6.5	6.3		11.3	7.9
500 Rev	19.0	16.5	27.5	23.1	39.0	30.4	*	*	32.6	34.1	*	42.3		34.6	23.1	26.2	30.2	29.6	28.1	27.4		35.0	29.3

* Not enough coarse material to test.

UPPER SAND & GRAVEL LAYER

Summary of Laboratory Results for <u>MIDDLE</u> Sand and Gravel Interval, Samantha Jean-Luck Ranch Project

TEST HOLE	SJ-10-01	SJ-10-02	SJ-10-03	SJ-10-04	SJ-10-05	SJ-10-06	SJ-10-07	SJ-10-08	SJ-10-09		SJ-10-10	SJ-10-11	Average
Grading — Depth >	60-65'	55-60'	60-65'	55-60'	55-60'	60-70'	60-65'	60-65	55-60	60-65'		60-65'	
Screen Size													
3 1/2"	100	100	100	100	100	100	100	100	100	100		100	100.0
3"	100	93	100	100	100	100	100	100	100	94		100	98.8
2 1/2"	100	89	100	100	100	100	100	92	100	85		100	96.9
2"	95	86	100	100	98	100	100	83	96	78		100	94.2
1 1/2"	91	81	96	83	98	100	100	78	82	69		97	88.6
1"	76	71	89	73	98	100	100	57	72	56		97	80.8
3/4"	69	65	85	67	97	100	100	45	67	52		97	76.7
1/2"	64	59	82	61	97	100	100	37	61	48		97	73.3
3/8"	61	57	80	58	97	100	100	32	58	46		97	71.5
No. 4	55	51	74	51	96	100	100	25	53	43		97	67.7
No. 8	52	46	72	44	95	99	99	22	47	39		97	64.7
No. 16	48	42	69	39	94	99	98	21	42	36		95	62.1
No. 30	40	32	65	33	92	97	96	15	32	27		92	56.5
No. 50	28	23	59	26	89	84	83	10	19	16		89	47.8
No. 100	20	14	54	21	76	65	55	7	11	8		78	37.2
No. 200	15.2	9.2	46.0	16.2	51.5	48.2	44.3	4.3	5.9	4.1		55.2	27.3
Sand Equivalent	20	45	10	19	11	15	22	43	74	70		15	
Washed SE	88	87	70	88	77	72	78	90	84	86		85	82
Durability, Df	77	67	32	87	56	40	76	73	77	77		17	62
Double Durability (Fine)			51		70	69						37	66
Durability, Dc	81	87	*	89	*	*	*	87	90	90		*	87
Soundness													
Specific Gravity (Unwashed Fine)													
Bulk Specific Gravity (Dry)	2.546	2.527	2.419	2.402	2.483	2.406	2.397	2.547	2.571	2.545		2.298	
Apparent Specific Gravity	2.621	2.684	2.563	2.638	2.507	2.497	2.521	2.645	2.632	2.633		2.357	2.573
Bulk Specific Gravity (SSD)	2.575	2.586	2.475	2.491	2.493	2.442	2.446	2.584	2.594	2.579		2.323	
Absorption (Fine)	1.13	2.31	2.33	3.73	0.38	1.51	2.04	1.46	0.91	1.32		1.09	1.66
Specific Gravity (Washed Fine)													
Bulk Specific Gravity (Dry)	2.535	2.541	2.442	2.561	2.549	2.611	2.457	2.556	2.540	2.540		2.406	
Apparent Specific Gravity	2.656	2.675	2.667	2.604	2.648	2.639	2.522	2.663	2.631	2.639		2.632	2.634
Bulk Specific Gravity (SSD)	2.623	2.591	2.527	2.577	2.587	2.622	2.483	2.596	2.575	2.577		2.492	
Absorption (Fine)	1.44	1.98	3.46	0.64	1.46	0.40	1.05	1.58	1.36	1.48		3.58	1.68
Specific Gravity (Coarse)													
Bulk Specific Gravity (Dry)	2.573	2.549	2.322	2.625	*	*	*	2.567	2.483	2.547		*	
Apparent Specific Gravity	2.681	2.685	2.461	2.686	*	*	*	2.660	2.659	2.684		*	2.645
Bulk Specific Gravity (SSD)	2.613	2.599	2.378	2.647	*	*	*	2.602	2.549	2.598		*	
Absorption (Coarse)	1.57	1.99	2.43	0.86	*	*	*	1.37	2.67	2.00		*	1.84
LA Rattler — Gradation	(A)	(A)		(A)				(A)	(A)				
100 Rev	15.8	15.0	*	21.1	*	*	*	11.1	9.2	*		*	14.4
500 Rev	39.8	37.6	*	44.1	*	*	*	36.9	44.0	*		*	40.5

* Not enough coarse material to test.

MIDDLE SAND & GRAVEL LAYER

Summary of Laboratory Results for **<u>LOWER</u> Sand and Gravel Interval, Samantha Jean-Luck Ranch Project**

TEST HOLE	SJ-10-01		SJ-10-02		SJ-10-03			SJ-10-04		SJ-10-05		SJ-10-06		SJ-10-07		SJ-10-08		SJ-10-09		SJ-10-10		SJ-10-11		Average
Grading — Depth >	80-85'	95-100'		75-80'	80-85'	90-95'	95-100'	75-80'	90-95'	75-80'	90-95'		85-90'		80-85'		80-85'		80-85'		70-75'	70-75'	85-90'	
Screen Size																								
3 1/2"	100	100		100	100	100	100	100	100	100	100		100		100		100		100		100.0	100	100.0	100.0
3"	100	100		100	100	100	100	100	100	100	100		100		100		100		100		100	100	93.0	99.6
2 1/2"	100	100		100	100	100	100	100	100	100	100		100		100		93		92		100	100	89.0	98.5
2"	96	100		98	100	100	100	100	100	100	94		100		100		88		84		96	100	75.0	95.9
1 1/2"	94	97		92	93	93	92	78	94	92	86		94		61		79		72		91	98	64.0	86.5
1"	85	91		72	85	74	68	68	86	78	72		86		52		67		55		84	94	53.0	74.7
3/4"	80	81		61	82	66	57	63	81	72	64		83		46		62		46		81	89	49.0	68.4
1/2"	74	74		53	77	57	50	59	75	65	53		80		40		53		41		78	85	44.0	62.2
3/8"	70	70		49	75	55	48	56	71	62	47		79		37		49		39		76	83	42.0	59.3
No. 4	61	63		45	71	53	47	52	64	55	39		78		30		43		34		73	79	38.0	54.4
No. 8	57	60		44	69	52	46	50	57	51	36		78		27		41		30		71	69	36.0	51.4
No. 16	52	52		42	64	51	45	48	52	47	33		77		23		40		26		68	64	32.0	48.0
No. 30	44	41		32	39	44	40	35	46	32	28		70		16		26		21		41	58	23.0	37.4
No. 50	23	30		21	12	19	19	14	36	17	21		58		8		8		14		19	54	12.0	22.6
No. 100	9	23		18	5	11	13	6	26	8	15		28		3		3		9		11	42	5.0	13.8
No. 200	3.8	16.5		11.4	3.3	7.8	9.4	3.9	18.6	4.0	10.5		22.7		2.1		2.0		6.7		5.6	28.1	2.5	9.3
Sand Equivalent	60	24		28	73	42	35	59	22	80	28		22		73		73		35		66	17	78	
Washed SE	87	91		79	78	71	64	90	87	91	84		82		93		80		80		86	39	78	80
Durability, Df	84	79		54	75	67	59	65	75	51	49		58		74		73		57		36	18	49	60
Double Durability (Fine)				61						76	71		70						71		77	62	84	68
Durability, Dc	84	81		85	81	77	83	89	86	76	86		87		90		86		85		89	85	87	85
Soundness																								
Specific Gravity (Unwashed Fine)																								
Bulk Specific Gravity (Dry)	2.588	2.543		2.508	2.539	2.469	2.457	2.543	2.572	2.596	2.603		2.495		2.535		2.493		2.564		2.577	2.414	2.6	
Apparent Specific Gravity	2.653	2.622		2.657	2.677	2.623	2.606	2.732	2.703	2.688	2.678		2.580		2.644		2.629		2.664		2.664	2.653	2.659	2.655
Bulk Specific Gravity (SSD)	2.613	2.573		2.564	2.591	2.528	2.514	2.612	2.621	2.630	2.631		2.528		2.576		2.545		2.601		2.610	2.504	2.60	
Absorption (Fine)	0.95	1.17		2.23	2.02	2.38	2.33	2.71	1.87	1.32	1.07		1.32		1.63		2.08		1.46		1.28	3.73	1.44	1.82
Specific Gravity (Washed Fine)																								
Bulk Specific Gravity (Dry)	2.547	2.568		2.619	2.556	2.491	2.506	2.559	2.574	2.560	2.554		2.580		2.530		2.494		2.568		2.509	2.513	2.610	
Apparent Specific Gravity	2.656	2.613		2.715	2.673	2.621	2.623	2.599	2.666	2.674	2.669		2.662		2.656		2.644		2.692		2.686	2.694	2.645	2.658
Bulk Specific Gravity (SSD)	2.588	2.585		2.654	2.600	2.541	2.561	2.575	2.608	2.603	2.597		2.611		2.577		2.551		2.614		2.575	2.580	2.623	
Absorption (Fine)	1.61	0.66		1.34	1.71	2.00	2.21	0.60	1.34	1.67	1.69		1.19		1.88		2.27		1.79		2.63	2.68	0.50	1.63
Specific Gravity (Coarse)																								
Bulk Specific Gravity (Dry)	2.637	2.560		2.552	2.491	2.503	2.497	2.559	2.591	2.473	2.543		2.560		2.563		2.568		2.528		2.546	2.560	2.575	
Apparent Specific Gravity	2.735	2.668		2.656	2.676	2.658	2.642	2.678	2.694	2.663	2.725		2.641		2.691		2.704		2.663		2.677	2.660	2.653	2.676
Bulk Specific Gravity (SSD)	2.673	2.601		2.591	2.560	2.561	2.552	2.604	2.629	2.545	2.610		2.591		2.611		2.618		2.579		2.595	2.600	2.605	
Absorption (Coarse)	1.35	1.58		1.54	2.78	2.34	2.20	1.73	1.48	2.89	2.63		1.19		1.85		1.96		2.00		1.93	1.47	1.14	1.89
LA Rattler — Gradation	(A)	(A)		(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)		(A)		(B)		(A)		(A)		(A)	(A)	(A)	
100 Rev	11.7	12.6		18.0	12.4	17.0	18.1	18.7	17.2	16.3	8.6		15.9		12.9		16.3		9.0		18.9	14.5	13.0	14.8
500 Rev	36.4	40.7		40.4	41.8	44.8	44.9	48.6	45.5	45.6	36.3		47.4		41.9		43.0		43.5		44.7	40.2	38.1	42.6

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-01

		Depth											
Grading	**Size**	20'-25'		40'-45'		60'-65'		80'-85'		95'-100'		N/A	
	Largest Observed	2"		2"		2"		2"		1-1/2"			
	3 1/2"	100		100		100		100		100			
	3"	100		100		100		100		100			
	2 1/2"	100		100		100		100		100			
	2"	91		75		95		96		100			
	1 1/2"	79		69		91		94		97			
	1"	68		60		76		85		91			
	3/4"	62		57		69		80		81			
	1/2"	56		53		64		74		74			
	3/8"	52	**-4 Material**	50	**-4 Material**	61	**-4 Material**	70	**-4 Material**	70	**-4 Material**		
	No. 4	47	100	46	100	55	100	61	100	63	100		
	No. 8	43	91	44	96	52	95	57	93	60	95		
	No. 16	38	81	42	91	48	87	52	85	52	83		
	No. 30	28	60	32	70	40	73	44	72	41	65		
	No. 50	20	43	20	43	28	51	23	38	30	48		
	No. 100	15	32	13	28	20	36	9	15	23	37		
	No. 200	9.8	21	8.6	19	15.2	28	3.8	6	16.5	26		
Sand Equivalent			35		29		20		60		24		
Washed SE			89		98		88		87		91		
Durability, Df			74		80		77		84		79		
Double Durability (Fine)			N/A		N/A		N/A		N/A		N/A		
Triple Durability (Fine)			N/A		N/A		N/A		N/A		N/A		
Durability, Dc		92		90		81		84		81			
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A			
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.535		2.577		2.546		2.588		2.543		
Apparent Specific Gravity			2.680		2.695		2.621		2.653		2.622		
Bulk Specific gravity (SSD)			2.589		2.621		2.575		2.613		2.573		
Absorption %			2.12		1.71		1.13		0.95		1.17		
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.609		2.603		2.535		2.547		2.568		
Apparent Specific Gravity			2.65		2.656		2.632		2.656		2.613		
Bulk Specific gravity (SSD)			2.625		2.623		2.572		2.588		2.585		
Absorption %			0.58		0.77		1.44		1.61		0.66		
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.610		2.612		2.573		2.637		2.560			
Apparent Specific Gravity		2.660		2.663		2.681		2.735		2.668			
Bulk Specific gravity (SSD)		2.628		2.631		2.613		2.673		2.601			
Absorption % (Coarse)		0.72		0.72		1.57		1.35		1.58			
LA Rattler (1, 2, 3, A, B, C, D)		(2)		(2)		(A)		(A)		(A)			
200 Rev / 100 Rev		6.5		4.8		15.8		11.7		12.6			
1000 Rev / 500 Rev		19		16.5		39.8		36.4		40.7			

SJ-10-01

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-02

		Depth											
Grading	**Size**	20'-25'		40'-45'		55'-60'		75'-80'		N/A		N/A	
	Largest Observed	2"		3"		3"		2"					
	3 1/2"	100		100		100		100					
	3"	100		91		93		100					
	2 1/2"	100		86		89		100					
	2"	94		74		86		98					
	1 1/2"	89		66		81		92					
	1"	79		56		71		72					
	3/4"	68		53		65		61					
	1/2"	59		49		59		53					
	3/8"	55	**-4 Material**	47	**-4 Material**	57	**-4 Material**	49	**-4 Material**				
	No. 4	50	100	44	100	51	100	45	100				
	No. 8	46	92	41	93	46	90	44	98				
	No. 16	44	88	39	89	42	82	42	93				
	No. 30	37	74	32	73	34	67	32	71				
	No. 50	26	52	14	32	23	45	21	47				
	No. 100	19	38	5	11	14	27	16	36				
	No. 200	14.7	29	2.2	5	9.2	18	11.4	25				
Sand Equivalent			28		81		45		28				
Washed SE			82		N/A		87		79				
Durability, Df			65		76		67		54				
Double Durability (Fine)			N/A		N/A		N/A		61				
Triple Durability (Fine)			N/A		N/A		N/A		N/A				
Durability, Dc		87		90		87		85					
Double Durability, Coarse		N/A		N/A		N/A		N/A					
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.613		2.619		2.527		2.508				
Apparent Specific Gravity			2.677		2.646		2.684		2.657				
Bulk Specific gravity (SSD)			2.637		2.629		2.586		2.564				
Absorption %			0.91		0.38		2.31		2.23				
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.618		2.64		2.541		2.619				
Apparent Specific Gravity			2.683		2.66		2.675		2.715				
Bulk Specific gravity (SSD)			2.642		2.647		2.591		2.654				
Absorption %			0.93		0.28		1.98		1.34				
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.603		2.595		2.549		2.552					
Apparent Specific Gravity		2.672		2.677		2.685		2.656					
Bulk Specific gravity (SSD)		2.629		2.626		2.599		2.591					
Absorption % (Coarse)		0.99		1.19		1.99		1.54					
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		(A)		(A)					
200 Rev / 100 Rev		8.7		7		15		18					
1000 Rev / 500 Rev		27.5		23.1		37.6		40.4					

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-03		Depth											
Grading	**Size**	20'-25'		40'-45'		60'-65'		80'-85'		90'-95'		95'-100'	
	Largest Observed	1-1/2"		1-1/2"		1-1/2"		1-1/2"		1-1/2"		1-1/2"	
	3 1/2"	100		100		100		100		100		100	
	3"	100		100		100		100		100		100	
	2 1/2"	100		100		100		100		100		100	
	2"	100		100		100		100		100		100	
	1 1/2"	98		71		96		93		93		92	
	1"	91		57		89		85		74		68	
	3/4"	85		49		85		82		66		57	
	1/2"	77		40		82		77		57		50	
	3/8"	73	**-4 Material**	35	**-4 Material**	80	**-4 Material**	75	**-4 Material**	55	**-4 Material**	48	-4 Material
	No. 4	65	100	28	100	74	100	71	100	53	100	47	100
	No. 8	59	91	24	86	72	97	69	97	52	98	46	98
	No. 16	54	83	22	79	69	93	64	90	51	96	45	96
	No. 30	41	63	18	64	65	88	39	55	44	83	40	85
	No. 50	30	46	12	43	59	80	12	17	19	36	19	40
	No. 100	23	35	9	32	54	73	5	7	11	21	13	28
	No. 200	17.2	26	6.4	23	46	62	3.3	5	7.8	15	9.4	20
Sand Equivalent			33		24		10		73		42		35
Washed SE			87		92		71		78		71		64
Durability, Df			47		79		32		75		67		59
Double Durability (Fine)			67		N/A		51		N/A		N/A		62
Triple Durability (Fine)			N/A		N/A		N/A		N/A		N/A		N/A
Durability, Dc		94		90		N/A		81		77		83	
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A		N/A	
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.553		2.426		2.419		2.539		2.469		2.457
Apparent Specific Gravity			2.679		2.578		2.563		2.677		2.623		2.606
Bulk Specific gravity (SSD)			2.600		2.485		2.475		2.591		2.528		2.514
Absorption %			1.83		2.42		2.33		2.02		2.38		2.33
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.59		2.603		2.442		2.556		2.491		2.506
Apparent Specific Gravity			2.654		2.676		2.667		2.673		2.621		2.653
Bulk Specific gravity (SSD)			2.614		2.63		2.527		2.6		2.541		2.561
Absorption %			0.93		1.05		3.46		1.71		2.00		2.21
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.488		2.566		2.322		2.491		2.503		2.497	
Apparent Specific Gravity		2.686		2.691		2.461		2.676		2.658		2.642	
Bulk Specific gravity (SSD)		2.562		2.613		2.378		2.560		2.561		2.552	
Absorption % (Coarse)		2.96		1.81		2.43		2.78		2.34		2.20	
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		N/A		(A)		(A)		(A)	
200 Rev / 100 Rev		10.7		7.4		N/A		12.4		17		18.1	
1000 Rev / 500 Rev		39		30.4		N/A		41.8		44.8		44.9	

SJ-10-03

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-04

		Depth											
Grading	**Size**	35'-40'		45'-50'		55'-60'		75'-80'		90'-95'		N/A	
	Largest Observed	1"		2"		1-1/2"		1-1/2"		1-1/2"			
	3 1/2"	100		100		100		100		100			
	3"	100		100		100		100		100			
	2 1/2"	100		100		100		100		100			
	2"	100		93		100		100		100			
	1 1/2"	100		85		83		78		94			
	1"	99		78		73		68		86			
	3/4"	97		76		67		63		81			
	1/2"	94		70		61		59		75			
	3/8"	93	**-4 Material**	67	**-4 Material**	58	**-4 Material**	56	**-4 Material**	71	**-4 Material**		
	No. 4	91	100	63	100	51	100	52	100	64	100		
	No. 8	90	99	59	94	44	86	50	96	57	89		
	No. 16	89	98	56	89	39	76	48	92	52	81		
	No. 30	82	90	34	54	33	65	35	67	46	72		
	No. 50	57	63	11	17	26	51	14	27	36	56		
	No. 100	35	38	5	8	21	41	6	12	26	41		
	No. 200	16.1	18	1.8	3	16.2	32	3.9	8	18.6	29		
Sand Equivalent			31		25		19		59		22		
Washed SE			87		91		88		90		87		
Durability, Df			72		79		87		65		75		
Double Durability (Fine)			N/A		N/A		N/A		N/A		N/A		
Triple Durability (Fine)			N/A		N/A		N/A		N/A		N/A		
Durability, Dc		N/A		85		89		89		86			
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A			
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.620		2.551		2.402		2.543		2.572		
Apparent Specific Gravity			2.662		2.676		2.638		2.732		2.703		
Bulk Specific gravity (SSD)			2.636		2.597		2.491		2.612		2.621		
Absorption %			0.60		1.83		3.73		2.71		1.87		
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.608		2.564		2.561		2.559		2.574		
Apparent Specific Gravity			2.660		2.648		2.604		2.599		2.666		
Bulk Specific gravity (SSD)			2.627		2.596		2.577		2.575		2.608		
Absorption %			0.75		1.24		0.64		0.60		1.34		
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.627		2.57		2.625		2.559		2.591			
Apparent Specific Gravity		2.694		2.702		2.686		2.678		2.694			
Bulk Specific gravity (SSD)		2.652		2.619		2.647		2.604		2.629			
Absorption % (Coarse)		0.94		1.91		0.86		1.73		1.48			
LA Rattler (1, 2, 3, A, B, C, D)		N/A		N/A		(A)		(A)		(A)			
200 Rev / 100 Rev		N/A		N/A		21.1		18.7		17.2			
1000 Rev / 500 Rev		N/A		N/A		44.1		48.6		45.5			

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-05		Depth											
Grading	**Size**	20'-25'		40'-45'		55'-60'		75'-80'		90'-95'		N/A	
	Largest Observed	1-1/2"		2"		2"		1-1/2"		2"			
	3 1/2"	100		100		100		100		100			
	3"	100		100		100		100		100			
	2 1/2"	100		100		100		100		100			
	2"	100		92		98		100		94			
	1 1/2"	97		75		98		92		86			
	1"	78		53		98		78		72			
	3/4"	69		43		97		72		64			
	1/2"	60		36		97		65		53			
	3/8"	56	**-4 Material**	32	**-4 Material**	97	**-4 Material**	62	**-4 Material**	47	**-4 Material**		
	No. 4	51	100	26	100	96	100	55	100	39	100		
	No. 8	49	96	24	92	95	99	51	93	36	92		
	No. 16	48	94	22	85	94	98	47	85	33	85		
	No. 30	41	80	18	69	92	96	32	58	28	72		
	No. 50	22	43	12	46	89	93	17	31	21	54		
	No. 100	12	24	7	27	76	79	8	15	15	38		
	No. 200	7.7	15	4.9	19	51.5	54	4	7	10.5	27		
Sand Equivalent			44		54		11		80		28		
Washed SE			86		87		77		91		84		
Durability, Df			69		75		56		51		49		
Double Durability (Fine)			N/A		N/A		70		76		71		
Triple Durability (Fine)			N/A		N/A		N/A		N/A		N/A		
Durability, Dc		93		89		N/A		76		86			
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A			
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.565		2.565		2.483		2.596		2.603		
Apparent Specific Gravity			2.677		2.677		2.507		2.688		2.678		
Bulk Specific gravity (SSD)			2.607		2.607		2.493		2.63		2.631		
Absorption %			1.63		1.63		0.38		1.32		1.07		
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.686		2.586		2.549		2.56		2.554		
Apparent Specific Gravity			2.699		2.675		2.648		2.674		2.669		
Bulk Specific gravity (SSD)			2.691		2.619		2.587		2.603		2.597		
Absorption %			0.18		1.30		1.46		1.67		1.69		
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.523		2.560		N/A		2.473		2.543			
Apparent Specific Gravity		2.683		2.694		N/A		2.663		2.725			
Bulk Specific gravity (SSD)		2.583		2.609		N/A		2.545		2.610			
Absorption % (Coarse)		2.36		1.95		N/A		2.89		2.63			
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		N/A		(A)		(A)			
200 Rev / 100 Rev		8.3		8.6		N/A		16.3		8.6			
1000 Rev / 500 Rev		32.6		34.1		N/A		45.6		36.3			

SJ-10-05

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-06		Depth											
Grading	**Size**	25'-30'		45'-50'		60'-70'		85'-90'		N/A		N/A	
	Largest Observed	1/2"		2"		#8		1-1/2"					
	3 1/2"	100		100		100		100					
	3"	100		100		100		100					
	2 1/2"	100		100		100		100					
	2"	100		97		100		100					
	1 1/2"	100		93		100		94					
	1"	100		80		100		86					
	3/4"	100		70		100		83					
	1/2"	99		62		100		80					
	3/8"	99	**-4 Material**	59	**-4 Material**	100	**-4 Material**	79	**-4 Material**				
	No. 4	99	100	53	100	100	100	78	100				
	No. 8	99	100	51	96	99	99	78	100				
	No. 16	99	100	48	91	99	99	77	99				
	No. 30	87	88	37	70	97	97	70	90				
	No. 50	54	55	25	47	84	84	58	74				
	No. 100	33	33	18	34	65	65	28	36				
	No. 200	21.5	22	14	26	48.2	48	22.7	29				
Sand Equivalent			33		75		15		22				
Washed SE			88		N/A		72		82				
Durability, Df			77		84		40		58				
Double Durability (Fine)			N/A		N/A		69		70				
Triple DUrability (Fine)			N/A		N/A		N/A		N/A				
Durability, Dc		N/A		90		N/A		87					
Double Durability, Coarse		N/A		N/A		N/A		N/A					
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.623		2.555		2.406		2.495				
Apparent Specific Gravity			2.658		2.639		2.497		2.580				
Bulk Specific gravity (SSD)			2.636		2.587		2.442		2.528				
Absorption %			0.50		1.26		1.51		1.32				
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.572		2.570		2.611		2.580				
Apparent Specific Gravity			2.662		2.646		2.639		2.662				
Bulk Specific gravity (SSD)			2.606		2.599		2.622		2.611				
Absorption %			1.32		1.11		0.40		1.19				
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		N/A		2.614		N/A		2.560					
Apparent Specific Gravity		N/A		2.684		N/A		2.641					
Bulk Specific gravity (SSD)		N/A		2.640		N/A		2.591					
Absorption % (Coarse)		N/A		0.99		N/A		1.19					
LA Rattler (1, 2, 3, A, B, C, D)		N/A		(A)		N/A		(C)					
200 Rev / 100 Rev		N/A		10.9		N/A		15.9					
1000 Rev / 500 Rev		N/A		42.3		N/A		47.4					

SJ-10-06

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-07		Depth											
Grading	**Size**	20'-25'		40'-45'		60'-65'		80'-85'				N/A	
	Largest Observed	1-1/2"		1-1/2"		#8		1-1/2"					
	3 1/2"	100		100		100		100					
	3"	100		100		100		100					
	2 1/2"	100		100		100		100					
	2"	100		100		100		100					
	1 1/2"	97		60		100		61					
	1"	92		47		100		52					
	3/4"	89		40		100		46					
	1/2"	86		35		100		40					
	3/8"	84	**-4 Material**	32	**-4 Material**	100	**-4 Material**	37	**-4 Material**				
	No. 4	81	100	28	100	100	100	30	100				
	No. 8	80	99	26	93	99	99	27	90				
	No. 16	78	96	25	89	98	98	23	77				
	No. 30	76	94	21	75	96	96	16	53				
	No. 50	64	79	15	54	83	83	8	27				
	No. 100	45	56	11	39	55	55	3	10				
	No. 200	30.1	37	7.8	28	44.3	44	2.1	7				
Sand Equivalent			20		27		22		73				
Washed SE			82		91		78		93				
Durability, Df			58		88		76		74				
Double Durability (Fine)			68		N/A		N/A		N/A				
Triple DUrability (Fine)			N/A		N/A		N/A		N/A				
Durability, Dc		N/A		93		N/A		90					
Double Durability, Coarse		N/A		N/A		N/A		N/A					
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.538		2.379		2.397		2.535				
Apparent Specific Gravity			2.656		2.497		2.521		2.644				
Bulk Specific gravity (SSD)			2.583		2.426		2.446		2.576				
Absorption %			1.75		1.99		2.04		1.63				
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.602		2.563		2.457		2.53				
Apparent Specific Gravity			2.685		2.637		2.522		2.656				
Bulk Specific gravity (SSD)			2.633		2.591		2.483		2.577				
Absorption %			1.19		1.09		1.05		1.88				
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.547		2.607		N/A		2.563					
Apparent Specific Gravity		2.701		2.672		N/A		2.691					
Bulk Specific gravity (SSD)		2.604		2.632		N/A		2.611					
Absorption % (Coarse)		2.24		0.93		N/A		1.85					
LA Rattler (1, 2, 3, A, B, C, D)		C		(A)		N/A		(B)					
200 Rev / 100 Rev		9.7		9.1		N/A		12.9					
1000 Rev / 500 Rev		32.9		34.6		N/A		41.9					

SJ-10-07

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-08		Depth											
Grading	**Size**	20'-25'		40'-45'		60'-65'		80'-85'		N/A		N/A	
	Largest Observed	2-1/2"		2"		2-1/2"		2-1/2"					
	3 1/2"	100		100		100		100					
	3"	100		100		100		100					
	2 1/2"	94		100		92		93					
	2"	80		96		83		88					
	1 1/2"	72		91		78		79					
	1"	61		84		57		67					
	3/4"	55		76		45		62					
	1/2"	51		70		37		53					
	3/8"	50	**-4 Material**	66	**-4 Material**	32	**-4 Material**	49	**-4 Material**				
	No. 4	47	100	60	100	25	100	43	100				
	No. 8	46	98	55	92	22	88	41	95				
	No. 16	43	91	50	83	21	84	40	93				
	No. 30	35	74	33	55	15	60	26	60				
	No. 50	21	45	17	28	10	40	8	19				
	No. 100	13	28	9	15	7	28	3	7				
	No. 200	7.8	17	5.9	10	4.3	17	2	5				
Sand Equivalent			36		62		43		73				
Washed SE			82		95		90		80				
Durability, Df			76		81		73		73				
Double Durability (Fine)			N/A		N/A		N/A		N/A				
Triple DUrability (Fine)			N/A		N/A		N/A		N/A				
Durability, Dc		90		90		87		86					
Double Durability, Coarse		N/A		N/A		N/A		N/A					
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.608		2.527		2.547		2.493				
Apparent Specific Gravity			2.690		2.668		2.645		2.629				
Bulk Specific gravity (SSD)			2.639		2.58		2.584		2.545				
Absorption %			1.17		2.08		1.46		2.08				
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.62		2.578		2.556		2.494				
Apparent Specific Gravity			2.689		2.669		2.663		2.644				
Bulk Specific gravity (SSD)			2.646		2.612		2.596		2.551				
Absorption %			0.99		1.32		1.58		2.27				
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.603		2.603		2.567		2.568					
Apparent Specific Gravity		2.656		2.684		2.66		2.704					
Bulk Specific gravity (SSD)		2.623		2.633		2.602		2.618					
Absorption % (Coarse)		0.76		1.15		1.37		1.96					
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		(A)		(A)					
200 Rev / 100 Rev		4.7		6.6		11.1		16.3					
1000 Rev / 500 Rev		23.1		26.2		36.9		43.0					

SJ-10-08

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-09

		Depth											
Grading	**Size**	20'-25'		40'-45'		55'-60'		60'-65'		80'-85'		N/A	
	Largest Observed	2"		3"		2"		3"		2-1/2"			
	3 1/2"	100		100		100		100		100			
	3"	100		89		100		94		100			
	2 1/2"	100		89		100		85		92			
	2"	95		89		96		78		84			
	1 1/2"	85		88		82		69		72			
	1"	69		81		72		56		55			
	3/4"	60		76		67		52		46			
	1/2"	51		72		61		48		41			
	3/8"	46	**-4 Material**	70	**-4 Material**	58	**-4 Material**	46	**-4 Material**	39	**-4 Material**		
	No. 4	41	100	66	100	53	100	43	100	34	100		
	No. 8	37	90	62	94	47	89	39	91	30	88		
	No. 16	34	83	59	89	42	79	36	84	26	76		
	No. 30	28	68	36	55	32	60	27	63	21	62		
	No. 50	23	56	13	20	19	36	16	37	14	41		
	No. 100	20	49	7	11	11	21	8	19	9	26		
	No. 200	15.3	37	4.3	7	5.9	11	4.1	10	6.7	20		
Sand Equivalent			19		76		74		70		35		
Washed SE			77		N/A		84		86		80		
Durability, Df			62		82		77		77		57		
Double Durability (Fine)			N/A		N/A		N/A		N/A		71		
Triple DUrability (Fine)			N/A		N/A		N/A		N/A		N/A		
Durability, Dc		85		87		90		90		85			
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A			
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.539		2.524		2.571		2.545		2.564		
Apparent Specific Gravity			2.664		2.639		2.632		2.633		2.664		
Bulk Specific gravity (SSD)			2.586		2.567		2.594		2.579		2.601		
Absorption %			1.9		1.73		0.91		1.32		1.46		
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.583		2.563		2.54		2.54		2.568		
Apparent Specific Gravity			2.664		2.647		2.631		2.639		2.692		
Bulk Specific gravity (SSD)			2.614		2.595		2.575		2.577		2.614		
Absorption %			1.17		1.24		1.36		1.48		1.79		
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.539		2.52		2.483		2.547		2.528			
Apparent Specific Gravity		2.668		2.665		2.659		2.684		2.663			
Bulk Specific gravity (SSD)		2.587		2.574		2.549		2.598		2.579			
Absorption % (Coarse)		1.91		2.16		2.67		2.0		2.0			
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		(A)		N/A		(A)			
200 Rev / 100 Rev		8.7		8.8		9.2		N/A		9.0			
1000 Rev / 500 Rev		30.2		29.6		44.0		N/A		43.5			

SJ-10-09

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-10		Depth											
Grading	**Size**	20'-25'		40'-45'		70'-75'		N/A		N/A		N/A	
	Largest Observed	3 1/2"		3 1/2"		2"							
	3 1/2"	90		58		100							
	3"	90		58		100							
	2 1/2"	90		55		100							
	2"	88		46		96							
	1 1/2"	75		42		91							
	1"	61		38		84							
	3/4"	54		36		81							
	1/2"	50		32		78							
	3/8"	48	**-4 Material**	29	**-4 Material**	76	**-4 Material**						
	No. 4	44	100	24	100	73	100						
	No. 8	42	95	21	88	71	97						
	No. 16	39	89	18	75	68	93						
	No. 30	34	77	13	54	41	56						
	No. 50	29	66	8	33	19	26						
	No. 100	23	52	4	17	11	15						
	No. 200	16	36	1.8	8	5.6	8						
Sand Equivalent			17		77		66						
Washed SE			78		93		86						
Durability, Df			36		89		36						
Double Durability (Fine)			70		N/A		77						
Triple DUrability (Fine)			N/A		N/A		N/A						
Durability, Dc		89		87		89							
Double Durability, Coarse		N/A		N/A		N/A							
Soundness		N/A	N/A	N/A	N/A	N/A	N/A						
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.571		2.630		2.577						
Apparent Specific Gravity			2.698		2.715		2.664						
Bulk Specific gravity (SSD)			2.618		2.661		2.610						
Absorption %			1.83		1.19		1.28						
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.615		2.610		2.509						
Apparent Specific Gravity			2.705		2.702		2.686						
Bulk Specific gravity (SSD)			2.648		2.644		2.575						
Absorption %			1.27		1.30		2.63						
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.608		2.583		2.546							
Apparent Specific Gravity		2.680		2.680		2.677							
Bulk Specific gravity (SSD)		2.635		2.620		2.595							
Absorption % (Coarse)		1.03		1.400		1.93							
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		(A)							
200 Rev / 100 Rev		6.5		6.3		18.9							
1000 Rev / 500 Rev		28.1		27.4		44.7							

SJ-10-10

KLEINFELDER
Bright People. Right Solutions.

LABORATORY TEST RESULT SUMMARY

TEST HOLE SJ-10-11		Depth											
Grading	**Size**	20'-25'		40'-45'		60'-65'		70'-75'		85'-90'		N/A	
	Largest Observed	2-1/2"		3"		1-1/2"		1-1/2"		3"			
	3 1/2"	100		100		100		100		100			
	3"	100		82		100		100		93			
	2 1/2"	94		82		100		100		89			
	2"	94		67		100		100		75			
	1 1/2"	82		65		97		98		64			
	1"	71		57		97		94		53			
	3/4"	65		51		97		89		49			
	1/2"	61		46		97		85		44			
	3/8"	59	**-4 Material**	42	**-4 Material**	97	**-4 Material**	83	**-4 Material**	42	**-4 Material**		
	No. 4	56	100	36	100	97	100	79	100	38	100		
	No. 8	54	96	33	92	97	100	69	87	36	95		
	No. 16	53	95	28	78	95	98	64	81	32	84		
	No. 30	52	93	22	61	92	95	58	73	23	61		
	No. 50	50	89	15	42	89	92	54	68	12	32		
	No. 100	47	84	8	22	78	80	42	53	5	13		
	No. 200	32.5	58	3.9	11	55.2	57	28.1	36	2.5	7		
Sand Equivalent			11		86		15		17		78		
Washed SE			59		N/A		85		39		N/A		
Durability, Df			42		73		17		18		49		
Double Durability (Fine)			60		N/A		37		62		84		
Triple DUrability (Fine)			N/A		N/A		N/A		N/A		N/A		
Durability, Dc		92		87		N/R		85		87			
Double Durability, Coarse		N/A		N/A		N/A		N/A		N/A			
Soundness		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Specific Gravity (Fine)													
Bulk Specific gravity (Dry)			2.573		2.641		2.298		2.414		2.561		
Apparent Specific Gravity			2.652		2.671		2.357		2.653		2.659		
Bulk Specific gravity (SSD)			2.603		2.652		2.323		2.504		2.597		
Absorption %			1.15		0.42		1.09		3.73		1.44		
Specific Gravity (Fine)	**After 200 Wash**												
Bulk Specific gravity (Dry)			2.597		2.620		2.406		2.513		2.610		
Apparent Specific Gravity			2.713		2.743		2.632		2.694		2.645		
Bulk Specific gravity (SSD)			2.640		2.665		2.492		2.580		2.623		
Absorption %			1.65		1.71		3.58		2.68		0.5		
Specific Gravity (Coarse)													
Bulk Specific gravity (Dry)		2.620		2.590		N/A		2.560		2.575			
Apparent Specific Gravity		2.670		2.690		N/A		2.660		2.653			
Bulk Specific gravity (SSD)		2.640		2.630		N/A		2.600		2.605			
Absorption % (Coarse)		0.83		1.35		N/A		1.47		1.14			
LA Rattler (1, 2, 3, A, B, C, D)		(A)		(A)		N/A		(A)		(A)			
200 Rev / 100 Rev		6.3		11.3		N/A		14.5		13.0			
1000 Rev / 500 Rev		26.5		35		N/A		40.2		38.1			

SJ-10-11

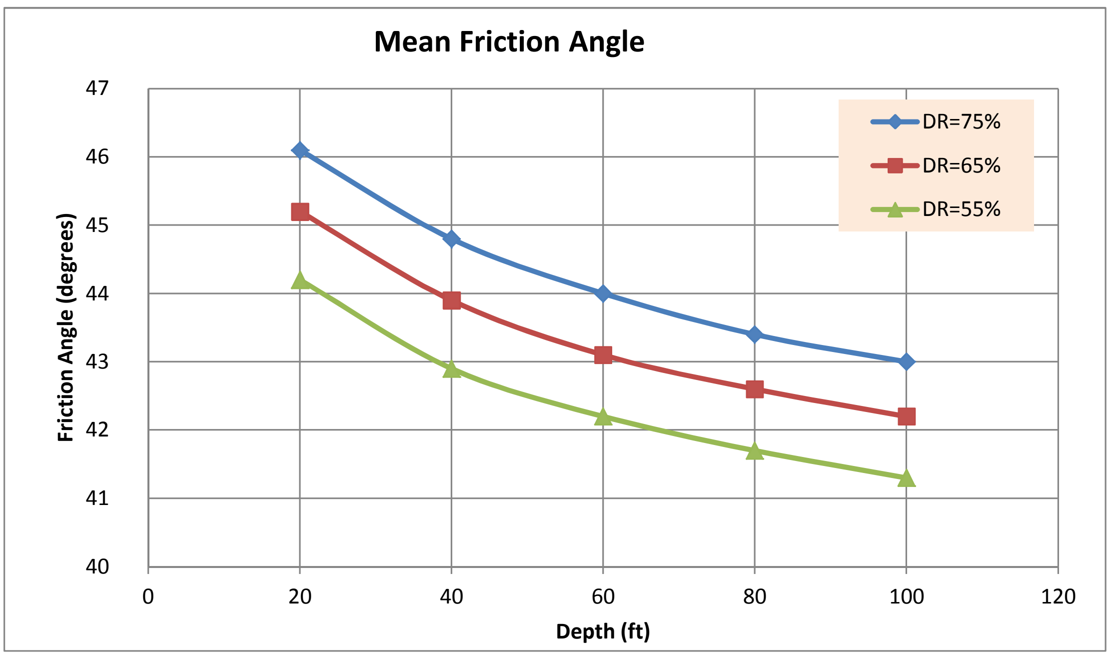
APPENDIX C

SLOPE STABILITY ANALYSES

Riverbend Sand and Gravel Quarries - Shear Strength Estimation for Granular Deposits

Sand & Gravel Shear Strength Estimation[1]

Relative Density (%)	Depth (ft)	Friction Angle (degrees)		
		Upper Bound	Mean	Lower Bound
75	20	49.3	46.1	42.9
	40	48.0	44.8	41.6
	60	47.2	44.0	40.8
	80	46.6	43.4	40.2
	100	46.2	43.0	39.8
65	20	48.4	45.2	42.0
	40	47.1	43.9	40.7
	60	46.3	43.1	39.9
	80	45.8	42.6	39.4
	100	45.4	42.2	39.0
55	20	47.4	44.2	41.0
	40	46.1	42.9	39.7
	60	45.4	42.2	39.0
	80	44.9	41.7	38.5
	100	44.5	41.3	38.1



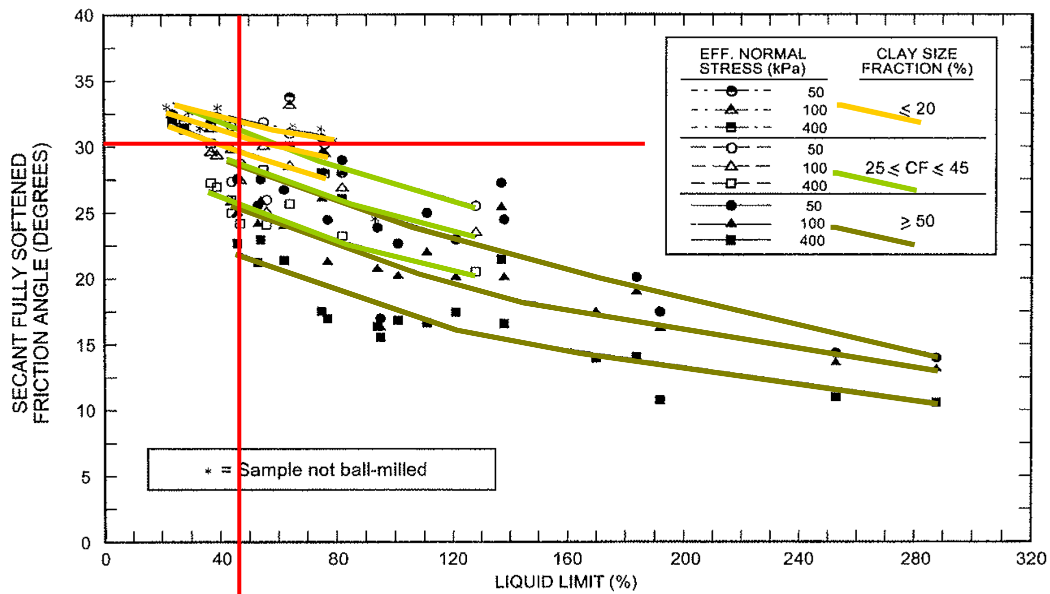
[1] Duncan, J.M., 2004, Friction Angles for Sand, Gravel and Rockfill: Lecture Notes Presented at the Kenneth L. Lee Memorial Seminar, Long Beach, California, April 28, 2004.

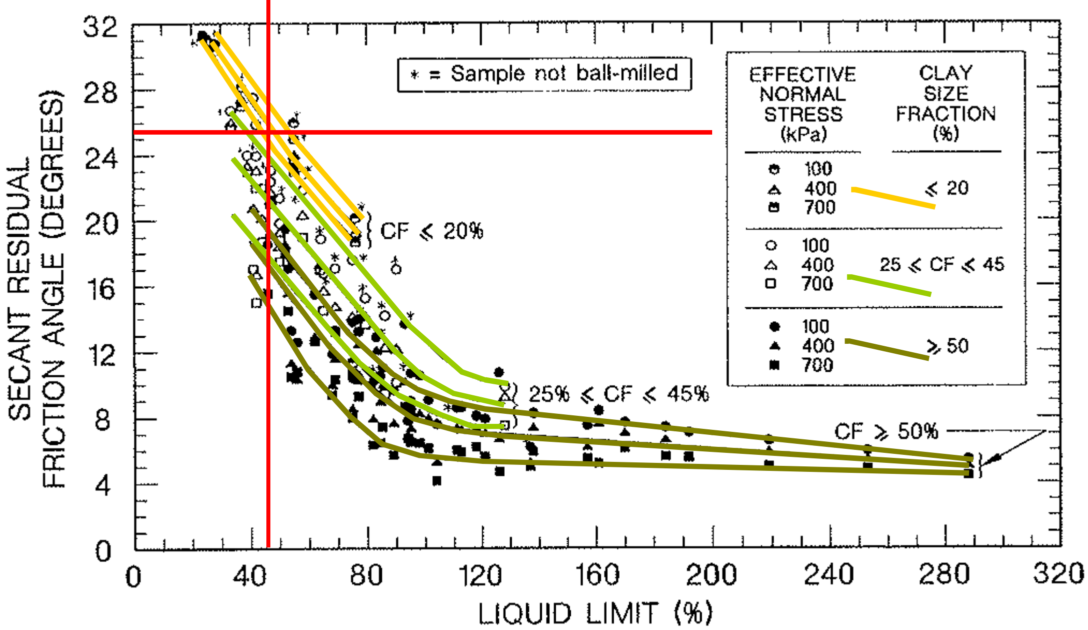
Riverbend Sand and Gravel Quarries - Shear Strength Estimation for Granular Deposits

Secant Fully-Softened and Residual Friction Angle Relationships with Liquid Limit, Clay-size Fraction, and Effective Normal Stress

Reference: T.D.Stark, H.Choi, and S.McCone: Drained shear Strength Parameters for analysis of Landslides; ASCE JGGE May 2005

ASTM Liquid Limit (LL)	36	%	ASTM Clay Fraction (CF) <0.002mm	10	%
Ball-milled Liquid Limit (LL)	48	%	Ball-milled Clay Fraction CF)	19	%
Investigated depth	58	ft	Effective normal stress (the higher stress - the lower strength)	217	kPa





Fully Softened Friction Angle	30	degrees
Residual Friction Angle	25.5	degrees

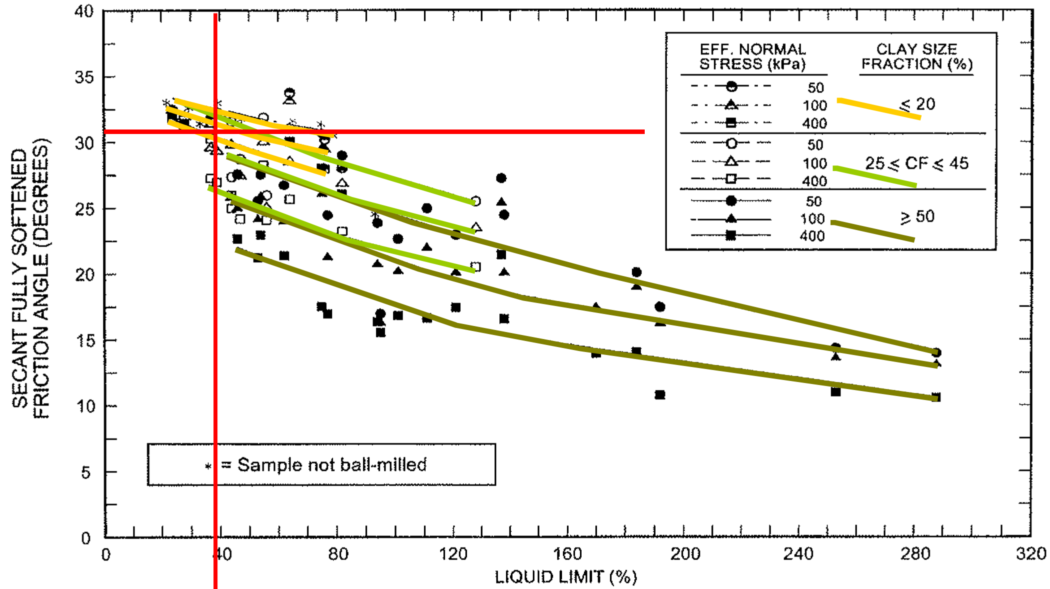
Printed on 7/5/2013

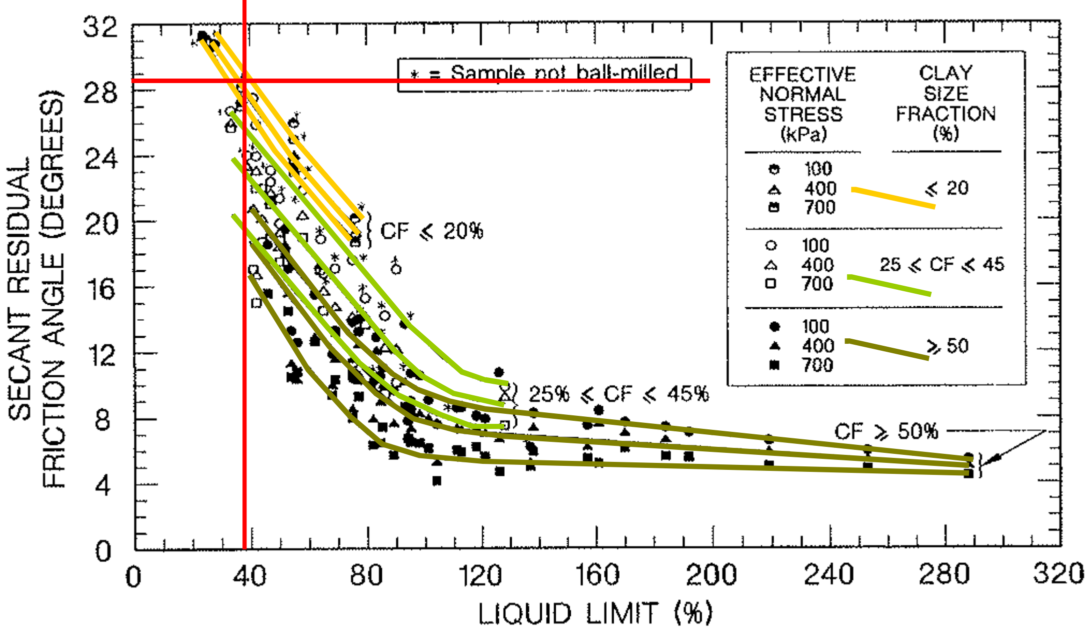
Riverbend Sand and Gravel Quarries - Shear Strength Estimation for Granular Deposits

Secant Fully-Softened and Residual Friction Angle Relationships with Liquid Limit, Clay-size Fraction, and Effective Normal Stress

Reference: T.D.Stark, H.Choi, and S.McCone: Drained shear Strength Parameters for analysis of Landslides; ASCE JGGE May 2005

ASTM Liquid Limit (LL)	30	%	ASTM Clay Fraction (CF) <0.002mm	8	%
Ball-milled Liquid Limit (LL)	40	%	Ball-milled Clay Fraction CF)	16	%
Investigated depth	63	ft	Effective normal stress (the higher stress - the lower strength)	232	kPa





Fully Softened Friction Angle	31	degrees
Residual Friction Angle	28.5	degrees

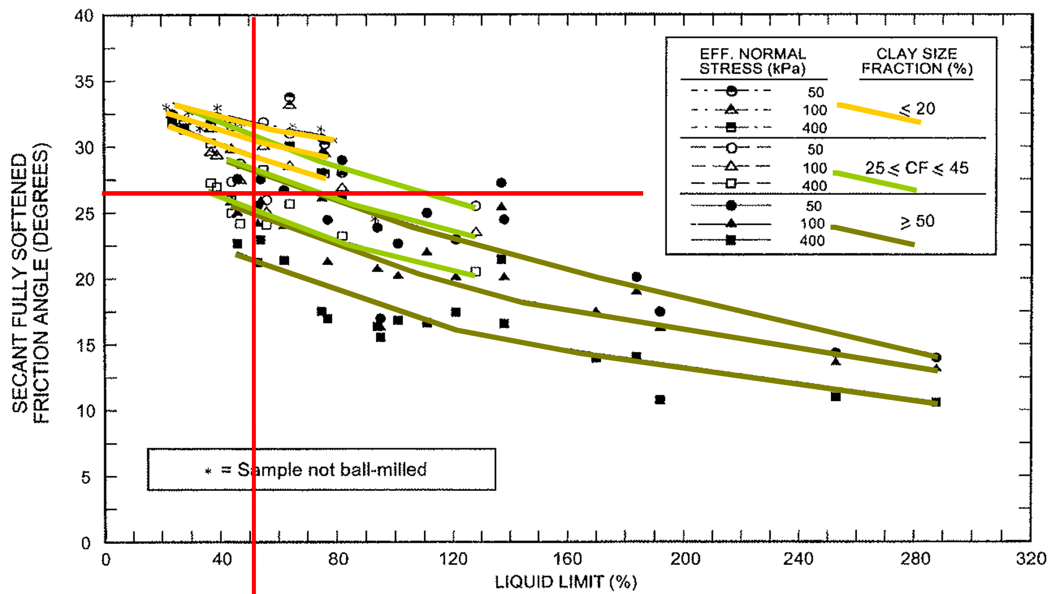
Printed on 7/5/2013

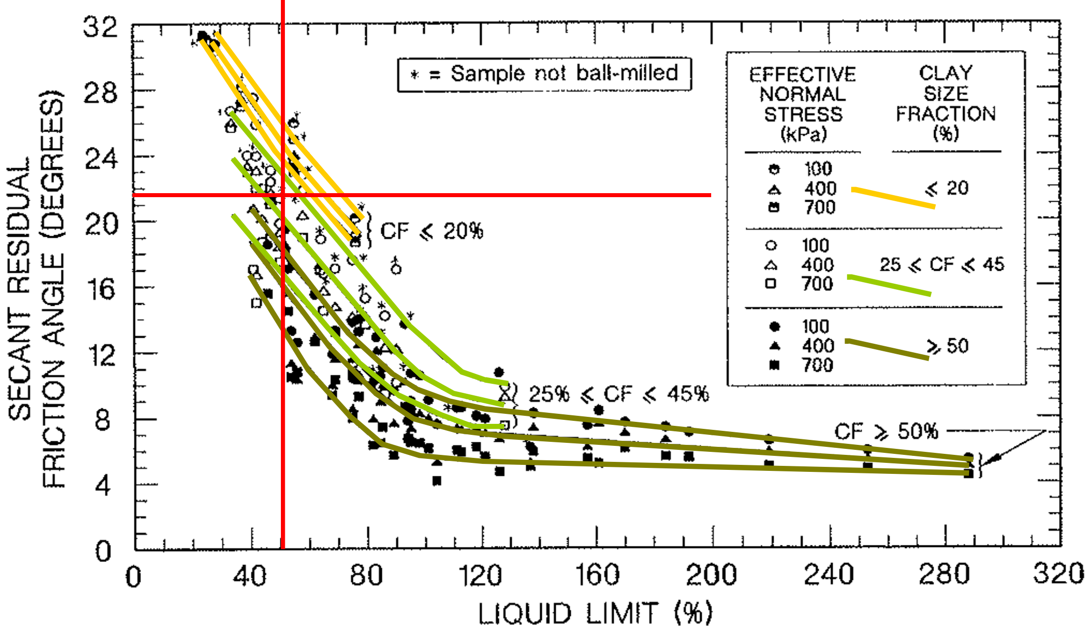
Riverbend Sand and Gravel Quarries - Shear Strength Estimation for Granular Deposits

Secant Fully-Softened and Residual Friction Angle Relationships with Liquid Limit, Clay-size Fraction, and Effective Normal Stress

Reference: T.D.Stark, H.Choi, and S.McCone: Drained shear Strength Parameters for analysis of Landslides; ASCE JGGE May 2005

ASTM Liquid Limit (LL)	38	%	ASTM Clay Fraction (CF) <0.002mm	18	%
Ball-milled Liquid Limit (LL)	51	%	Ball-milled Clay Fraction CF)	30	%
Investigated depth	81	ft	Effective normal stress (the higher stress - the lower strength)	288	kPa



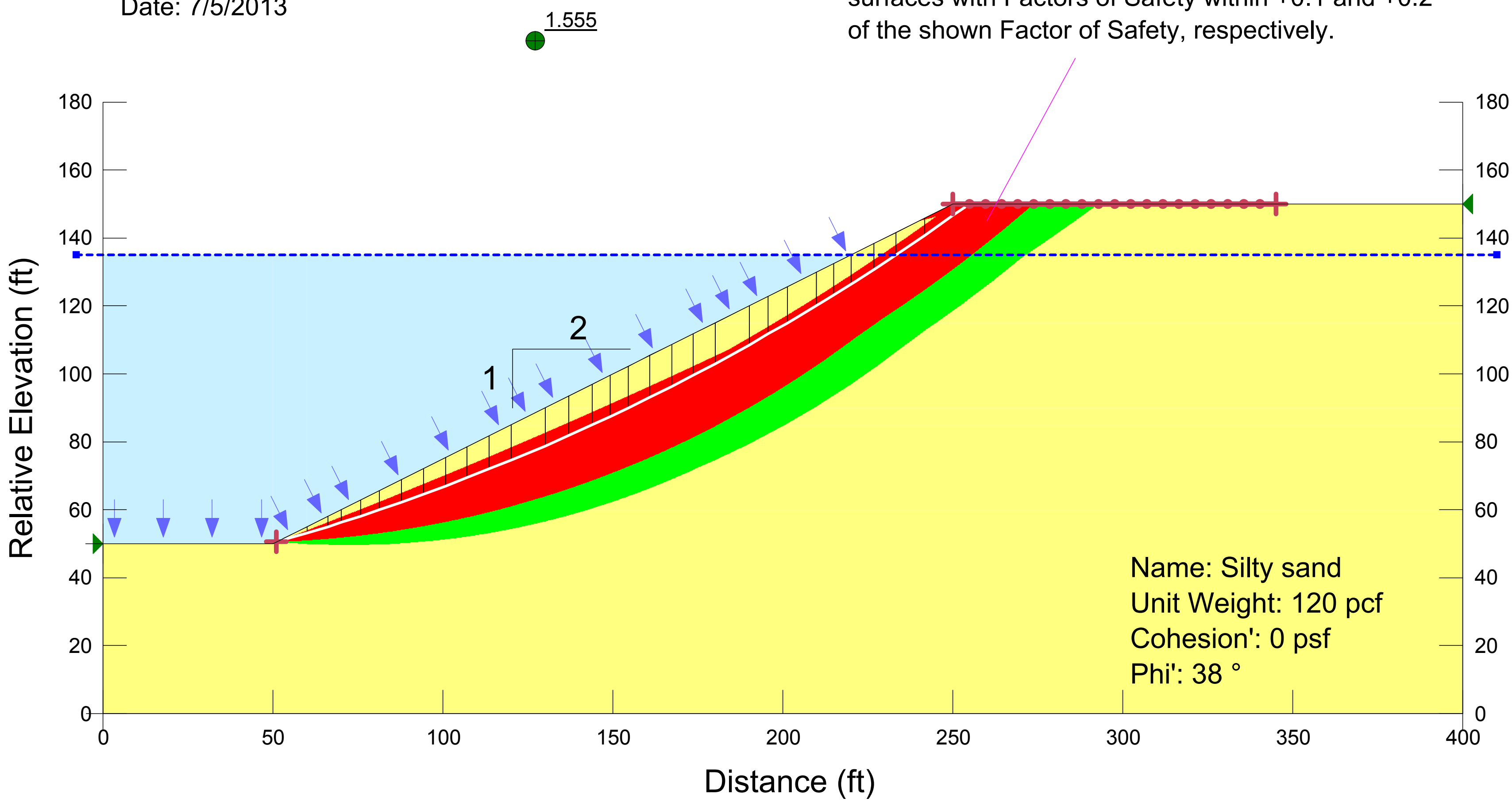


Fully Softened Friction Angle	27	degrees
Residual Friction Angle	21	degrees

Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: 100-foot-high slope without clay layer
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013

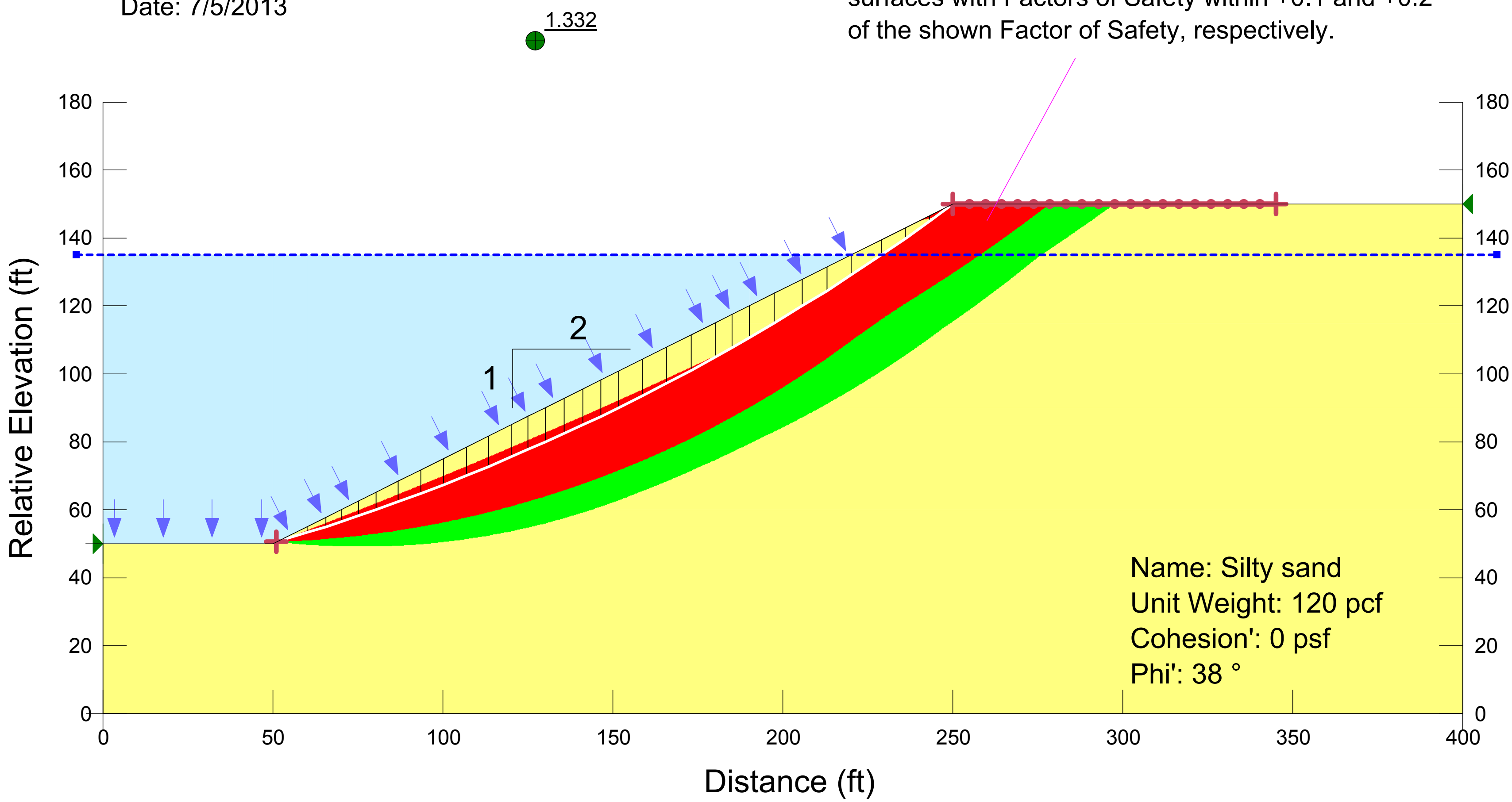
Red and green shading indicate regions with slip surfaces with Factors of Safety within +0.1 and +0.2 of the shown Factor of Safety, respectively.



Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: 100-foot-high slope without clay layer
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.034
Date: 7/5/2013

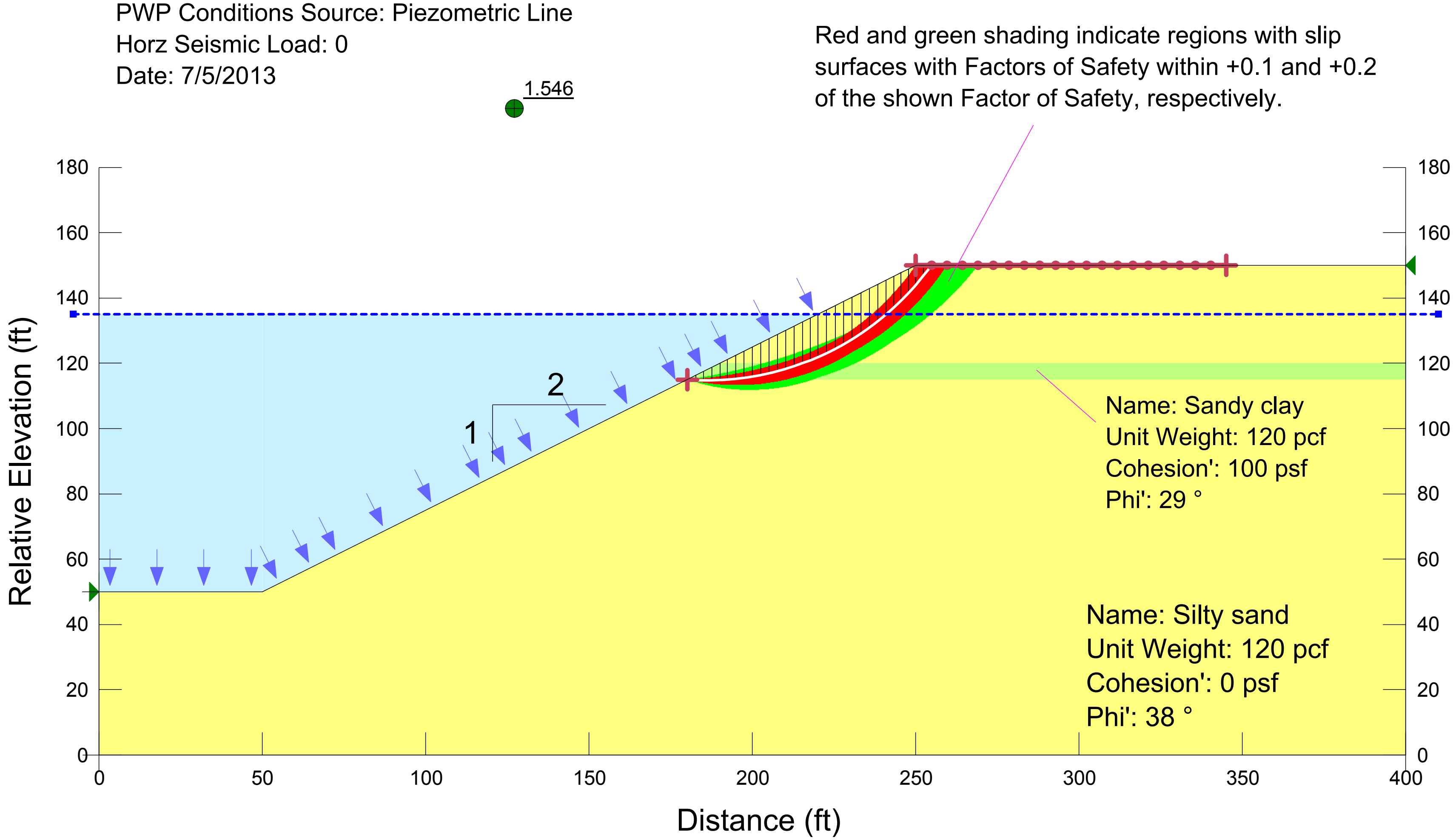
Red and green shading indicate regions with slip surfaces with Factors of Safety within +0.1 and +0.2 of the shown Factor of Safety, respectively.



C-1b

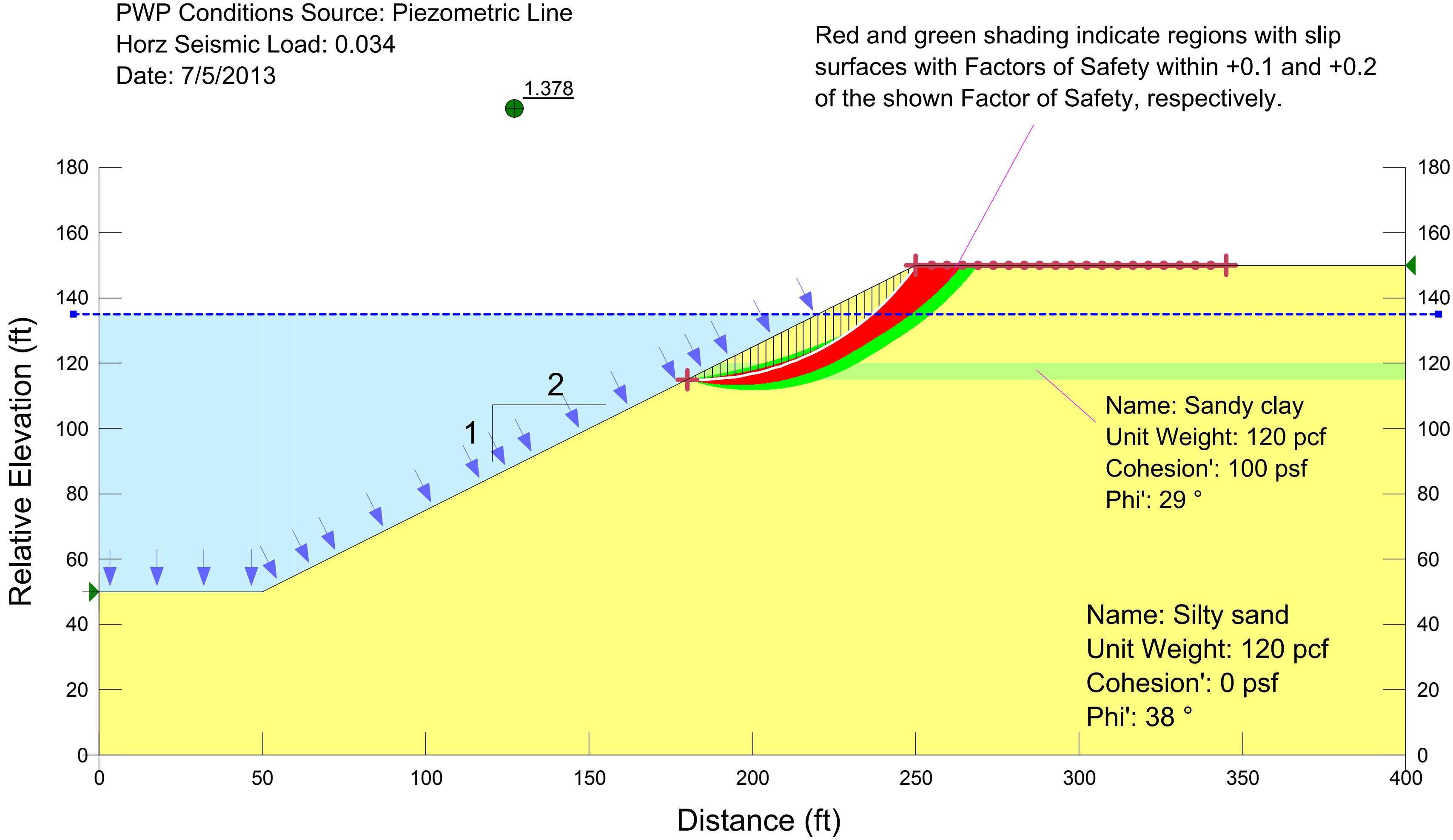
Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @30 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013



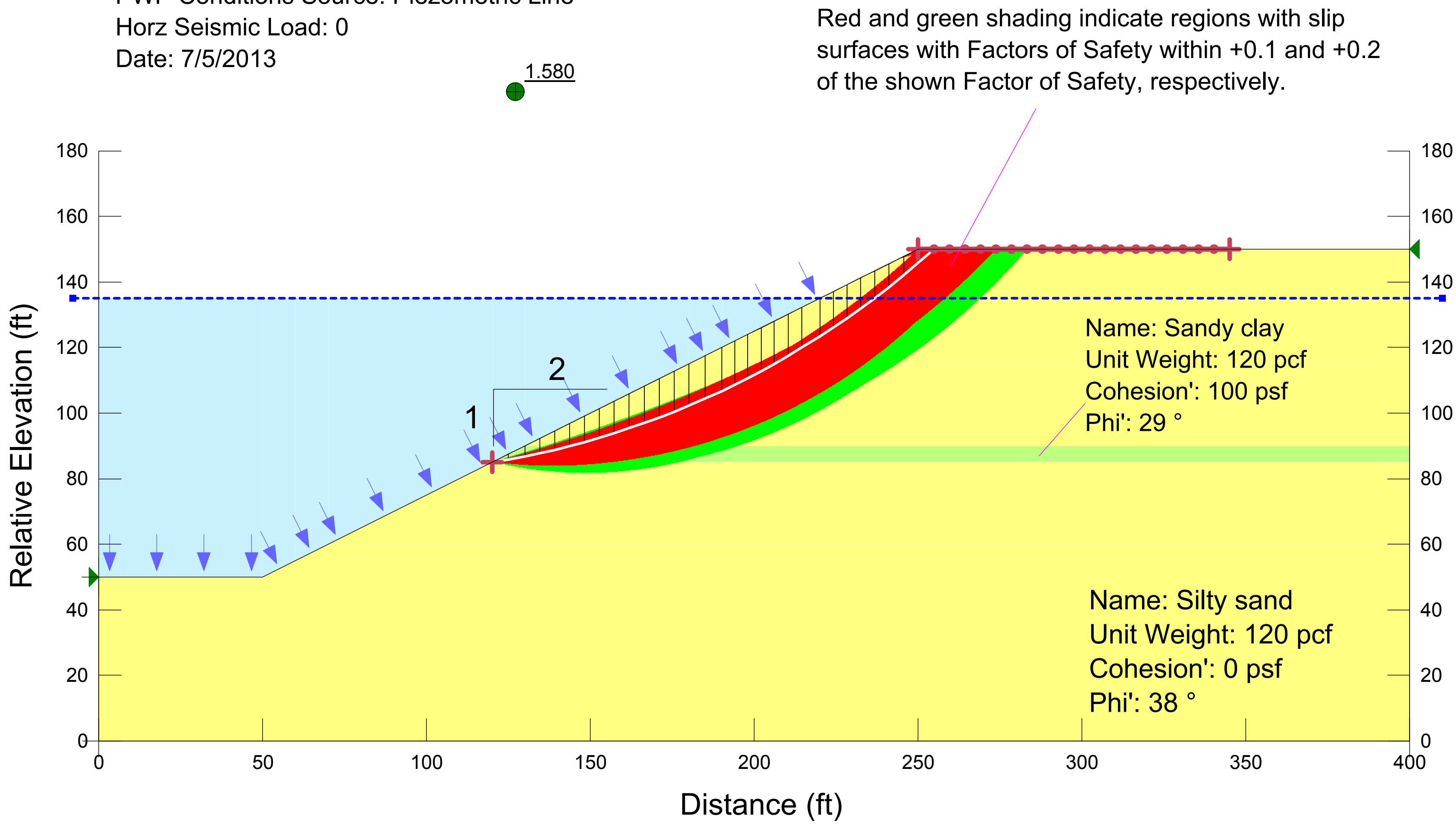
Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @30 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.034
Date: 7/5/2013



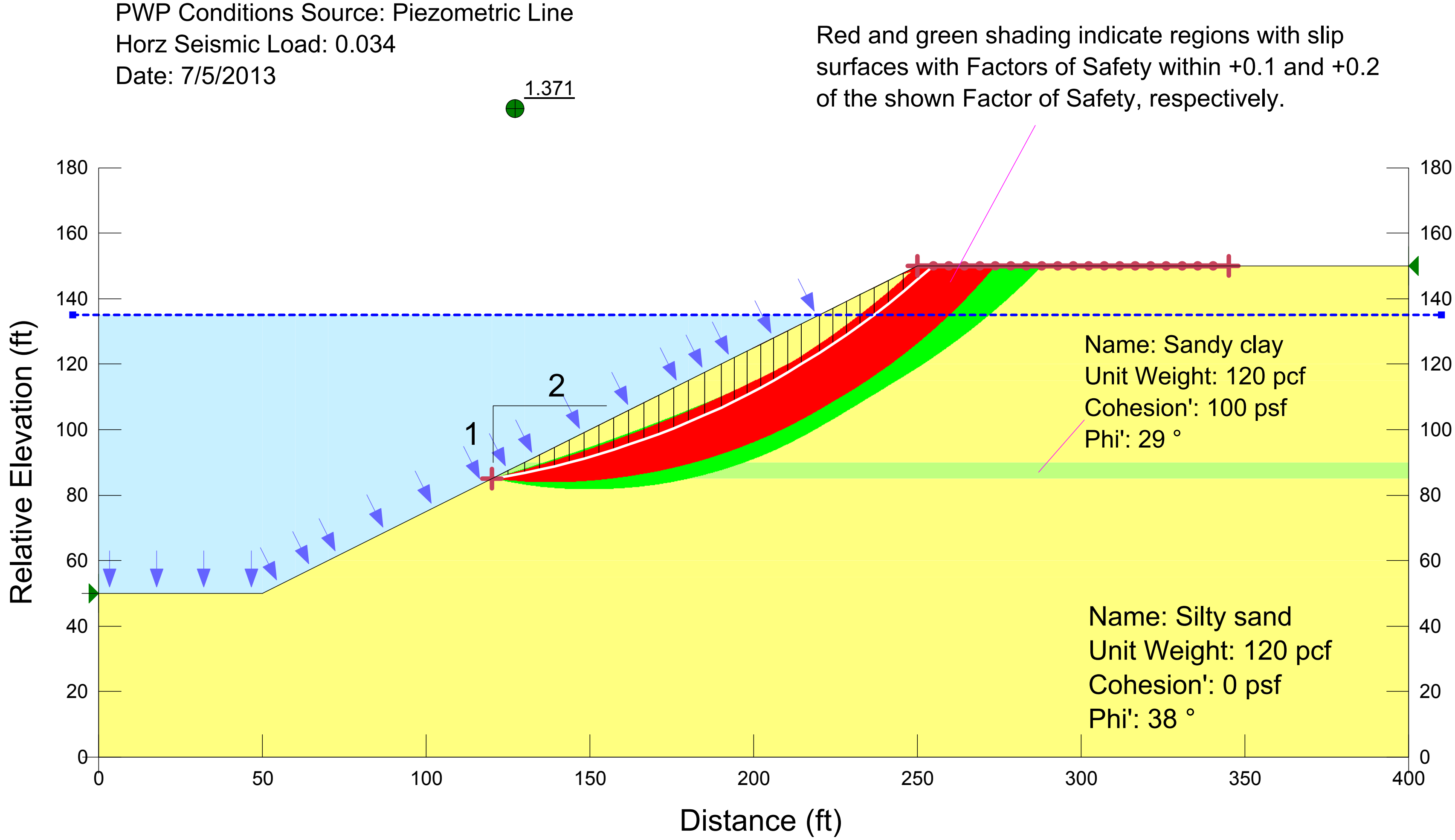
Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @60 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013



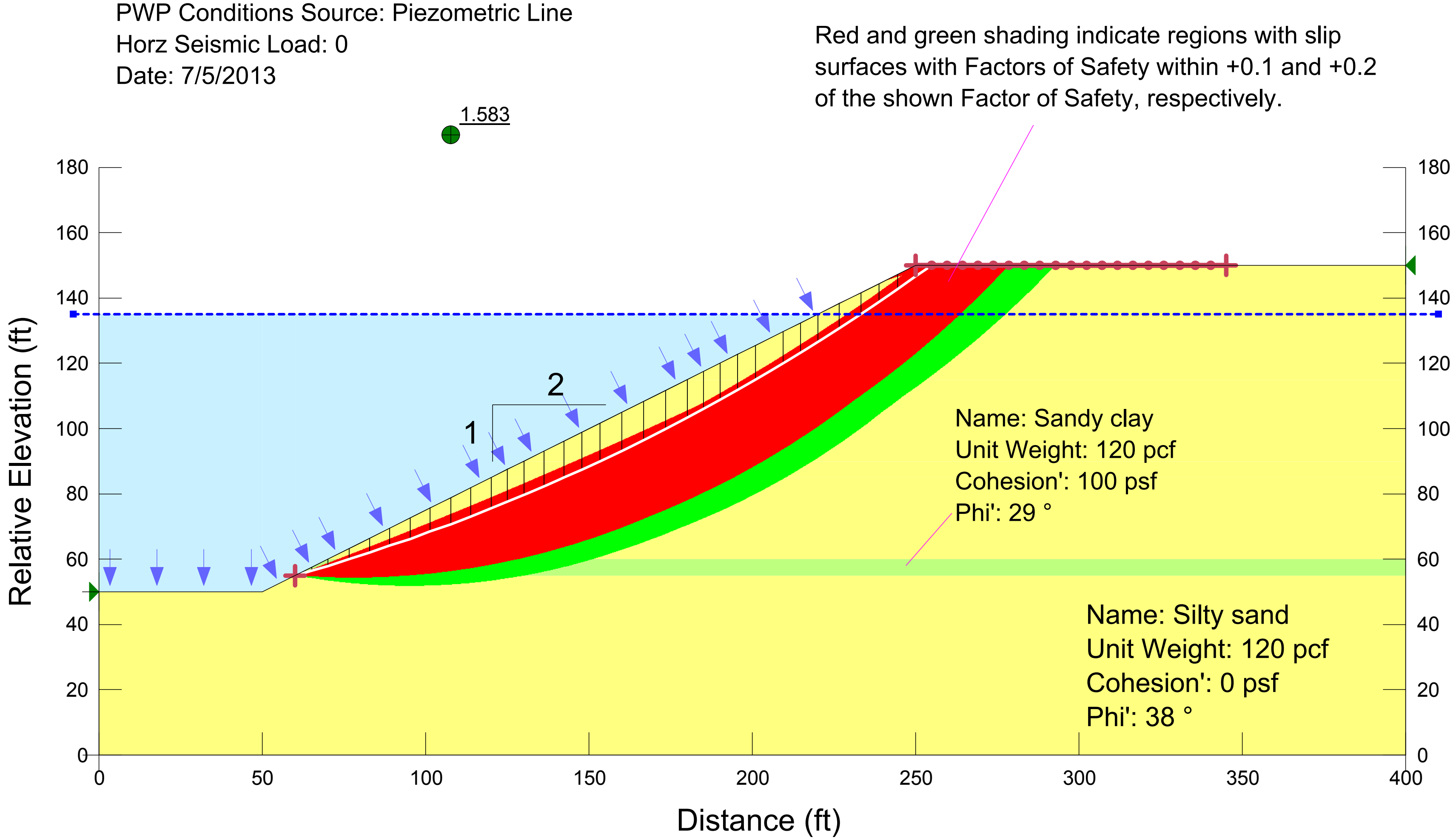
Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @60 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.034
Date: 7/5/2013



Riverbend Sand and Gravel Quarries
Slope Stability Analysis

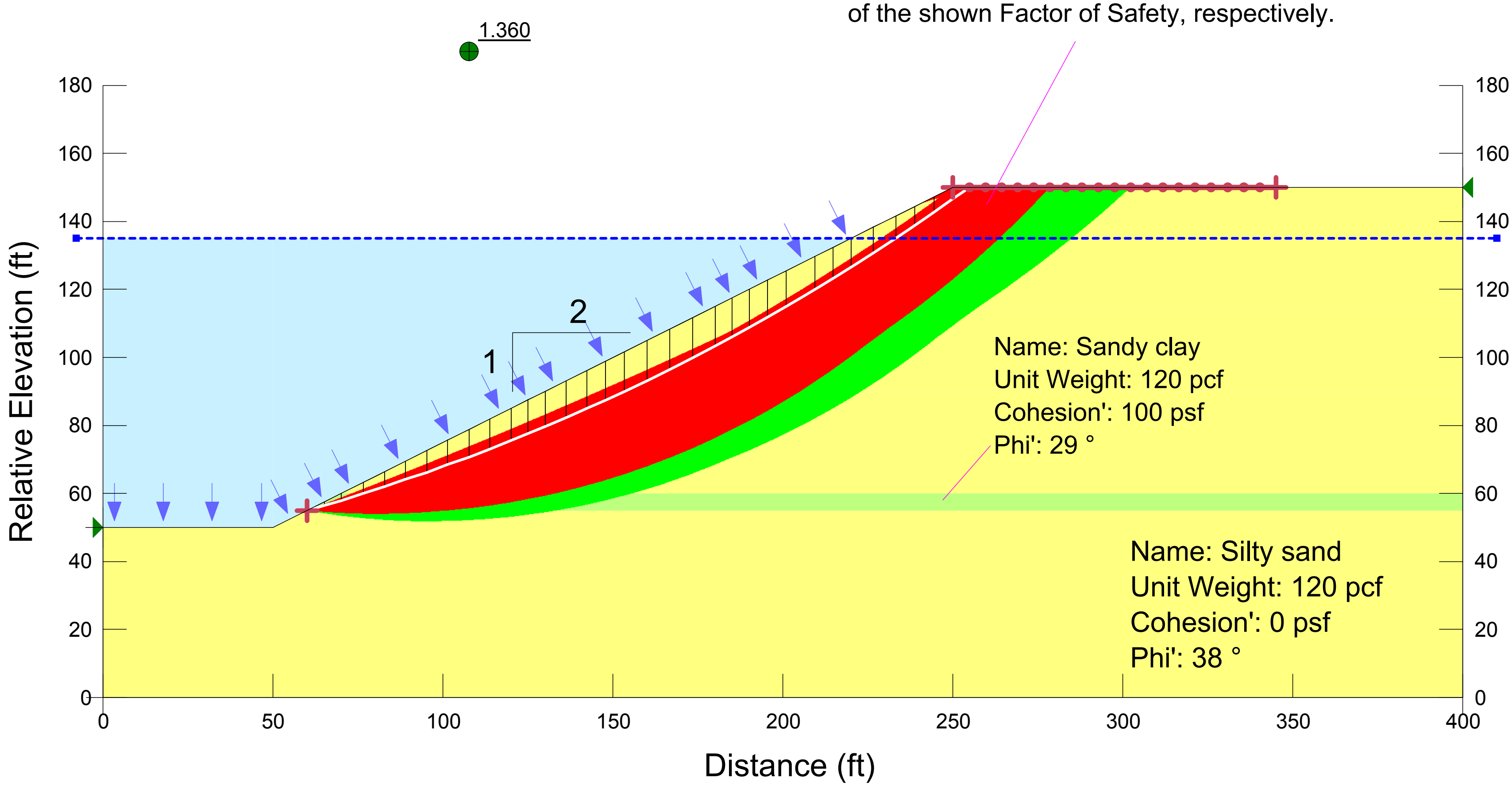
Description: Clay layer @90 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013



Riverbend Sand and Gravel Quarries
Slope Stability Analysis

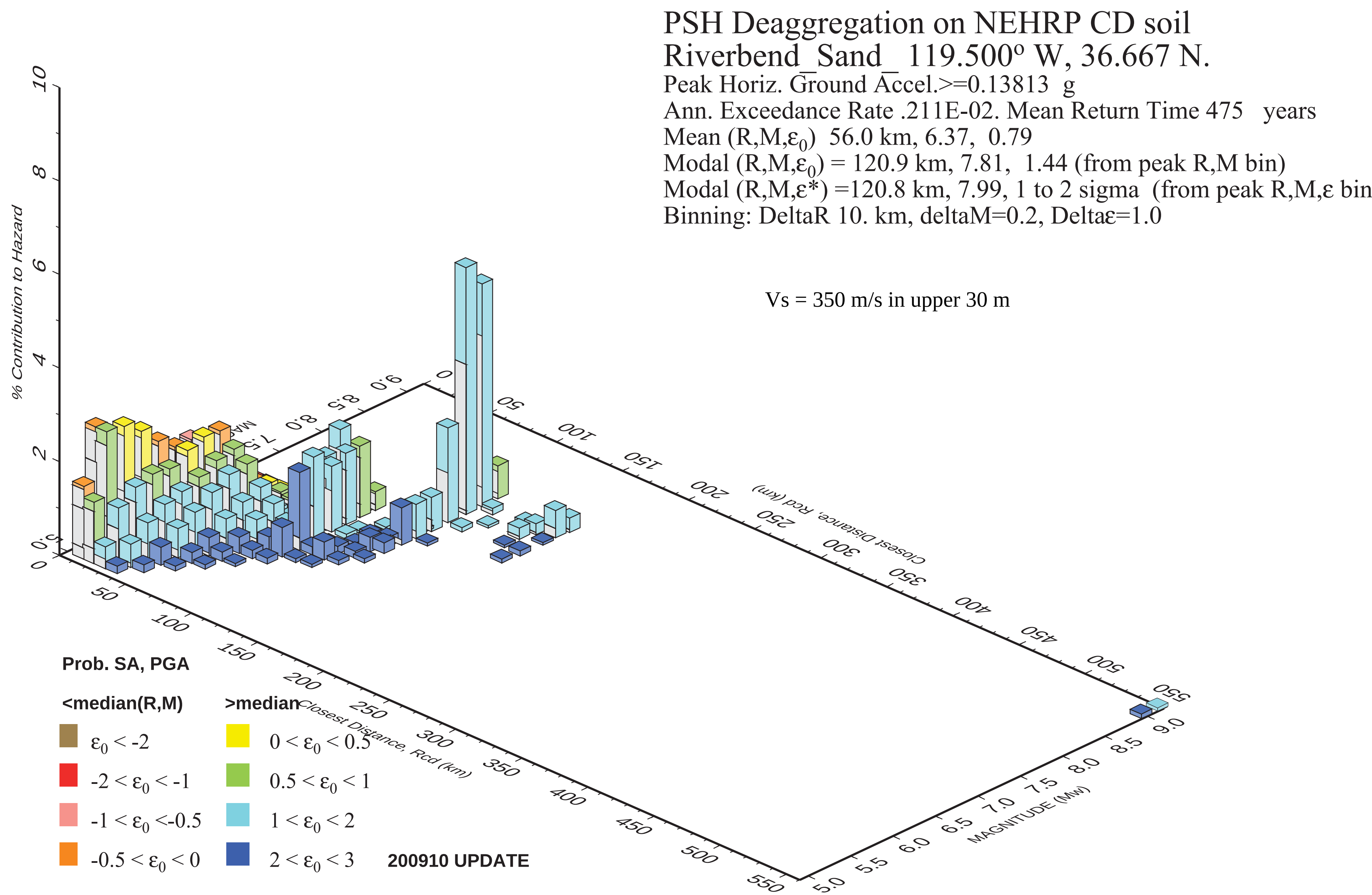
Description: Clay layer @90 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.034
Date: 7/5/2013

Red and green shading indicate regions with slip surfaces with Factors of Safety within +0.1 and +0.2 of the shown Factor of Safety, respectively.



APPENDIX D

USGS DEAGGREGATION ANALYSIS

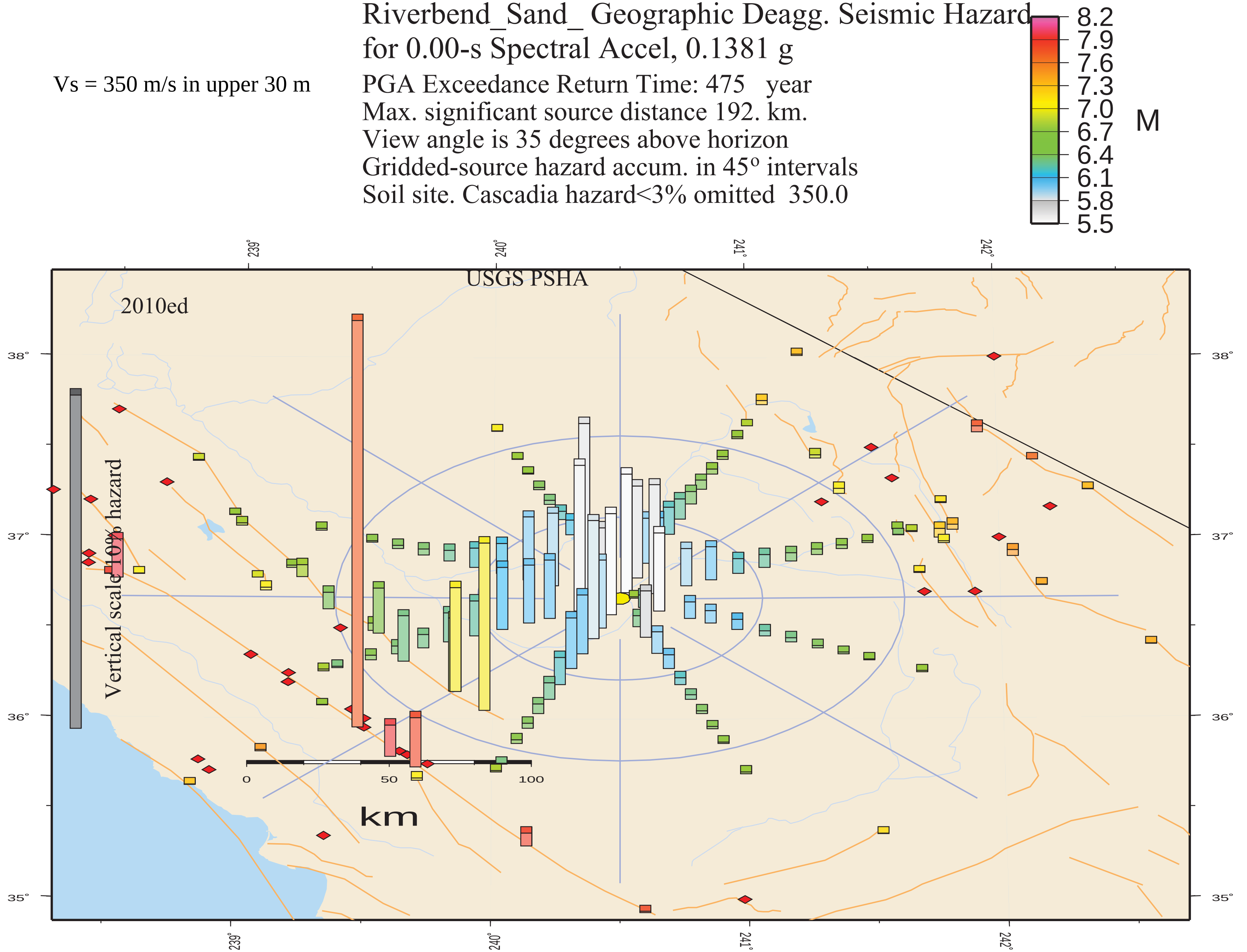


GMT 2013 Jul 5 20:12:28 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 350. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

Riverbend_Sand_ Geographic Deagg. Seismic Hazard
for 0.00-s Spectral Accel, 0.1381 g

Vs = 350 m/s in upper 30 m

PGA Exceedance Return Time: 475 year
Max. significant source distance 192. km.
View angle is 35 degrees above horizon
Gridded-source hazard accum. in 45° intervals
Soil site. Cascadia hazard<3% omitted 350.0



GMT 2013 Jul 5 20:12:29

Site Coords:-119.500 36.6670 (yellow disk) Vs30= 350.0. Max annual ExcdRate .2569E-03 (column height prop. to ExRate). Red diamonds: historical earthquakes, M>6

>

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2008 version ***
PSHA Deaggregation. %contributions. site: Riverbend_Sand_ long: 119.500 W., lat: 36.667 N.
 Vs30(m/s)= 350.0 (some WUS atten. models use Site Class not Vs30).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 475   yrs. Exceedance PGA =0.13813  g. Weight * Computed_Rate_Ex 0.211E-02
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02247
#This deaggregation corresponds to Mean Hazard w/all GMPEs
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
    8.7    5.05    1.559    0.071    0.420    0.828    0.233    0.007    0.000
   16.1    5.05    1.307    0.194    0.794    0.318    0.000    0.000    0.000
   24.8    5.05    0.465    0.261    0.204    0.000    0.000    0.000    0.000
   33.7    5.05    0.159    0.149    0.010    0.000    0.000    0.000    0.000
    8.8    5.20    2.696    0.107    0.642    1.414    0.516    0.016    0.000
   16.3    5.20    2.688    0.295    1.511    0.869    0.014    0.000    0.000
   25.0    5.20    1.167    0.447    0.698    0.022    0.000    0.000    0.000
   34.0    5.21    0.503    0.410    0.093    0.000    0.000    0.000    0.000
   43.5    5.21    0.170    0.170    0.000    0.000    0.000    0.000    0.000
    8.9    5.40    2.148    0.074    0.444    1.052    0.554    0.023    0.000
   16.6    5.40    2.638    0.204    1.183    1.191    0.059    0.000    0.000
   25.2    5.40    1.445    0.325    1.006    0.114    0.000    0.000    0.000
   34.2    5.40    0.791    0.453    0.338    0.000    0.000    0.000    0.000
   44.0    5.41    0.388    0.352    0.036    0.000    0.000    0.000    0.000
   54.4    5.42    0.102    0.102    0.000    0.000    0.000    0.000    0.000
    9.0    5.60    1.643    0.051    0.307    0.754    0.492    0.039    0.000
   16.8    5.60    2.365    0.141    0.842    1.254    0.128    0.000    0.000
   25.4    5.60    1.554    0.226    1.032    0.296    0.000    0.000    0.000
   34.3    5.60    1.016    0.374    0.630    0.012    0.000    0.000    0.000
   44.2    5.60    0.622    0.460    0.162    0.000    0.000    0.000    0.000
   54.6    5.61    0.241    0.237    0.005    0.000    0.000    0.000    0.000
   64.2    5.61    0.093    0.093    0.000    0.000    0.000    0.000    0.000
    9.0    5.80    1.220    0.036    0.213    0.531    0.399    0.042    0.000
   16.9    5.80    1.978    0.098    0.584    1.113    0.184    0.000    0.000
   25.5    5.80    1.497    0.156    0.855    0.484    0.001    0.000    0.000
   34.5    5.80    1.126    0.273    0.783    0.069    0.000    0.000    0.000
   44.4    5.80    0.807    0.429    0.378    0.000    0.000    0.000    0.000
   54.8    5.81    0.392    0.334    0.058    0.000    0.000    0.000    0.000
   64.5    5.81    0.201    0.199    0.002    0.000    0.000    0.000    0.000
   74.2    5.81    0.072    0.072    0.000    0.000    0.000    0.000    0.000
    8.4    6.01    1.152    0.031    0.183    0.460    0.417    0.062    0.001
   16.7    6.00    1.681    0.068    0.408    0.939    0.265    0.000    0.000
   25.6    6.01    1.716    0.133    0.776    0.793    0.014    0.000    0.000
   34.6    6.00    1.260    0.204    0.870    0.187    0.000    0.000    0.000
   44.4    6.01    1.055    0.369    0.674    0.012    0.000    0.000    0.000
   54.7    6.01    0.613    0.413    0.200    0.000    0.000    0.000    0.000
   64.6    6.01    0.351    0.314    0.037    0.000    0.000    0.000    0.000
   74.4    6.01    0.184    0.184    0.001    0.000    0.000    0.000    0.000
   84.4    6.03    0.124    0.124    0.000    0.000    0.000    0.000    0.000
    7.8    6.20    1.054    0.026    0.157    0.394    0.388    0.089    0.001
   16.0    6.20    1.673    0.058    0.344    0.845    0.424    0.003    0.000
   25.3    6.20    1.836    0.109    0.648    1.026    0.053    0.000    0.000
   34.9    6.20    1.445    0.166    0.882    0.398    0.000    0.000    0.000
   44.8    6.20    1.273    0.299    0.905    0.069    0.000    0.000    0.000
   55.1    6.20    0.814    0.384    0.430    0.000    0.000    0.000    0.000
   65.1    6.21    0.553    0.412    0.141    0.000    0.000    0.000    0.000
   74.8    6.20    0.315    0.289    0.025    0.000    0.000    0.000    0.000
   84.6    6.21    0.632    0.603    0.029    0.000    0.000    0.000    0.000
   94.3    6.21    0.080    0.080    0.000    0.000    0.000    0.000    0.000
  104.7    6.24    0.070    0.070    0.000    0.000    0.000    0.000    0.000
    7.7    6.40    0.805    0.019    0.116    0.292    0.291    0.085    0.002
   15.3    6.39    1.276    0.039    0.230    0.576    0.419    0.012    0.000
   24.9    6.40    1.791    0.085    0.505    1.041    0.160    0.000    0.000
   35.3    6.40    1.530    0.134    0.764    0.630    0.003    0.000    0.000
```

45.4	6.40	1.337	0.215	0.932	0.190	0.000	0.000	0.000
55.6	6.40	0.965	0.300	0.648	0.017	0.000	0.000	0.000
65.5	6.40	0.731	0.386	0.345	0.000	0.000	0.000	0.000
75.2	6.41	0.454	0.350	0.104	0.000	0.000	0.000	0.000
85.5	6.39	1.659	1.398	0.262	0.000	0.000	0.000	0.000
94.3	6.41	0.172	0.171	0.001	0.000	0.000	0.000	0.000
103.2	6.41	0.377	0.366	0.010	0.000	0.000	0.000	0.000
113.0	6.43	0.090	0.090	0.000	0.000	0.000	0.000	0.000
6.0	6.60	0.204	0.005	0.029	0.073	0.073	0.024	0.001
14.7	6.60	0.384	0.011	0.066	0.166	0.132	0.008	0.000
24.7	6.60	0.495	0.022	0.130	0.285	0.058	0.000	0.000
35.0	6.60	0.456	0.035	0.203	0.216	0.003	0.000	0.000
45.0	6.60	0.388	0.050	0.254	0.084	0.000	0.000	0.000
54.9	6.60	0.322	0.072	0.232	0.018	0.000	0.000	0.000
64.7	6.60	0.271	0.101	0.169	0.001	0.000	0.000	0.000
78.6	6.62	0.740	0.334	0.406	0.000	0.000	0.000	0.000
84.2	6.58	1.815	1.056	0.759	0.000	0.000	0.000	0.000
94.6	6.60	0.077	0.072	0.005	0.000	0.000	0.000	0.000
103.5	6.56	0.160	0.144	0.016	0.000	0.000	0.000	0.000
114.1	6.61	0.147	0.142	0.005	0.000	0.000	0.000	0.000
121.6	6.60	0.087	0.087	0.000	0.000	0.000	0.000	0.000
5.9	6.80	0.142	0.003	0.020	0.050	0.050	0.018	0.001
15.1	6.80	0.406	0.011	0.068	0.170	0.142	0.015	0.000
25.1	6.80	0.380	0.015	0.091	0.210	0.063	0.000	0.000
35.1	6.80	0.431	0.027	0.159	0.235	0.010	0.000	0.000
45.4	6.80	0.397	0.041	0.226	0.131	0.000	0.000	0.000
54.7	6.80	0.348	0.055	0.246	0.048	0.000	0.000	0.000
64.4	6.80	0.297	0.078	0.209	0.010	0.000	0.000	0.000
79.2	6.80	1.570	0.464	1.087	0.020	0.000	0.000	0.000
83.1	6.81	1.405	0.518	0.884	0.003	0.000	0.000	0.000
94.8	6.80	0.106	0.088	0.018	0.000	0.000	0.000	0.000
104.2	6.76	0.067	0.062	0.005	0.000	0.000	0.000	0.000
114.4	6.78	0.305	0.279	0.025	0.000	0.000	0.000	0.000
121.3	6.83	0.229	0.229	0.000	0.000	0.000	0.000	0.000
5.9	6.95	0.054	0.001	0.008	0.019	0.019	0.007	0.000
14.7	6.95	0.169	0.005	0.027	0.068	0.062	0.008	0.000
25.1	6.95	0.194	0.007	0.043	0.104	0.041	0.000	0.000
34.8	6.95	0.196	0.011	0.066	0.112	0.008	0.000	0.000
45.2	6.95	0.204	0.018	0.101	0.085	0.000	0.000	0.000
55.0	6.95	0.183	0.025	0.122	0.036	0.000	0.000	0.000
65.1	6.95	0.152	0.032	0.110	0.010	0.000	0.000	0.000
79.7	6.96	2.023	0.445	1.401	0.177	0.000	0.000	0.000
82.2	6.99	1.519	0.359	1.028	0.133	0.000	0.000	0.000
94.8	6.95	0.056	0.040	0.015	0.000	0.000	0.000	0.000
103.2	6.96	0.083	0.077	0.005	0.000	0.000	0.000	0.000
117.3	6.94	0.197	0.179	0.018	0.000	0.000	0.000	0.000
121.2	7.04	0.797	0.682	0.115	0.000	0.000	0.000	0.000
80.0	7.14	1.087	0.142	0.687	0.257	0.000	0.000	0.000
82.1	7.16	1.529	0.242	0.998	0.289	0.000	0.000	0.000
102.5	7.14	0.066	0.049	0.016	0.000	0.000	0.000	0.000
121.4	7.21	0.734	0.577	0.157	0.000	0.000	0.000	0.000
132.1	7.18	0.062	0.059	0.003	0.000	0.000	0.000	0.000
79.9	7.31	0.118	0.013	0.066	0.039	0.000	0.000	0.000
82.1	7.34	0.402	0.047	0.233	0.122	0.000	0.000	0.000
119.6	7.32	0.053	0.030	0.024	0.000	0.000	0.000	0.000
121.8	7.38	0.735	0.479	0.256	0.000	0.000	0.000	0.000
175.4	7.38	0.086	0.086	0.000	0.000	0.000	0.000	0.000
120.7	7.60	2.021	0.964	1.057	0.000	0.000	0.000	0.000
133.9	7.56	0.094	0.076	0.018	0.000	0.000	0.000	0.000
163.7	7.59	0.056	0.051	0.004	0.000	0.000	0.000	0.000
176.7	7.57	0.110	0.109	0.001	0.000	0.000	0.000	0.000
120.9	7.81	5.276	2.070	3.124	0.081	0.000	0.000	0.000
141.1	7.75	0.059	0.043	0.016	0.000	0.000	0.000	0.000
162.5	7.79	0.236	0.178	0.058	0.000	0.000	0.000	0.000
176.7	7.84	0.060	0.060	0.000	0.000	0.000	0.000	0.000
120.8	8.00	4.764	1.116	3.230	0.418	0.000	0.000	0.000

```
  131.6    7.95    0.136    0.055    0.081    0.000    0.000    0.000    0.000
  153.8    8.00    0.081    0.043    0.038    0.000    0.000    0.000    0.000
  165.2    7.94    0.237    0.187    0.050    0.000    0.000    0.000    0.000
  175.3    8.01    0.584    0.386    0.198    0.000    0.000    0.000    0.000
  120.3    8.19    0.704    0.122    0.468    0.113    0.000    0.000    0.000
  176.6    8.16    0.305    0.244    0.061    0.000    0.000    0.000    0.000
  555.3    9.00    0.098    0.098    0.000    0.000    0.000    0.000    0.000
  555.3    9.20    0.067    0.050    0.017    0.000    0.000    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):  100.0
 Mean src-site R=   56.0 km; M= 6.37; eps0=   0.79. Mean calculated for all sources.
Modal src-site R=  120.9 km; M= 7.81; eps0=   1.44 from peak (R,M) bin
 MODE R*= 120.8km; M*= 7.99; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  3.230

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                  % contr.  R(km)    M   epsilon0 (mean values).
California B-faults Char            10.06    90.8   6.93    1.41
California B-faults GR               5.63    84.1   6.72    1.52
California A-faults                 16.41   125.9   7.79    1.47
CA Compr. crustal gridded           58.20    28.2   5.87    0.39
Extensional Zones gridded            9.23    37.3   6.07    0.89
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                          % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
Great Valley 14 (Kettleman Hills    2.89    82.1   7.11    0.99    -144.8
Great Valley 13 (Coalinga) Char     3.12    80.0   7.01    1.03    -134.0
Great Valley 14 (Kettleman Hil G    2.11    82.1   6.83    1.34    -144.7
Great Valley 13 (Coalinga) GR       2.19    80.0   6.77    1.33    -133.4
SSAnd;PK+CH+CC+BB+NM+SM aPriori     3.26   120.3   7.90    1.28    -130.2
#*********End of deaggregation corresponding to Mean Hazard w/all GMPEs  *********#

PSHA Deaggregation. %contributions. site: Riverbend_Sand_ long: 119.500 W., lat: 36.667 N.
 Vs30(m/s)= 350.0 (some WUS atten. models use Site Class not Vs30).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 475   yrs. Exceedance PGA =0.13813  g. Weight * Computed_Rate_Ex 0.741E-03
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.01579
#This deaggregation corresponds to Boore-Atkinson 2008
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
    8.4    5.05    0.352    0.070    0.244    0.037    0.000    0.000    0.000
   16.1    5.05    0.230    0.153    0.077    0.000    0.000    0.000    0.000
   25.0    5.05    0.091    0.089    0.002    0.000    0.000    0.000    0.000
   33.8    5.05    0.037    0.037    0.000    0.000    0.000    0.000    0.000
    8.5    5.20    0.638    0.107    0.440    0.090    0.000    0.000    0.000
   16.3    5.20    0.522    0.275    0.247    0.000    0.000    0.000    0.000
   25.2    5.20    0.252    0.233    0.019    0.000    0.000    0.000    0.000
   34.1    5.21    0.131    0.131    0.000    0.000    0.000    0.000    0.000
   43.6    5.21    0.051    0.051    0.000    0.000    0.000    0.000    0.000
    8.7    5.40    0.538    0.074    0.367    0.097    0.000    0.000    0.000
   16.6    5.40    0.566    0.203    0.363    0.001    0.000    0.000    0.000
   25.4    5.40    0.342    0.259    0.083    0.000    0.000    0.000    0.000
   34.3    5.41    0.221    0.213    0.008    0.000    0.000    0.000    0.000
   44.1    5.41    0.124    0.124    0.000    0.000    0.000    0.000    0.000
   54.4    5.42    0.036    0.036    0.000    0.000    0.000    0.000    0.000
    8.8    5.60    0.436    0.051    0.283    0.102    0.000    0.000    0.000
   16.8    5.60    0.563    0.141    0.415    0.007    0.000    0.000    0.000
   25.6    5.60    0.410    0.216    0.194    0.000    0.000    0.000    0.000
   34.5    5.60    0.314    0.262    0.052    0.000    0.000    0.000    0.000
   44.3    5.61    0.219    0.216    0.003    0.000    0.000    0.000    0.000
   54.7    5.61    0.095    0.095    0.000    0.000    0.000    0.000    0.000
   64.2    5.62    0.037    0.037    0.000    0.000    0.000    0.000    0.000
    8.9    5.80    0.343    0.036    0.204    0.103    0.000    0.000    0.000
   17.0    5.80    0.520    0.098    0.403    0.019    0.000    0.000    0.000
   25.7    5.80    0.442    0.156    0.286    0.000    0.000    0.000    0.000
   34.6    5.80    0.392    0.244    0.147    0.000    0.000    0.000    0.000
   44.5    5.80    0.322    0.286    0.036    0.000    0.000    0.000    0.000
   54.9    5.81    0.176    0.176    0.000    0.000    0.000    0.000    0.000
```

64.6	5.81	0.094	0.094	0.000	0.000	0.000	0.000	0.000
74.1	5.81	0.036	0.036	0.000	0.000	0.000	0.000	0.000
8.3	6.01	0.342	0.031	0.182	0.130	0.000	0.000	0.000
16.7	6.00	0.469	0.068	0.356	0.044	0.000	0.000	0.000
25.8	6.01	0.544	0.133	0.409	0.003	0.000	0.000	0.000
34.7	6.00	0.470	0.200	0.270	0.000	0.000	0.000	0.000
44.5	6.01	0.453	0.321	0.132	0.000	0.000	0.000	0.000
54.8	6.01	0.293	0.273	0.020	0.000	0.000	0.000	0.000
64.7	6.01	0.179	0.179	0.000	0.000	0.000	0.000	0.000
74.4	6.01	0.099	0.099	0.000	0.000	0.000	0.000	0.000
84.3	6.03	0.055	0.055	0.000	0.000	0.000	0.000	0.000
7.7	6.20	0.325	0.026	0.157	0.142	0.000	0.000	0.000
16.0	6.20	0.485	0.058	0.332	0.095	0.000	0.000	0.000
25.4	6.20	0.597	0.109	0.472	0.017	0.000	0.000	0.000
35.0	6.20	0.557	0.166	0.392	0.000	0.000	0.000	0.000
44.9	6.20	0.567	0.289	0.278	0.000	0.000	0.000	0.000
55.1	6.20	0.404	0.321	0.083	0.000	0.000	0.000	0.000
65.1	6.21	0.291	0.277	0.015	0.000	0.000	0.000	0.000
74.8	6.20	0.172	0.172	0.000	0.000	0.000	0.000	0.000
84.5	6.21	0.231	0.230	0.001	0.000	0.000	0.000	0.000
94.3	6.21	0.042	0.042	0.000	0.000	0.000	0.000	0.000
7.7	6.40	0.253	0.019	0.116	0.117	0.000	0.000	0.000
15.4	6.39	0.380	0.039	0.229	0.112	0.000	0.000	0.000
25.0	6.40	0.587	0.085	0.449	0.053	0.000	0.000	0.000
35.5	6.40	0.596	0.134	0.458	0.005	0.000	0.000	0.000
45.5	6.40	0.599	0.214	0.385	0.000	0.000	0.000	0.000
55.7	6.40	0.484	0.284	0.200	0.000	0.000	0.000	0.000
65.6	6.40	0.387	0.318	0.068	0.000	0.000	0.000	0.000
75.2	6.41	0.249	0.238	0.011	0.000	0.000	0.000	0.000
85.5	6.39	0.634	0.558	0.076	0.000	0.000	0.000	0.000
94.3	6.41	0.093	0.093	0.000	0.000	0.000	0.000	0.000
104.1	6.41	0.146	0.146	0.000	0.000	0.000	0.000	0.000
5.9	6.60	0.065	0.005	0.029	0.031	0.000	0.000	0.000
14.7	6.60	0.120	0.011	0.066	0.043	0.000	0.000	0.000
24.8	6.60	0.177	0.022	0.125	0.030	0.000	0.000	0.000
35.2	6.60	0.197	0.035	0.156	0.007	0.000	0.000	0.000
45.1	6.60	0.196	0.050	0.146	0.000	0.000	0.000	0.000
54.9	6.60	0.182	0.072	0.110	0.000	0.000	0.000	0.000
64.7	6.60	0.162	0.096	0.066	0.000	0.000	0.000	0.000
77.9	6.61	0.300	0.166	0.134	0.000	0.000	0.000	0.000
84.2	6.58	0.688	0.411	0.277	0.000	0.000	0.000	0.000
94.6	6.61	0.049	0.049	0.000	0.000	0.000	0.000	0.000
104.5	6.59	0.063	0.061	0.002	0.000	0.000	0.000	0.000
113.5	6.61	0.054	0.054	0.000	0.000	0.000	0.000	0.000
5.9	6.80	0.046	0.003	0.020	0.022	0.000	0.000	0.000
15.2	6.80	0.130	0.011	0.068	0.051	0.000	0.000	0.000
25.2	6.80	0.138	0.015	0.090	0.032	0.000	0.000	0.000
35.2	6.80	0.184	0.027	0.141	0.016	0.000	0.000	0.000
45.5	6.80	0.201	0.041	0.157	0.003	0.000	0.000	0.000
54.8	6.80	0.194	0.055	0.139	0.000	0.000	0.000	0.000
64.5	6.80	0.180	0.077	0.103	0.000	0.000	0.000	0.000
78.7	6.80	0.609	0.213	0.390	0.006	0.000	0.000	0.000
83.2	6.81	0.564	0.222	0.340	0.001	0.000	0.000	0.000
94.8	6.80	0.068	0.066	0.003	0.000	0.000	0.000	0.000
104.7	6.78	0.040	0.039	0.002	0.000	0.000	0.000	0.000
113.8	6.79	0.159	0.156	0.003	0.000	0.000	0.000	0.000
120.8	6.85	0.105	0.105	0.000	0.000	0.000	0.000	0.000
14.8	6.95	0.054	0.005	0.027	0.022	0.000	0.000	0.000
25.2	6.95	0.069	0.007	0.043	0.019	0.000	0.000	0.000
35.0	6.95	0.081	0.011	0.061	0.010	0.000	0.000	0.000
45.3	6.95	0.098	0.018	0.077	0.003	0.000	0.000	0.000
55.1	6.95	0.099	0.025	0.074	0.000	0.000	0.000	0.000
65.2	6.95	0.087	0.032	0.056	0.000	0.000	0.000	0.000
79.6	6.96	0.716	0.167	0.495	0.054	0.000	0.000	0.000
82.4	6.99	0.552	0.145	0.363	0.045	0.000	0.000	0.000
94.8	6.95	0.034	0.031	0.003	0.000	0.000	0.000	0.000

```
  103.1    6.96    0.055    0.050    0.005    0.000    0.000    0.000    0.000
  116.2    6.94    0.080    0.077    0.002    0.000    0.000    0.000    0.000
  120.6    7.04    0.488    0.390    0.098    0.000    0.000    0.000    0.000
  132.0    7.01    0.023    0.023    0.000    0.000    0.000    0.000    0.000
   80.0    7.13    0.353    0.054    0.240    0.059    0.000    0.000    0.000
   82.1    7.17    0.530    0.085    0.365    0.079    0.000    0.000    0.000
  102.5    7.14    0.041    0.029    0.012    0.000    0.000    0.000    0.000
  121.9    7.21    0.468    0.342    0.126    0.000    0.000    0.000    0.000
   79.9    7.31    0.038    0.005    0.024    0.009    0.000    0.000    0.000
   82.1    7.36    0.094    0.012    0.056    0.027    0.000    0.000    0.000
  119.6    7.32    0.053    0.029    0.023    0.000    0.000    0.000    0.000
  121.2    7.38    0.335    0.202    0.133    0.000    0.000    0.000    0.000
  131.1    7.41    0.023    0.022    0.001    0.000    0.000    0.000    0.000
  120.8    7.59    1.092    0.394    0.698    0.000    0.000    0.000    0.000
  141.0    7.61    0.030    0.021    0.009    0.000    0.000    0.000    0.000
  120.8    7.81    2.426    0.710    1.587    0.130    0.000    0.000    0.000
  132.3    7.85    0.018    0.007    0.011    0.000    0.000    0.000    0.000
  154.1    7.78    0.048    0.038    0.010    0.000    0.000    0.000    0.000
  120.8    8.00    1.894    0.410    1.296    0.188    0.000    0.000    0.000
  136.8    7.95    0.030    0.013    0.017    0.000    0.000    0.000    0.000
  154.0    7.96    0.058    0.039    0.018    0.000    0.000    0.000    0.000
  163.0    7.95    0.020    0.016    0.004    0.000    0.000    0.000    0.000
  177.4    8.01    0.107    0.104    0.003    0.000    0.000    0.000    0.000
  120.3    8.19    0.274    0.041    0.186    0.047    0.000    0.000    0.000
  177.0    8.18    0.038    0.033    0.004    0.000    0.000    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):   35.1
 Mean src-site R=   61.7 km; M= 6.51; eps0=   0.97. Mean calculated for all sources.
Modal src-site R=  120.8 km; M= 7.81; eps0=   1.28 from peak (R,M) bin
 MODE R*= 120.8km; M*= 7.81; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  1.587

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                  % contr.  R(km)    M   epsilon0 (mean values).
California B-faults Char             3.51    91.3   6.94    1.45
California A-faults                  7.14   122.9   7.75    1.38
CA Compr. crustal gridded           18.48    33.1   5.99    0.63
Extensional Zones gridded            3.88    45.2   6.20    1.07
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                          % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
Great Valley 14 (Kettleman Hills    0.97    82.1   7.10    1.02    -144.8
Great Valley 13 (Coalinga) Char     1.03    80.0   7.00    1.07    -134.0
Great Valley 14 (Kettleman Hil G    0.76    82.1   6.83    1.32    -144.7
Great Valley 13 (Coalinga) GR       0.76    80.0   6.77    1.33    -133.4
SSAnd;PK+CH+CC+BB+NM+SM aPriori     1.41   120.3   7.90    1.19    -130.2
#*********End of deaggregation corresponding to Boore-Atkinson 2008      *********#

PSHA Deaggregation. %contributions. site: Riverbend_Sand_ long: 119.500 W., lat: 36.667 N.
 Vs30(m/s)= 350.0 (some WUS atten. models use Site Class not Vs30).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 475   yrs. Exceedance PGA =0.13813  g. Weight * Computed_Rate_Ex 0.712E-03
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02677
#This deaggregation corresponds to Campbell-Bozorgnia 2008
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
    8.8    5.05    0.591    0.071    0.381    0.139    0.000    0.000    0.000
   16.0    5.05    0.506    0.187    0.313    0.006    0.000    0.000    0.000
   24.7    5.05    0.168    0.146    0.022    0.000    0.000    0.000    0.000
   33.6    5.05    0.053    0.053    0.000    0.000    0.000    0.000    0.000
    8.9    5.20    1.023    0.108    0.605    0.310    0.000    0.000    0.000
   16.3    5.20    1.068    0.294    0.741    0.033    0.000    0.000    0.000
   25.0    5.20    0.450    0.328    0.122    0.000    0.000    0.000    0.000
   33.9    5.21    0.187    0.184    0.003    0.000    0.000    0.000    0.000
   43.5    5.21    0.063    0.063    0.000    0.000    0.000    0.000    0.000
    9.0    5.40    0.813    0.074    0.436    0.303    0.000    0.000    0.000
   16.6    5.40    1.076    0.204    0.786    0.085    0.000    0.000    0.000
   25.2    5.40    0.597    0.301    0.296    0.000    0.000    0.000    0.000
```

34.2	5.41	0.326	0.284	0.042	0.000	0.000	0.000	0.000
44.0	5.41	0.163	0.163	0.000	0.000	0.000	0.000	0.000
54.4	5.42	0.046	0.046	0.000	0.000	0.000	0.000	0.000
9.0	5.60	0.609	0.051	0.306	0.251	0.000	0.000	0.000
16.8	5.60	0.939	0.141	0.678	0.119	0.000	0.000	0.000
25.4	5.60	0.627	0.223	0.402	0.001	0.000	0.000	0.000
34.3	5.60	0.409	0.292	0.117	0.000	0.000	0.000	0.000
44.2	5.60	0.252	0.241	0.011	0.000	0.000	0.000	0.000
54.7	5.60	0.100	0.100	0.000	0.000	0.000	0.000	0.000
64.3	5.61	0.044	0.044	0.000	0.000	0.000	0.000	0.000
9.0	5.80	0.437	0.036	0.212	0.189	0.000	0.000	0.000
16.9	5.80	0.737	0.098	0.522	0.117	0.000	0.000	0.000
25.5	5.80	0.554	0.156	0.393	0.005	0.000	0.000	0.000
34.4	5.80	0.407	0.237	0.170	0.000	0.000	0.000	0.000
44.3	5.80	0.287	0.254	0.033	0.000	0.000	0.000	0.000
54.8	5.80	0.137	0.137	0.000	0.000	0.000	0.000	0.000
64.6	5.81	0.074	0.074	0.000	0.000	0.000	0.000	0.000
74.3	5.81	0.029	0.029	0.000	0.000	0.000	0.000	0.000
8.5	6.01	0.401	0.031	0.183	0.187	0.000	0.000	0.000
16.7	6.00	0.597	0.068	0.392	0.137	0.000	0.000	0.000
25.6	6.01	0.592	0.133	0.447	0.012	0.000	0.000	0.000
34.6	6.00	0.420	0.191	0.228	0.000	0.000	0.000	0.000
44.3	6.00	0.339	0.264	0.075	0.000	0.000	0.000	0.000
54.7	6.01	0.191	0.185	0.006	0.000	0.000	0.000	0.000
64.7	6.00	0.111	0.111	0.000	0.000	0.000	0.000	0.000
74.5	6.01	0.061	0.061	0.000	0.000	0.000	0.000	0.000
84.5	6.03	0.052	0.052	0.000	0.000	0.000	0.000	0.000
7.8	6.20	0.362	0.026	0.157	0.179	0.000	0.000	0.000
16.0	6.20	0.578	0.058	0.339	0.182	0.000	0.000	0.000
25.3	6.20	0.610	0.109	0.473	0.028	0.000	0.000	0.000
34.9	6.20	0.456	0.164	0.292	0.000	0.000	0.000	0.000
44.8	6.20	0.383	0.251	0.131	0.000	0.000	0.000	0.000
55.1	6.20	0.236	0.212	0.024	0.000	0.000	0.000	0.000
65.1	6.21	0.160	0.159	0.001	0.000	0.000	0.000	0.000
74.9	6.20	0.095	0.095	0.000	0.000	0.000	0.000	0.000
84.5	6.20	0.270	0.243	0.027	0.000	0.000	0.000	0.000
94.5	6.21	0.032	0.032	0.000	0.000	0.000	0.000	0.000
103.8	6.22	0.031	0.031	0.000	0.000	0.000	0.000	0.000
7.7	6.40	0.274	0.019	0.116	0.139	0.000	0.000	0.000
15.3	6.39	0.434	0.039	0.229	0.166	0.000	0.000	0.000
24.9	6.40	0.582	0.085	0.432	0.066	0.000	0.000	0.000
35.3	6.40	0.466	0.133	0.332	0.002	0.000	0.000	0.000
45.4	6.40	0.387	0.200	0.188	0.000	0.000	0.000	0.000
55.6	6.40	0.266	0.212	0.054	0.000	0.000	0.000	0.000
65.5	6.40	0.203	0.188	0.015	0.000	0.000	0.000	0.000
75.2	6.41	0.129	0.128	0.000	0.000	0.000	0.000	0.000
85.6	6.39	0.671	0.530	0.141	0.000	0.000	0.000	0.000
94.4	6.41	0.060	0.060	0.000	0.000	0.000	0.000	0.000
103.3	6.39	0.191	0.181	0.010	0.000	0.000	0.000	0.000
114.6	6.42	0.047	0.047	0.000	0.000	0.000	0.000	0.000
6.0	6.60	0.070	0.005	0.029	0.036	0.000	0.000	0.000
14.7	6.60	0.133	0.011	0.066	0.056	0.000	0.000	0.000
24.7	6.60	0.169	0.022	0.120	0.028	0.000	0.000	0.000
35.0	6.60	0.149	0.035	0.113	0.002	0.000	0.000	0.000
45.0	6.60	0.120	0.049	0.071	0.000	0.000	0.000	0.000
54.9	6.60	0.094	0.061	0.033	0.000	0.000	0.000	0.000
64.7	6.60	0.078	0.066	0.012	0.000	0.000	0.000	0.000
78.8	6.62	0.229	0.123	0.106	0.000	0.000	0.000	0.000
84.6	6.58	0.696	0.401	0.295	0.000	0.000	0.000	0.000
94.6	6.60	0.026	0.026	0.000	0.000	0.000	0.000	0.000
102.7	6.54	0.085	0.071	0.014	0.000	0.000	0.000	0.000
114.2	6.60	0.116	0.111	0.005	0.000	0.000	0.000	0.000
5.9	6.80	0.048	0.003	0.020	0.025	0.000	0.000	0.000
15.1	6.80	0.137	0.011	0.068	0.058	0.000	0.000	0.000
25.1	6.80	0.122	0.015	0.084	0.023	0.000	0.000	0.000
35.0	6.80	0.132	0.027	0.101	0.004	0.000	0.000	0.000

45.3	6.80	0.113	0.040	0.072	0.000	0.000	0.000	0.000
54.6	6.80	0.095	0.050	0.044	0.000	0.000	0.000	0.000
64.4	6.80	0.077	0.058	0.019	0.000	0.000	0.000	0.000
79.3	6.81	0.465	0.177	0.288	0.000	0.000	0.000	0.000
83.2	6.80	0.393	0.168	0.225	0.000	0.000	0.000	0.000
94.9	6.80	0.031	0.031	0.000	0.000	0.000	0.000	0.000
103.8	6.75	0.022	0.019	0.003	0.000	0.000	0.000	0.000
114.6	6.77	0.129	0.112	0.017	0.000	0.000	0.000	0.000
122.2	6.85	0.078	0.078	0.000	0.000	0.000	0.000	0.000
133.6	6.75	0.030	0.030	0.000	0.000	0.000	0.000	0.000
5.9	6.95	0.018	0.001	0.008	0.009	0.000	0.000	0.000
14.7	6.95	0.057	0.005	0.027	0.025	0.000	0.000	0.000
25.0	6.95	0.061	0.007	0.041	0.013	0.000	0.000	0.000
34.8	6.95	0.058	0.011	0.045	0.002	0.000	0.000	0.000
45.1	6.95	0.057	0.017	0.040	0.000	0.000	0.000	0.000
54.9	6.95	0.048	0.024	0.025	0.000	0.000	0.000	0.000
65.1	6.95	0.039	0.026	0.013	0.000	0.000	0.000	0.000
79.7	6.97	0.476	0.146	0.307	0.023	0.000	0.000	0.000
82.2	6.99	0.445	0.133	0.288	0.024	0.000	0.000	0.000
102.3	6.96	0.023	0.022	0.001	0.000	0.000	0.000	0.000
117.7	6.94	0.062	0.060	0.002	0.000	0.000	0.000	0.000
121.7	7.03	0.243	0.222	0.021	0.000	0.000	0.000	0.000
174.2	7.01	0.023	0.023	0.000	0.000	0.000	0.000	0.000
80.0	7.14	0.283	0.054	0.183	0.046	0.000	0.000	0.000
82.1	7.16	0.398	0.081	0.259	0.059	0.000	0.000	0.000
102.5	7.14	0.021	0.017	0.004	0.000	0.000	0.000	0.000
121.1	7.20	0.222	0.182	0.040	0.000	0.000	0.000	0.000
134.3	7.20	0.017	0.017	0.000	0.000	0.000	0.000	0.000
166.2	7.17	0.019	0.019	0.000	0.000	0.000	0.000	0.000
172.6	7.22	0.027	0.027	0.000	0.000	0.000	0.000	0.000
79.9	7.31	0.022	0.004	0.016	0.002	0.000	0.000	0.000
82.1	7.34	0.099	0.016	0.065	0.018	0.000	0.000	0.000
122.0	7.38	0.254	0.169	0.085	0.000	0.000	0.000	0.000
167.2	7.40	0.027	0.027	0.000	0.000	0.000	0.000	0.000
176.7	7.38	0.073	0.073	0.000	0.000	0.000	0.000	0.000
120.8	7.58	0.423	0.285	0.138	0.000	0.000	0.000	0.000
135.2	7.56	0.031	0.027	0.004	0.000	0.000	0.000	0.000
155.9	7.57	0.017	0.015	0.002	0.000	0.000	0.000	0.000
163.8	7.63	0.023	0.020	0.004	0.000	0.000	0.000	0.000
177.3	7.54	0.062	0.061	0.001	0.000	0.000	0.000	0.000
183.2	7.59	0.025	0.025	0.000	0.000	0.000	0.000	0.000
120.9	7.82	1.654	0.753	0.901	0.000	0.000	0.000	0.000
141.2	7.77	0.017	0.014	0.004	0.000	0.000	0.000	0.000
165.7	7.79	0.150	0.109	0.041	0.000	0.000	0.000	0.000
172.6	7.77	0.019	0.016	0.003	0.000	0.000	0.000	0.000
121.4	8.02	0.882	0.289	0.580	0.012	0.000	0.000	0.000
153.8	7.98	0.050	0.025	0.025	0.000	0.000	0.000	0.000
165.3	7.94	0.047	0.039	0.008	0.000	0.000	0.000	0.000
176.3	8.01	0.445	0.297	0.148	0.000	0.000	0.000	0.000
120.3	8.19	0.170	0.044	0.112	0.014	0.000	0.000	0.000
176.0	8.21	0.080	0.046	0.034	0.000	0.000	0.000	0.000

```
Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):   33.7
 Mean src-site R=   52.6 km; M= 6.27; eps0=   0.75. Mean calculated for all sources.
Modal src-site R=  120.9 km; M= 7.82; eps0=   1.53 from peak (R,M) bin
 MODE R*= 120.9km; M*= 7.82; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  0.901

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                  % contr.  R(km)    M   epsilon0 (mean values).
California B-faults Char            3.34    95.1   6.88    1.60
California A-faults                 4.60   131.2   7.78    1.65
CA Compr. crustal gridded          21.03    27.7   5.83    0.33
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                          % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
Great Valley 14 (Kettleman Hills    0.77    82.1   7.10    1.13    -144.8
```

Great Valley 13 (Coalinga) Char	0.80	80.0	7.00	1.19	-134.0
Great Valley 14 (Kettleman Hil G	0.63	82.1	6.82	1.41	-144.7
Great Valley 13 (Coalinga) GR	0.63	80.0	6.76	1.42	-133.4
SSAnd;PK+CH+CC+BB+NM+SM aPriori	0.78	120.3	7.90	1.45	-130.2

#*********End of deaggregation corresponding to Campbell-Bozorgnia 2008 *********#

PSHA Deaggregation. %contributions. site: Riverbend_Sand_ long: 119.500 W., lat: 36.667 N.
Vs30(m/s)= 350.0 (some WUS atten. models use Site Class not Vs30).
NSHMP 2007-08 See USGS OFR 2008-1128. dM=0.2 below
Return period: 475 yrs. Exceedance PGA =0.13813 g. Weight * Computed_Rate_Ex 0.653E-03
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02601
#This deaggregation corresponds to Chiou-Youngs 2008

DIST(KM)	MAG(MW)	ALL_EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
8.8	5.05	0.616	0.071	0.396	0.149	0.000	0.000	0.000
16.1	5.05	0.570	0.193	0.372	0.005	0.000	0.000	0.000
24.8	5.05	0.206	0.177	0.029	0.000	0.000	0.000	0.000
33.7	5.05	0.069	0.069	0.000	0.000	0.000	0.000	0.000
8.9	5.20	1.035	0.107	0.621	0.307	0.000	0.000	0.000
16.3	5.20	1.098	0.295	0.777	0.026	0.000	0.000	0.000
25.0	5.20	0.464	0.350	0.115	0.000	0.000	0.000	0.000
33.9	5.20	0.186	0.185	0.000	0.000	0.000	0.000	0.000
43.4	5.21	0.056	0.056	0.000	0.000	0.000	0.000	0.000
9.0	5.40	0.796	0.074	0.439	0.283	0.000	0.000	0.000
16.5	5.40	0.996	0.204	0.731	0.061	0.000	0.000	0.000
25.1	5.40	0.506	0.299	0.207	0.000	0.000	0.000	0.000
34.1	5.40	0.244	0.233	0.011	0.000	0.000	0.000	0.000
43.8	5.41	0.102	0.102	0.000	0.000	0.000	0.000	0.000
54.1	5.41	0.019	0.019	0.000	0.000	0.000	0.000	0.000
9.0	5.60	0.598	0.051	0.307	0.240	0.000	0.000	0.000
16.7	5.60	0.864	0.141	0.636	0.086	0.000	0.000	0.000
25.3	5.60	0.517	0.222	0.295	0.000	0.000	0.000	0.000
34.2	5.60	0.293	0.250	0.043	0.000	0.000	0.000	0.000
44.0	5.60	0.151	0.151	0.000	0.000	0.000	0.000	0.000
54.4	5.61	0.046	0.046	0.000	0.000	0.000	0.000	0.000
9.0	5.80	0.441	0.036	0.213	0.193	0.000	0.000	0.000
16.9	5.80	0.722	0.098	0.517	0.106	0.000	0.000	0.000
25.4	5.80	0.501	0.156	0.343	0.002	0.000	0.000	0.000
34.3	5.80	0.327	0.225	0.102	0.000	0.000	0.000	0.000
44.2	5.80	0.198	0.191	0.007	0.000	0.000	0.000	0.000
54.7	5.81	0.079	0.079	0.000	0.000	0.000	0.000	0.000
64.3	5.81	0.032	0.032	0.000	0.000	0.000	0.000	0.000
8.5	6.01	0.409	0.031	0.183	0.195	0.000	0.000	0.000
16.6	6.00	0.614	0.068	0.398	0.149	0.000	0.000	0.000
25.5	6.01	0.580	0.133	0.438	0.009	0.000	0.000	0.000
34.5	6.00	0.371	0.191	0.180	0.000	0.000	0.000	0.000
44.2	6.01	0.263	0.232	0.032	0.000	0.000	0.000	0.000
54.6	6.01	0.128	0.128	0.000	0.000	0.000	0.000	0.000
64.5	6.01	0.061	0.061	0.000	0.000	0.000	0.000	0.000
74.1	6.02	0.024	0.024	0.000	0.000	0.000	0.000	0.000
84.3	6.05	0.017	0.017	0.000	0.000	0.000	0.000	0.000
7.8	6.20	0.368	0.026	0.157	0.185	0.000	0.000	0.000
16.0	6.20	0.610	0.058	0.342	0.211	0.000	0.000	0.000
25.3	6.20	0.629	0.109	0.490	0.030	0.000	0.000	0.000
34.8	6.20	0.432	0.164	0.268	0.000	0.000	0.000	0.000
44.7	6.20	0.324	0.239	0.084	0.000	0.000	0.000	0.000
54.9	6.20	0.175	0.169	0.006	0.000	0.000	0.000	0.000
64.9	6.21	0.102	0.102	0.000	0.000	0.000	0.000	0.000
74.6	6.20	0.048	0.048	0.000	0.000	0.000	0.000	0.000
84.7	6.22	0.131	0.131	0.000	0.000	0.000	0.000	0.000
7.7	6.40	0.278	0.019	0.116	0.142	0.000	0.000	0.000
15.3	6.39	0.462	0.039	0.230	0.193	0.000	0.000	0.000
24.8	6.40	0.623	0.085	0.453	0.086	0.000	0.000	0.000
35.2	6.40	0.467	0.133	0.333	0.001	0.000	0.000	0.000
45.2	6.40	0.350	0.199	0.152	0.000	0.000	0.000	0.000
55.5	6.40	0.215	0.187	0.027	0.000	0.000	0.000	0.000
65.4	6.40	0.142	0.140	0.002	0.000	0.000	0.000	0.000

```
  75.1    6.41    0.076    0.076    0.000    0.000    0.000    0.000    0.000
  85.5    6.39    0.315    0.293    0.022    0.000    0.000    0.000    0.000
  94.0    6.41    0.019    0.019    0.000    0.000    0.000    0.000    0.000
 102.8    6.40    0.058    0.058    0.000    0.000    0.000    0.000    0.000
   6.0    6.60    0.069    0.005    0.029    0.036    0.000    0.000    0.000
  14.6    6.60    0.130    0.011    0.066    0.053    0.000    0.000    0.000
  24.5    6.60    0.149    0.022    0.111    0.017    0.000    0.000    0.000
  34.8    6.60    0.109    0.034    0.075    0.000    0.000    0.000    0.000
  44.8    6.60    0.072    0.044    0.028    0.000    0.000    0.000    0.000
  54.7    6.60    0.046    0.041    0.005    0.000    0.000    0.000    0.000
  64.5    6.60    0.030    0.030    0.000    0.000    0.000    0.000    0.000
  79.6    6.62    0.209    0.091    0.118    0.000    0.000    0.000    0.000
  83.7    6.58    0.470    0.306    0.164    0.000    0.000    0.000    0.000
 102.6    6.55    0.033    0.033    0.000    0.000    0.000    0.000    0.000
 113.3    6.62    0.026    0.026    0.000    0.000    0.000    0.000    0.000
   5.9    6.80    0.049    0.003    0.020    0.025    0.000    0.000    0.000
  15.1    6.80    0.140    0.011    0.068    0.061    0.000    0.000    0.000
  25.0    6.80    0.120    0.015    0.083    0.021    0.000    0.000    0.000
  34.9    6.80    0.115    0.027    0.086    0.002    0.000    0.000    0.000
  45.2    6.80    0.084    0.039    0.045    0.000    0.000    0.000    0.000
  54.5    6.80    0.060    0.043    0.017    0.000    0.000    0.000    0.000
  64.3    6.81    0.041    0.037    0.003    0.000    0.000    0.000    0.000
  79.7    6.80    0.497    0.145    0.339    0.014    0.000    0.000    0.000
  82.8    6.81    0.403    0.150    0.253    0.000    0.000    0.000    0.000
 113.3    6.78    0.040    0.039    0.001    0.000    0.000    0.000    0.000
   5.9    6.95    0.018    0.001    0.008    0.010    0.000    0.000    0.000
  14.7    6.95    0.059    0.005    0.027    0.028    0.000    0.000    0.000
  25.0    6.95    0.064    0.007    0.042    0.016    0.000    0.000    0.000
  34.7    6.95    0.057    0.011    0.044    0.002    0.000    0.000    0.000
  45.0    6.95    0.049    0.017    0.032    0.000    0.000    0.000    0.000
  54.8    6.95    0.036    0.022    0.015    0.000    0.000    0.000    0.000
  64.9    6.95    0.025    0.021    0.004    0.000    0.000    0.000    0.000
  79.9    6.96    0.806    0.150    0.556    0.099    0.000    0.000    0.000
  82.1    7.01    0.678    0.134    0.473    0.071    0.000    0.000    0.000
 112.6    6.95    0.022    0.018    0.004    0.000    0.000    0.000    0.000
 121.0    7.06    0.043    0.043    0.000    0.000    0.000    0.000    0.000
  80.0    7.14    0.487    0.049    0.277    0.161    0.000    0.000    0.000
  82.1    7.17    0.522    0.064    0.312    0.146    0.000    0.000    0.000
 121.5    7.22    0.092    0.091    0.001    0.000    0.000    0.000    0.000
  79.9    7.31    0.046    0.004    0.022    0.019    0.000    0.000    0.000
  82.1    7.34    0.179    0.016    0.086    0.077    0.000    0.000    0.000
 121.3    7.39    0.109    0.091    0.019    0.000    0.000    0.000    0.000
 120.7    7.58    0.400    0.265    0.135    0.000    0.000    0.000    0.000
 135.5    7.60    0.022    0.019    0.002    0.000    0.000    0.000    0.000
 120.9    7.80    1.713    0.720    0.994    0.000    0.000    0.000    0.000
 154.1    7.79    0.036    0.029    0.007    0.000    0.000    0.000    0.000
 177.7    7.84    0.027    0.027    0.000    0.000    0.000    0.000    0.000
 120.7    8.00    1.638    0.357    1.112    0.169    0.000    0.000    0.000
 132.9    7.95    0.042    0.017    0.025    0.000    0.000    0.000    0.000
 154.0    8.00    0.044    0.030    0.014    0.000    0.000    0.000    0.000
 164.7    7.94    0.063    0.046    0.017    0.000    0.000    0.000    0.000
 176.7    8.03    0.147    0.104    0.043    0.000    0.000    0.000    0.000
 120.3    8.19    0.272    0.041    0.179    0.052    0.000    0.000    0.000
 177.0    8.16    0.102    0.082    0.020    0.000    0.000    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):   30.9
 Mean src-site R=   49.5 km; M= 6.30; eps0=   0.61. Mean calculated for all sources.
Modal src-site R=  120.9 km; M= 7.80; eps0=   1.50 from peak (R,M) bin
 MODE R*= 120.7km; M*= 8.00; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  1.112

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                  % contr.  R(km)    M   epsilon0 (mean values).
California B-faults Char             3.20    85.7   6.98    1.17
California A-faults                  4.68   125.4   7.88    1.43
CA Compr. crustal gridded           18.70    23.9   5.80    0.23
```

```
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                         % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
Great Valley 14 (Kettleman Hills    1.16    82.1   7.12    0.86    -144.8
Great Valley 13 (Coalinga) Char     1.28    80.0   7.02    0.90    -134.0
Great Valley 14 (Kettleman Hil G    0.72    82.1   6.85    1.30    -144.7
Great Valley 13 (Coalinga) GR       0.80    80.0   6.78    1.27    -133.4
SSAnd;PK+CH+CC+BB+NM+SM aPriori     1.07   120.3   7.91    1.29    -130.2
#*********End of deaggregation corresponding to Chiou-Youngs 2008        *********#

******************** Central  California ****************************************
```

Appendix G-2 Geology Soils Memorandum

Memorandum

To: Maya Rohr, Sespe Consulting

From: John Bennett, P.G., SLR Consulting

Date: November 8, 2013

Subject: Geology and Soils, EIR/EIS, Proposed Riverbend Sand and Gravel Project, Sanger, CA

1. INTRODUCTION

This section describes the local and regional geologic, soils, and seismic conditions that occur in the vicinity of the Site. These conditions are described and evaluated so ensure potential impacts related to seismic hazards such as ground rupture or ground shaking due to seismic activity; and that quarry slopes would not present physical hazards as a result of slope failures. Much of the information in this section is derived from Geotechnical Review of Quarry Slope Stability and Geologic Hazards, Proposed Riverbend Sand and Gravel Quarries (Tetratech, 2013). Tetratech (2013) is on file with the County of Fresno, and is included as Appendix XX of this Environmental Impact Report (EIR).

2. GEOLOGY

2.1 Regional

The Site is located in the Great Valley of California, which formed by millions of years of alluvial and fluvial deposition of Quaternary sediments derived from the Sierra Nevada and Coast Ranges, which bound the Great Valley on its east and west. The Great Valley is an alluvial plain about 50 miles wide and 400 miles long (north-south). Sediments have been deposited into the Great Valley for the last 160 million years, and can range up to more than 50,000 feet thick in certain areas.

The Coast Range and Sierra Nevada have been uplifted relative to the Great Valley. Numerous rivers and streams originating in the higher elevations of these areas flow into the Great Valley, leading to deposition of alluvium. In general, coarse sediments have been deposited in areas nearest the mountains, and sediments gradually become finer toward the center of the valley.

Alluvial fans are the dominant geologic feature on the eastern portion of the Great Valley, forming as streams migrate laterally over time. Laterally shifting stream channels create coalescing fans, consisting of broad sheets of interfingered lenses of gravel, sand, and finer detritus.

The Great Valley is underlain by a sequence of marine and continental sedimentary rocks consisting of shale, siltstone, and sandstone. Beneath these rocks lie impermeable basement complex of igneous and metamorphic rocks that are up to 13,000 feet bgs. These basement rocks are a subsurface extension of the same rocks that occur in the Sierra Nevada.

2.2 Site Geology

The site is located at the western base of the Sierra Nevada on alluvial fan sediments deposited by the Kings River, which is adjacent to the Site (Figure 1). Because of the Kings River drains a portion of the Sierra Nevada where glaciation previously carved out valleys, and relatively high rate of tectonic basin subsidence realized in the Site vicinity, the Kings River alluvial fan is relatively thick compared to other fans located in the eastern Great Valley (Faunt et al., 2009). Alluvial materials in the Site vicinity are composed of the same granitic materials as the parent rocks of the Sierra Nevada.

In 2010 and 2011, 14 exploratory test holes were drilled at the part of the project site. Each boring was 100 feet deep. In general, coarse grained alluvial materials associated with the Kings River alluvial fan were encountered in borings drilled at the Site. Bedrock was not encountered. The observed alluvium consists of sand, gravelly sand, and lesser amounts of silty sands and silt with clay.

Based on these site investigations, relatively coarse-grained deposits of the ancestral Kings River are generally predominant in the subsurface above a depth of about 200 to 220 feet. These deposits are primarily sand, gravel, and cobbles, and have been termed the Quaternary Older Alluvium. Some interlayered clay and silt layers are also present, but these are generally thin and discontinuous. Clay is also intermixed with the coarse-grained deposits in some depth intervals. Based on information from Sanger, Reedley, and the Great Western School, where deeper test holes and supply wells have been drilled, the top of the bedrock in the vicinity of the project site is expected to be below a depth of 700 feet (Schmidt 2012).

2.3 Soils

Surface soils in the Site vicinity generally consist of alluvium such as silt and silty sands (Tetratech, 2012), likely deposited during previous flooding of the Kings River. These soils likely originated from the granitic rocks of the Sierra Nevada.

Most of the Site is covered with Grangeville fine sandy loam (Figure 1). Soil types covering lesser proportions of the Site include Tujunga sand, Hanford fine sandy loam, and Tujunga soils.

2.4 Groundwater Conditions

The Central Valley is often regarded as one continuous but heterogeneous aquifer system. The principal aquifer in the area is the coarse grained sediments located near the surface, consisting of intercalated lenses of clay, silt, silty and sandy clay, clayey and silty sand, sand, gravel, cobbles, and boulders (Page and LeBlanc, 1969; Faunt et al., 2009). The eastern portion of the San Joaquin Valley contains aquifer material characterized as coarse-grained well-sorted medium-to-coarse-grained fluvial sediments, ranging between 400 and 500 feet thick in the valley center, and thinner toward the east and west.

The alluvial aquifer is mostly unconfined and regional groundwater flow is generally toward the southwest, although pumping depressions in certain areas have caused localized deviant flow patterns (Page and LeBlanc, 1969). Based on monitor wells installed at the Site, groundwater flows toward the south, parallel with the Kings River in the Site vicinity. As of June 2012, depth to water in the onsite wells ranged between 14 and 20 feet below ground surface (bgs) (Schmidt, 2012).

Surface waters in the area consist of natural rivers and manmade canals, seepage from which is the greatest source of groundwater recharge. Rainfall averages less than 10 inches per year, so agricultural interests must rely on surface water deliveries and groundwater production for irrigation.

3. SEISMICITY AND GROUND MOTION PARAMETERS

Geologic hazards include earthquake-induced hazards such surface fault ruptures, soil liquefaction, and seismically induced landslides. Because these hazards are caused by ground shaking, the potential for ground shaking must be assessed to provide the basis to evaluate these potential hazards.

The Site is not within or near an Alquist Priolo Fault Zone. However, based on a review of available fault source information nearby active and potentially active faults to the site include the following.

Active faults:

- Great Valley Fault (Segments 13, 14), approximately 82 km west, southwest of Site;

- Kern Canyon Fault, approximately 100 km east, southeast of Site;

- Poso Creek Fault complex (closest active splay), approximately 112 km south of Site;
- Independence Fault, approximately 113 km east of Site;
- Owens Valley Fault Zone, approximately 120 km east of Site;
- San Andreas Fault, approximately 120 km southwest of Site.

Potentially active fault:

- Poso Creek Fault complex, approximately 88 km south of site.

Seismic Ground Motion Parameters

To quantify the possible impact of ground shaking at the Site during seismic events, the Peak Ground Acceleration (PGA) was evaluated. Tetratech (2013) performed a probabilistic analysis to assess the PGA for the Site, using U.S. Geological Survey 2008 deaggregation methodology (https://geohazards.usgs.gov/deaggint/2008). The faults listed above were utilized in this evaluation, as well as the following parameters:

- Location: N36.667, W 119.500;
- Exceedance probability of 10% in 50 years (475-yr return period)
- Vs_{30} = 350 m/s (Soil Type D; Bozorgonia and Bertero, 2004)

The PGA evaluated for the site, based on the faults identified and the parameters listed above, is 0.138 g and is associated with a modal earthquake of magnitude Mw 7.99 at a distance of 121 kilometers. This estimated value of PGA indicates that the Site could experience strong ground shaking in the event of an earthquake.

4. SLOPE STABILITY EVALUATION

The Project involves excavation of multiple mine pits for production of sand and gravel products (Figure 3). Mine pits will be excavated to a depth of up to 100 feet bgs. Reclaimed slopes will be completed at a slope angle of 2:1. Underwater mining will be conducted to remove materials from areas beneath the groundwater elevation. No dewatering will be conducted. Silt byproducts from the aggregate plant will be used to backfill selected mine phases (Figure 4). The Site is currently relatively flat, with a gentle south-southwest gradient of 0.18%.

Tetratech (2013) evaluated proposed slopes consistent with the Recommended Procedures for Implementation of DMG Special Publication 117A *Guidelines For Evaluating and Mitigating Seismic Hazards in California* (CGS, 2008), which is considered the standard of practice for slope stability analyses in California. A discussion and summary of these analyses is presented below.

Slope stability analyses were performed for the proposed typical slope cross-section assuming a 100 feet high slope. Based upon the available data, clay layers are present at depth across the property and in adjacent offsite areas (Gronberg et al., 1998; Schmidt, 2012). Therefore, several configurations were evaluated to understand the impact of clay layers at depths of 30, 60, and 90 feet below the top of slope on the stability of the proposed quarry slopes.

The results of all critical slope stability analyses are summarized in the Table 1, for static and pseudostatic conditions, respectively. Results of the stability analyses indicate that, under the assumed site conditions, proposed 100 feet high quarry slopes excavated at a maximum gradient of 2(H):1(V) will be stable for static and pseudostatic conditions.

The calculated static and pseudo-static factors of safety are greater than 1.5 and 1.3 respectively, for the proposed slope configurations. These results satisfy Surface Mining and Reclamation Act (SMARA) guidelines and standard of practice for slope stability, based on the intended open space and habitat end uses of the reclaimed Site.

5. EVALUATION OF OTHER GEOLOGIC HAZARDS

In addition to ground shaking due to earthquakes, Geologic hazards include surface fault rupture, soil liquefaction, seismically-induced differential settlement, ground lurching, seismically induced landsliding, lateral spreading, earthquake-induced flooding, seiches, and tsunamis. These potential impacts are further described below.

5.1 Liquefaction Potential

Liquefaction occurs when saturated sediments temporarily lose strength during an earthquake and act like a liquid rather than a solid. Liquefaction potential is a function of three factors: soil type, depth to groundwater, and seismic induced ground shaking potential.

The available data for the site indicate that the percentage of fines (passing the #200 sieve) for the granular deposits (sand, gravelly sand, and lesser amounts of silty sands and silt with clay as described in Section 2.2) within the planned depth of mining range from less than 5 percent to about 30 percent. Clay and silt lens materials, which occur at depth, contain greater than 50 percent fines.

Whereas these materials namely sand and gravelly sand, may be generally considered potentially liquefiable, the high percentage of fines within their matrix, the depth of groundwater (15 to 20 ft), the anticipated level of ground shaking (PGA=0.138),and the fact that the density of those materials is likely to increase with depth, the potential for liquefaction and its detrimental effects on the site performance is considered low.

5.2 Surface Fault Rupture

Official Maps of Earthquake Fault Zones were reviewed to evaluate the location of the project site relative to active fault zones. Earthquake Fault Zones (known as Special Studies Zones prior to 1994) have been established in accordance with the Alquist-Priolo Special Studies Zones Act enacted in 1972 (California Geological Survey, 2007). The Act directs the State Geologist to delineate the regulatory zones that encompass surface traces of active faults that have a potential for future surface fault rupture. The purpose of the Alquist-Priolo Act is to regulate development near active faults in order to mitigate the hazard of surface fault rupture.

The Site is not located within a designated Alquist-Priolo Earthquake Fault Zone for fault surface rupture hazard. Further review of the 2010 Fault Activity Map of California (Figure 5; Jennings and Bryant, 2010) indicates that no surface traces of any active or potentially active faults pass directly through or in the vicinity of the site. The potential for surface rupture due to faulting occurring beneath the Site is considered to be minimal.

5.3 Seismically-Induced Settlement

Earthquake induced settlement is compression of the underlying loose soils due to liquefaction or densification that occur during strong ground shaking and causes uneven settlement of the ground surface. The potential for soil liquefaction is considered low, and therefore the potential for liquefaction-induced settlement is low.

5.4 Ground Lurching and Seismically-Induced Landsliding

Ground lurching is the horizontal movement of ground located adjacent to slope faces caused by seismic forces exerted during an earthquake. It can occur in areas underlain by soft or weak deposits and often results in permanent displacement and longitudinal cracking parallel to the slope face at some distance setback from the top of the slope. In steep slope areas, significant ground shaking may cause landslides or rock slope failures.

The Site could experience strong ground shaking in the event of an earthquake. However, ground acceleration was considered in the slope stability evaluation described above in Section 4, which concluded that factors of safety for the proposed slopes are acceptable.

5.5 Lateral Spreading

Seismically induced lateral spreading involves lateral movement of earth materials due to ground shaking. Lateral spreading is characterized by near-vertical cracks with predominantly horizontal movement of the soil mass involved along potentially liquefiable layers. Because the potential for liquefaction at the Site is low, the potential for lateral spreading is also low.

5.6 Earthquake Induced Flooding

Flooding may be caused by failure of dams or dikes in the event of an earthquake. The closest significant dam to the site, the Pine Flat Dam, is located approximately 14 miles to the northeast (upstream). The dam was constructed in 1956 for flood control and water storage purposes, and controls upstream flow of the Kings River. The dam has withstood numerous earthquakes since it was constructed, and a catastrophic earthquake-induced failure of the dam is considered unlikely.

In addition, several confined bodies of water include mining related ponds are located adjacent to the Kings River near the Site. Water elevations in these ponds or lakes are similar to that of Kings River. Therefore, these lakes or ponds are not considered to be a likely cause of earthquake related flooding at the Site.

5.7 Tsunamis and Seiches

Tsunamis are generated in large bodies of water by fault displacement or major ground movement. A seiche is an earthquake-induced wave in a confined body of water such as a lake, reservoir, or bay. Because there are no substantially sized lakes, reservoirs, or bays near the Site, there is no risk of tsunamis or seiches.

6. REGULATORY SETTING

6.1 Federal Regulations

The 1997 Uniform Building Code (UBC) was developed by the International Conference of Building Officials (ICBO) and is used by most states, including California, as well as local jurisdictions to set basic standards for acceptable design of structures and facilities. The UBC provides information on criteria for seismic design, construction, and load-bearing capacity associated with various buildings and other structures and features.
Additionally, the UBC identifies design and construction requirements for addressing and mitigating potential geologic hazards. New construction generally must meet the requirements of the most recent version of the UBC.

6.2 State Regulations

Alquist-Priolo Earthquake Fault Zone Act

The State Alquist-Priolo Earthquake Fault Zoning Act (A-P Act) of 1972 was passed to mitigate the hazards associated with surface faulting in California. Administered by the California Department of Conservation (DOC), the A-P Act prevents construction of buildings used for human occupancy on the surface traces of active faults. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults.

Seismic Hazards Mapping Act

The 1990 Seismic Hazards Mapping Act and related regulations establish a statewide minimum public safety standard for mitigation of earthquake hazards. The purpose of this Act is to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure as well as other hazards caused by earthquakes. The Act provides the minimum level of mitigation needed to reduce the risk of a building collapse. Under this Act, the lead agency can withhold permits until geologic investigations are conducted and mitigation measures are incorporated into building plans. In addition, the Act addresses not only seismically induced hazards but also expansive soils, settlement, and slope stability. The program and actions mandated by this Act closely resemble those of the A-P Act by requiring the State Geologist to delineate various "seismic hazard zones"; and Cities, counties, and/or other local permitting authority to regulate certain development "projects" within these zones by withholding the development permits for a site until the geologic and soil conditions are investigated and appropriate mitigation measures (if required) are incorporated into development plans.

California Building Code

The California Building Code (CBC), known as Title 24, CCR, Part 2, specifies the acceptable design and construction requirements associated with various facilities or structures. These codes are administered and updated by the California Building Standards Commission. This Code specifies criteria for open excavation, seismic design, and load-bearing capacity directly related to construction in the State. The CBC augments the UBC and provides information for specific changes to various sections in it. The seismic building requirements under the CBC are more stringent than the federal UBC.

Surface Mining and Reclamation Act

With respect to addressing geotechnical slope stability for final reclamation slopes, SMARA does not specify a minimum factor of safety for slope stability. However, §3502(b)(3) indicates that final reclaimed slopes shall be flatter than the critical gradient, which implies that static factors of safety should be greater than 1.0. The section further states:

> *"Wherever final slopes approach the critical gradient for the type of material involved, regulatory agencies shall require an engineering analysis of slope stability. Special emphasis on slope stability and design shall be taken when public safety or adjacent property are affected."*
> Section 3704(f) states that,
>
> *"Cut slopes, including final highwalls and quarry faces, shall have a minimum slope stability factor of safety that is suitable for the proposed*

end use and conform with the surrounding topography and/or approved end use."

6.3 Local Regulations

The Fresno County General Plan outlines several goals and policies related to seismic and geologic hazards for projects within their jurisdictional area. These goals and policies are summarized as follows:

Goal HS-D: To minimize the loss of life, injury, and property damage due to seismic and geologic hazards.

Policy HS-D.2: The County shall ensure that the General Plan and/or County Ordinance Code is revised, as necessary, to incorporate geologic hazards areas formally designated by the State Geologist.

Policy HS-D.3: The County shall require that a soils engineering and geologic seismic analysis be prepared by a California-registered engineer or engineering geologist prior to permitting development in areas prone to geologic or seismic hazards.

Policy HS-D.4: The County shall require all proposed structures, additions to structures, or public facilities situated within areas subject to geologic-seismic hazards as identified in the soils engineering and geologic-seismic analysis to be sited, designed, and constructed in accordance with the applicable provision of the
Uniform Building Code.

Policy HS-D.8: The County shall require a soils report by a California-registered engineer or engineering geologist for any proposed development that requires a County permit and is located in an area containing soils with high "expansive" or "shrink-swell" properties.

7. PROJECT IMPACTS AND MITIGATION MEASURES

7.1 Analysis Methodology and Significance Criteria

Appendix G of the California Environmental Quality Act (CEQA) Guidelines contains the following criteria in evaluating impacts a project may have relative to Geology and Soils.

a) Expose people or structures to potential substantial adverse effects, involving the risk of loss, injury, or death involving:
   - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zone Map issued by the State Geologist for the area or based on other substantial evidence of known fault;
   - Strong seismic ground shaking;
   - Seismic-related ground failure, including liquefaction; or
   - Landslides;

b) Result in substantial soil erosion or the loss of topsoil.

c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to the life or property.
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

Criteria (a), (b), and (c) are discussed below. The Project Area does not contain expansive soils, and no septic systems are planned for the Project Area. Therefore, no impacts would occur under criteria (d) and (e) above, and those criteria are not considered further.

7.2 Impact GS-1: Seismic Hazards

Seismic events such as earthquakes cause ground shaking which can damage structures. Earthquake intensities vary throughout the State, depending upon the magnitude of the earthquake, the distance from the causative fault, and the type of geologic material underlying a given location. In most of California, ground shaking caused by earthquakes is likely to occur due to the presence of active faults over much of the State. Structure design is also an important factor in regard to the extent of damage that is caused by ground shaking.

The Site is not located within a currently designated Alquist Priolo Fault Zone. A Peak ground acceleration of 0.138 g was calculated for the Site in Tetratech (2013) for the 475 year return period earthquake. This means that the Site could experience strong ground acceleration (shaking) during an earthquake.

The Project involves construction of an aggregate processing plant, asphalt plant, ready-mix concrete plant, and other ancillary facilities. Construction of these structures will require acquisition of building permits from the County of Fresno. Pursuant to requirements of County of Fresno building permits, CBC design and construction requirements must be implemented, including a series of seismic related standards. These standards are intended to minimize structural damages resulting from seismic shaking. Compliance with these requirements would therefore minimize the probability of seismic related structural damage to proposed structures.

In addition to ground shaking, effects of seismic activity may include surface fault rupture, soil liquefaction, seismically induced differential settlement, ground lurching, lateral spreading, and earthquake-induced flooding. Other geologic hazards include seiches, and tsunamis. As described in Section 5, none of these geologic hazards is considered likely to occur at the Site. As a result, the impact of these potential geologic hazards is considered less than significant under criteria (a) and (c) and no mitigation is required.

Level of Significance Prior to Mitigation: Less than Significant
Mitigation Measures: None Required

7.3 Impact GS-2: Slope Stability

The Site and surrounding area are currently relatively flat; with a gentle south-southwest gradient of 0.18%.The Project will involve excavation of mine pits of up to 100 feet deep. Upon reclamation, certain pits will remain as water features, and selected areas will be backfilled to native grade. Remaining pits will have 2:1 slopes upon reclamation. As described in Section 4 above, slope stability analyses were conducted to determine if the slopes would remain stable during static conditions and during seismic events.

As described in Section 4, factors of safety calculated by Tetratech (2013) exceed 1.5 for static and 1.3 for pseudo-static (seismic) conditions. These calculated factors of safety indicate that the proposed slopes will be suitably stable against gross failure for the anticipated long term conditions, including the effects of seismic shaking. Therefore, this potential impact is considered less than significant under criteria (a) and (c) and no mitigation is required.

Level of Significance Prior to Mitigation: Less than significant
Mitigation Measures: None required

Impact GS-3: Soil Erosion

Erosion is the removal of soils and rocks due to natural processes such as flow of wind or water. Heavy rainfall can create stormwater runoff that is capable of eroding soils, as can high winds. Erosion is particularly problematic in areas that are devoid of vegetation. Erosion can lead to problems such as removal of agriculturally productive soils, air pollution, and water pollution. A variety of control measures can minimize erosion.

Mine development will involve grubbing and removal of topsoil and overburden. Such activities will result in surface disturbance and removal of vegetation, leading to increased soil exposure and the potential for increased soil erosion. The Site is relatively flat. Much of the Site is currently used for agriculture and has been previously disturbed, but there do not appear to be any current erosion problems.

The Project will be developed in phases. Topsoil will not be removed until immediately prior to mining each phase, and will be stored separately for later use as final cover for reclaimed farmland and final slopes of ponds. Overburden will be removed and stored for later use as fill or transported directly to fill the phases to be reclaimed as farmland. Farming operations will continue on all phases not being mined or reclaimed. Upon reclamation, remaining cut slopes will be revegetated to as an erosion control measure.

The Site operator will be required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Industrial Activities (Permit; Order 97-03-

DWQ). As a condition of the Permit, the operator will be required to prepare a site specific Storm Water Pollution Prevention Plan (SWPPP). The SWPPP will contain descriptions of aspects such as potential discharge areas, significant materials, and sediment and erosion control measures. The Site will be required to maintain coverage under the Permit for the life of the project, and will be subject to its requirements and conditions.

Chang (2012) documents erosion and sediment controls that will be implemented during mining and reclamation phases. Runoff will be directed into quarry pits or local detention areas to the extent practical. Plant area runoff will be conveyed to an onsite detention basin to minimize offsite discharges. Energy dissipaters such as ditches and berms will minimize the potential for erosion off-site transport of pollutants.

The site will be required to maintain compliance with the Permit, and numerous sediment and erosion control measures will be implemented as documented in prescribed in the Chang (2012). Topsoils and overburden removed during mine development will not be discarded, but will be segregated and stored onsite for future use in Site reclamation. The Site is relatively flat, and non-mined areas will therefore remain flat, so will not be predisposed to erosion. Therefore, soil erosion represents a less than significant impact under criterion (b) above and no mitigation is required.

Level of Significance Before Mitigation: **Less Than Significant**
Mitigation Measures: **None required**

8. REFERENCES

Bozorgonia, Y. and Bertero, V.V. (eds.), Earthquake Engineering from Engineering Seismology to Performance-Based Engineering: CRC Press.

Buada and Associates, 2013, Operational Statement – Riverbend Sand and Gravel Project, 25 p.

California Geologic Survey (CGS). 2002 (revised December). California Geological Survey, Note 36: California Geomorphic Provinces.

California Geological Survey, 2007, Fault Rupture Hazard Zones in California, Alquist Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, Special Publication 42, 42 p.

California Geological Survey, 2008, Guidelines for Evaluating and Mitigating Seismic Hazards in California: Special Publication 117A, 102 p.

Faunt, C., Hanson, R., Belitz, K., 2009, Introduction, Overview of Hydrogeology, and Textural Model of California's Central Valley, *In:* USGS Professional Paper 1766.
Schmidt, 2012, Groundwater Conditions

Jennings, C.W. and Bryant, W.A., 2010, Fault Activity Map of California: California Geological Survey Geologic Data Map No. 6, scale: 1:750,000.

Page and LeBlanc, 1969, Geology, Hydrology, and Water Quality in the Fresno Area, California. United States Geological Survey Open File Report. 163p.

Schmidt and Associates, 2013, Groundwater Conditions at the Riverbend Sand and Gravel Project, 35 p.

Tetratech, 2012, Geotechnical Review of Quarry Slope Stability and Geology Hazards, Proposed Riverbend Sand and Gravel Quarries.

**TABLE 1:
Stability Analyses for Planned Temporary and Permanent Quarry Slopes**

Factor of Safety Static / Pseudostatic	**Analysis Description**
1.555 / 1.332	Overall stability of the 100-foot-high slope without clay layers.
1.546 / 1.378	Overall stability of the 100-foot-high slope with clay layer[1] at 30 feet below grade.
1.580 / 1.371	Overall stability of the 100-foot-high slope with clay layer[1] at 60 feet below grade.
1.583 / 1.360	Overall stability of the 100-foot-high slope with clay layer[1] at 90 feet below grade.

Appendix G-3 Slope Stability Considerations Addendum to Geotechnical Review of Quarry Slope Stability & Geologic Hazards

Project No. RSG 13-01E
April 30, 2014

Riverbend Sand and Gravel, LLC
14962 E Fantz Ave
Parlier, CA 93648-9734

c/o Mr. John Buada
Buada Associates
4872 N Arcade Ave, Fig Garden Studio
Fresno, California 93704

Subject: **SLOPE STABILITY CONSIDERATIONS**
Proposed Riverbend Sand and Gravel Quarries
2.5 miles Southeast of Sanger, Fresno County, California

References: Tetra Tech BAS GeoScience, 2013, "Geotechnical Review of Quarry Slope Stability and Geologic Hazards, Proposed Riverbend Sand and Gravel Quarries, Fresno County, California", Project No. RSG 13-01E, dated **August 13, 2013**.

Dear Mr. Buada:

Tetra Tech BAS GeoScience (Tt-BASg) is providing this letter to corroborate the slope stability analyses presented in the above-referenced Geotechnical Review report dated August 13, 2013. It is understood that the Office of Mine Reclamation (OMR) does not consider a displacement-based approach of evaluating slope stability [1, 2, 3, 4] consistent with SMARA regulation Section 3502(b).

Title 14 CCR Section 3502(b)(3) states that: "*The designed steepness and proposed treatment of the mined lands' final slopes shall take into consideration the physical properties of the slope material, its probable maximum water content, landscaping requirements, and other factors. In all cases, reclamation plans shall specify slope angles flatter than the critical gradient for the type of material involved. Whenever final slopes approach the critical gradient for the type of material involved, regulatory agencies shall require an engineering analysis of the slope stability. Special emphasis on slope stability and design shall be necessary when public safety or adjacent property may be affected.*" Further, Title 14 CCR Section 3704(f) provides a prescriptive standard for slope stability evaluations "*Cut slopes, including final highwalls and quarry faces, shall have a minimum slope stability factor of safety that is suitable for the proposed end use and conform with the surrounding topography and/or approved end use.*" It is

---

[1] SCEC, 1999 "Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines For Analyzing And Mitigating Liquefaction Hazards In California"

[2] Bray, J.D. and Rathje, E.M. 1998. "Earthquake-Induced Displacements of Solid-Waste Landfills," Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 124(3), pp. 242-253

[3] Bray, J.D., Travasarou, T., 2007. Simplified Procedure for Estimating Earthquake-Induced Deviatoric Slope Displacements,". Journal of Geotechnical and Geoenvironmental Engineering, 133, 381-392

[4] Rathje, E.M. and Antonakos, G. 2011. "A Unified Model for Predicting Earthquake-Induced Sliding Displacements of Rigid and Flexible Slopes," Engineering Geology, 122, 51-60

our interpretation that it is the requirement and intent of the SMARA regulations to evaluate and characterize the slope stability based on a suitable Factor of Safety.

The proposed end use of the project area is a combination of quarry pits backfilled with overburden and wash materials, and permanent lakes. Consequently, as discussed in the referenced Geotechnical Review report dated August 13, 2013 we have determined the Factors of Safety suitable for the proposed end use of the project as 1.3 for the static conditions and 1.0 for the pseudo-static conditions.

These acceptance Factors of Safety were selected considering the non-critical nature of the slopes without appreciable potential of impacting permanent on-site and adjacent improvements. The selected acceptance Factor of Safety for static conditions of 1.3 is consistent with such an end use and the presented stability analyses demonstrate that this factor is in fact significantly exceeded for all investigated scenarios and is in excess of 1.5.

The acceptance Factor of Safety for the pseudo-static conditions is developed in conjunction with the selection of the horizontal seismic coefficient, which is defined as a ratio value of the weight of the sliding mass that is considered acting in the horizontal direction due to the earthquake shaking. This ratio is related to the parameters of the triggering seismic event. The project site is located in a relatively low seismicity region and the design seismic event was determined for a probability exceedance of 10 percent in 50 years, i.e., return period of 475 years, as described in the referenced Geotechnical Review report. The design event is expected to generate a peak ground acceleration (PGA) of 0.138g for a modal earthquake magnitude Mw7.99 at a distance of 121 kilometers. The horizontal seismic coefficient is determined by reducing, due to the seismic wave scattering within the slope mass, the PGA. Based on the NCHRP Report 611[5], the horizontal seismic coefficient for the on-site soil type D for slope height 100 feet is 60 percent of the PGA, i.e., 0.138 x 0.6 = 0.083.

The summary of relevant static and pseudostatic slope stability analyses utilizing the horizontal seismic coefficient of 0.083 is provided in the table below.

Stability Analyses for Planned Temporary and Permanent Quarry Slopes[1]

Factor of Safety Static / Pseudostatic $k_{eq} = 0.083$	**Analysis Description**	Attachment page
1.555 / 1.088	Overall stability of the 100-foot-high slope without clay layers.	C-1a/1c
1.546 / 1.182	Overall stability of the 100-foot-high slope with clay layer[1] at 30 feet below grade.	C-2a/2c

Note: [1] For analysis purposes clay layers were assumed to be horizontal.

The analyses demonstrate that both the static and pseudostatic Factors of Safety comfortably exceed the acceptance targets indicating a favorable robustness of the proposed design.

[5] Transportation Research Board, 2008, “National Cooperative Highway Research Program Report 611, Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments”

This conclusion further corroborates and supports the pseudostatic analyses presented in the Geotechnical Review report, which also indicated a comfortably high Factor of Safety in excess of 1.3 against permanent seismic deformations greater than 12 inches, which are commonly considered acceptable for unimproved slopes.

CONCLUSION

Based on the herein presented discussion and analysis results we conclude that both the static and the pseudostatic stability of the proposed cut slopes meet the suitable Factors of Safety in accordance and intent with the requirements of SMARA.

CLOSURE

This document is intended to provide specific engineering information for the subject project. Consequently, it cannot be considered an independent document, as it does not contain adequate background information. Thus, this document is directed only to the personnel with detailed knowledge of the subject project and should be used only in conjunction with the project geotechnical report. The recommendations, assumptions, conditions, and limitations presented in the project geotechnical report remain valid and applicable, unless specifically superseded in this document.

This letter report has been prepared in accordance with generally accepted geotechnical practices and makes no other warranties either express or implied, as to the professional advice or data included in it.

We appreciate the opportunity to provide our professional services on this project. If you have any questions regarding this letter report or if we can be of further service, please do not hesitate to contact the undersigned.

Respectfully submitted,
Tetra Tech BAS GeoScience

David M. Luka, C.E.G.
Senior Geologist

PROFESSIONAL GEOLOGIST David M. Luka EG 1767 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

Yonglang Li, Ph.D., P.E.
Project Engineer

REGISTERED PROFESSIONAL ENGINEER YONGLANG LI No. 75350 CIVIL STATE OF CALIFORNIA

Peter Skopek, Ph.D., G.E.
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER PETER SKOPEK GE 2635 GEOTECHNICAL STATE OF CALIFORNIA

Attachment Slope stability analyses (2 pages)

Distribution: Addressee (pdf via e-mail jcbuada@buada.com)

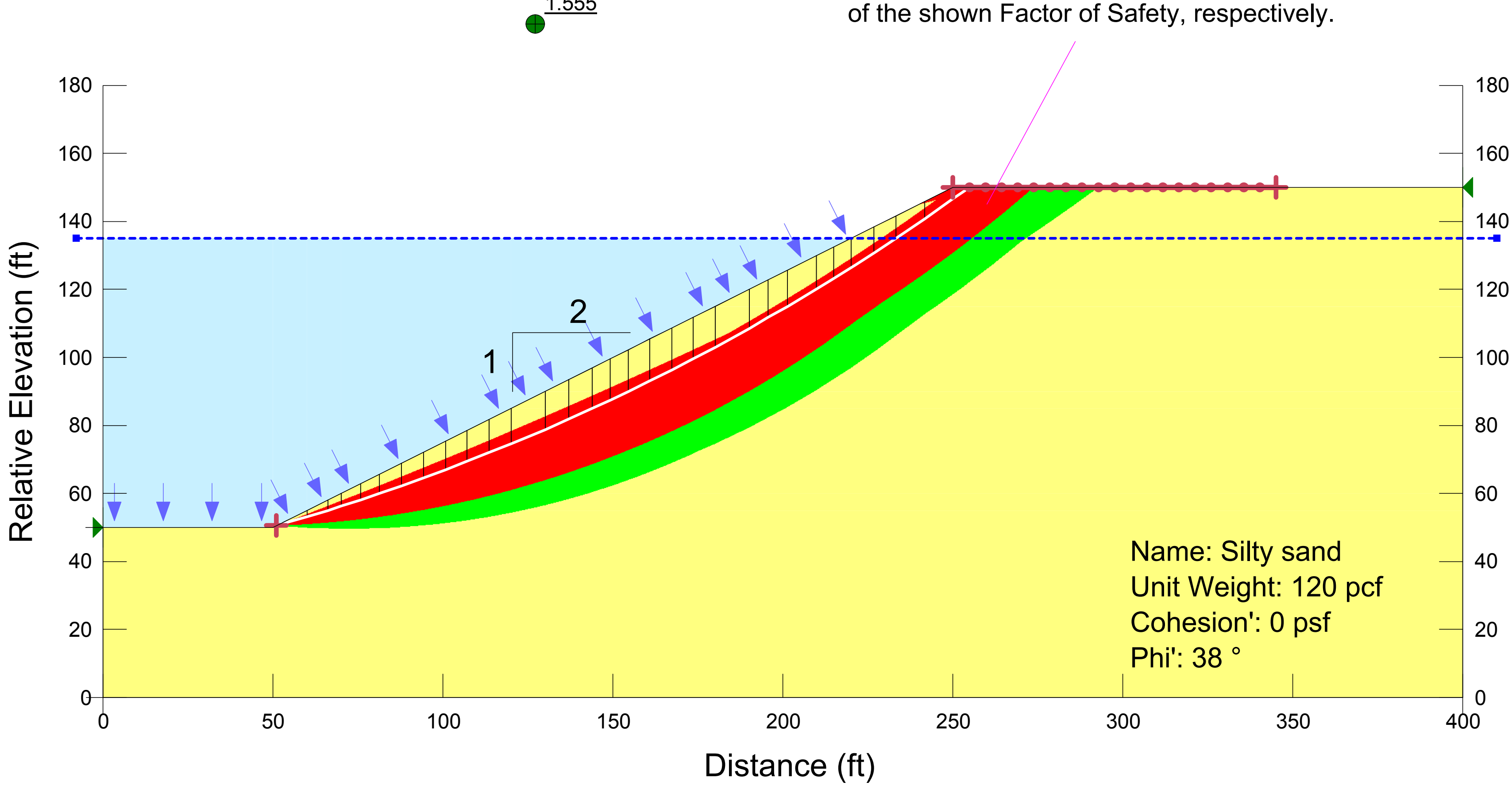
Filename: Pseudostatic Slope Stability FS 2014-04-30.doc

ATTACHMENTS

Riverbend Sand and Gravel Quarries
Slope Stability Analysis

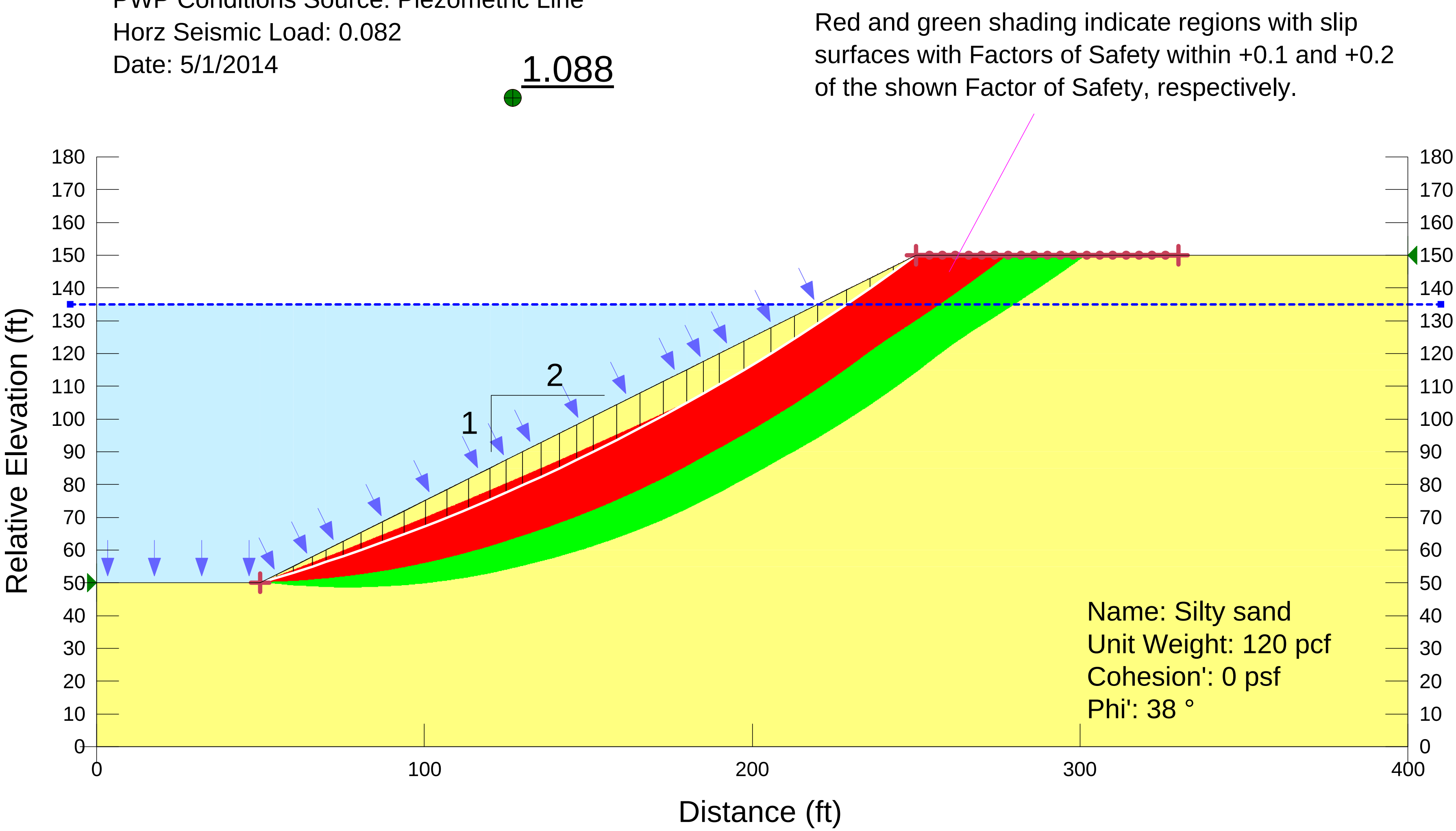
Description: 100-foot-high slope without clay layer
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013

Red and green shading indicate regions with slip surfaces with Factors of Safety within +0.1 and +0.2 of the shown Factor of Safety, respectively.



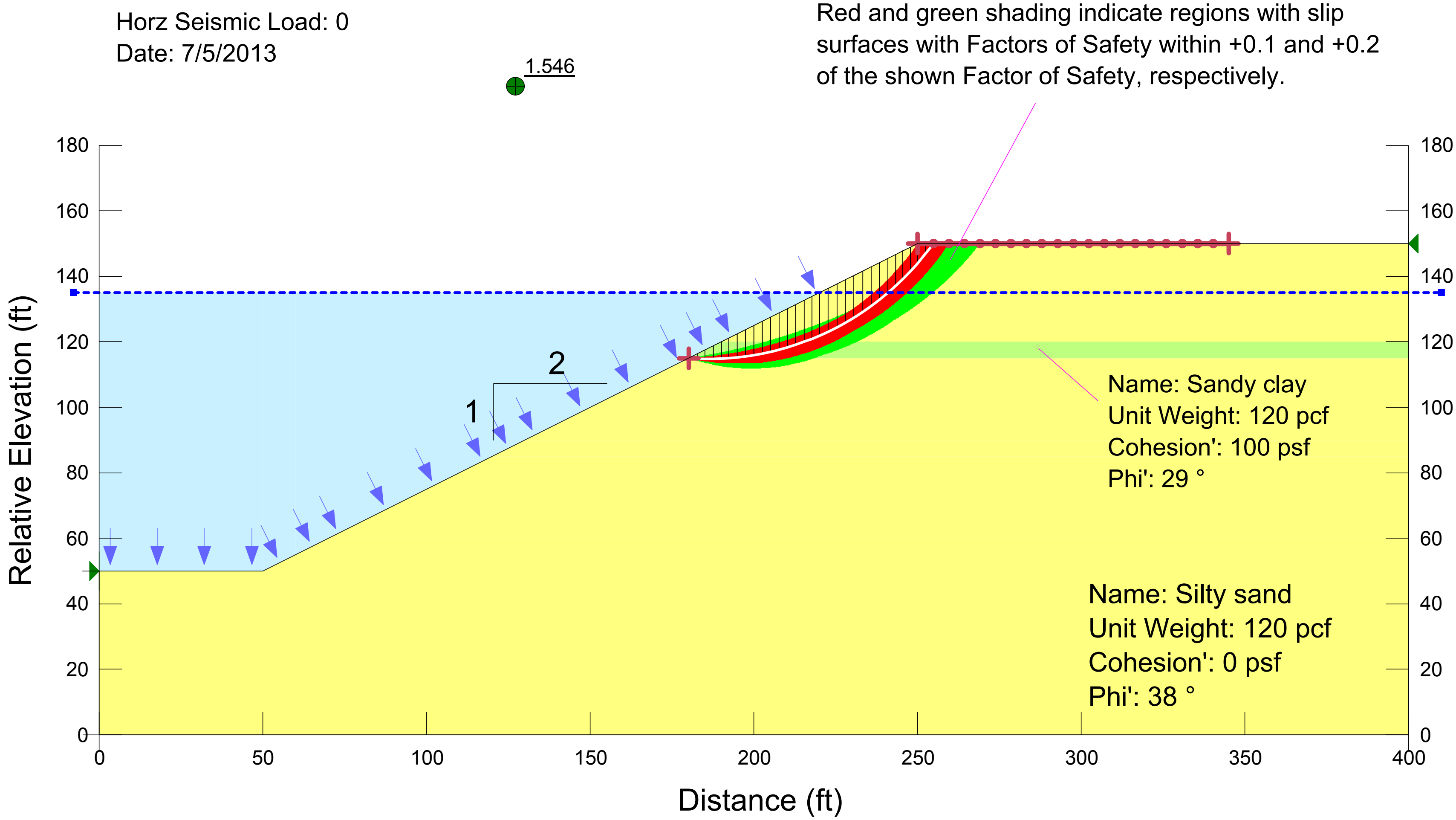
Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: 100-foot-high slope without clay layer
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.082
Date: 5/1/2014



Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @30 feet below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0
Date: 7/5/2013



Riverbend Sand and Gravel Quarries
Slope Stability Analysis

Description: Clay layer @30 ft below grade
Method: Spencer
Optimize Critical Slip Surface Location: No
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.082
Date: 5/1/2014