GEO SOLUTIONS

ENGINEERING GEOLOGY INVESTIGATION UPDATE

September 18, 2020
SL10982-3

Client:
Alison and Matt Brynildson
2250 Del Sol Place
Paso Robes, CA 93446

Project name:
Old Creek Road
APNs: 046-031-033 & 046-131-043
Cayucos area, San Luis Obispo County, California

Dear Mr. and Mrs. Brynildson:

1.0 INTRODUCTION

This report presents the results of the geologic investigation for the proposed single-family residence and separate ADU with a pool to be located at Old Creek Road, APN: 046-031-033 & 046-131-043, in the Cayucos area of San Luis Obispo County, California. See Figure 1: Area Location Map for the general location of the project area. Figure 1: Area Location Map was obtained from the computer program *Topo USA 8.0* (DeLorme, 2009). A Review of Engineering Geology Investigation was performed by LandSet Engineers, Inc. dated June 11, 2020. The purpose of this update is to provide a response to comments to the referenced Review of Engineering Geology Investigation. As part of the response to comments, a separate Roadway Evaluation was provided to evaluate the proposed roadway improvements. A previous Geotechnical Engineering Report was prepared for the proposed access road by Beacon Geotechnical Inc. The subsurface data from that report is included in the previously referenced Roadway Evaluation.

1.1 Site Description

The parcel is located at 35.5089 degrees north latitude and -120.8507 degrees west longitude at a general elevation of 1760 feet above mean sea level. The project property will hereafter be referred to as the "Site."

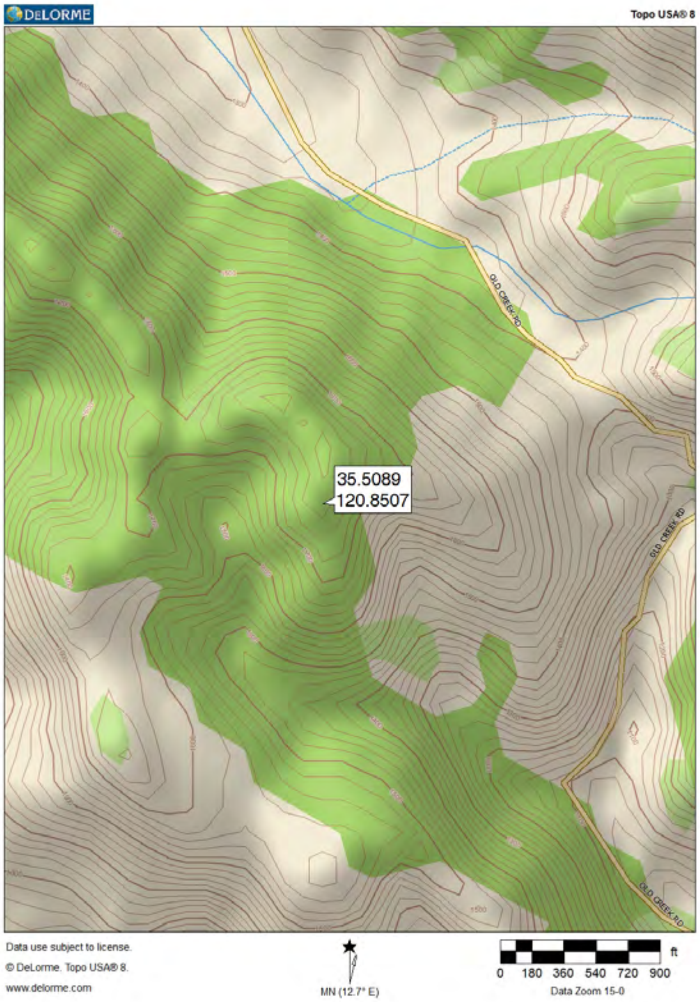

Figure 1: Area Location Map

The Site is situated along the top of a hill that drops to the south in the vicinity of the proposed single-family residence and southeast in the vicinity of the proposed ADU. Annual grasses and oak tress currently vegetate the Site.

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1.2 Project Description

An existing dirt road provides access to the proposed development areas. The proposed single-family residence is proposed to be located at the end of the existing roadway (to the south) within the existing oak trees.

The main house is anticipated to be 5,568 square foot, three stories in height and constructed using light wood framing and CMU retaining walls. Retaining walls up to 12.5 feet are proposed within the main residence. A 2,237 square foot, 2-story ADU with a swimming pool is proposed northeast of the proposed main house in the vicinity of the water well (see Figure 2). The ADU is anticipated to be constructed using light wood framing and CMU retaining walls. Roadway improvements are also proposed as part of the project and are discussed in a separate Roadway Evaluation. It is anticipated that footings will be founded into competent formational material. Per the project plans provided, surface drainage is to be diverted to energy dissipaters away from the proposed structures. Cut and fill quantities for the building areas are estimated to be 800-yards^3.

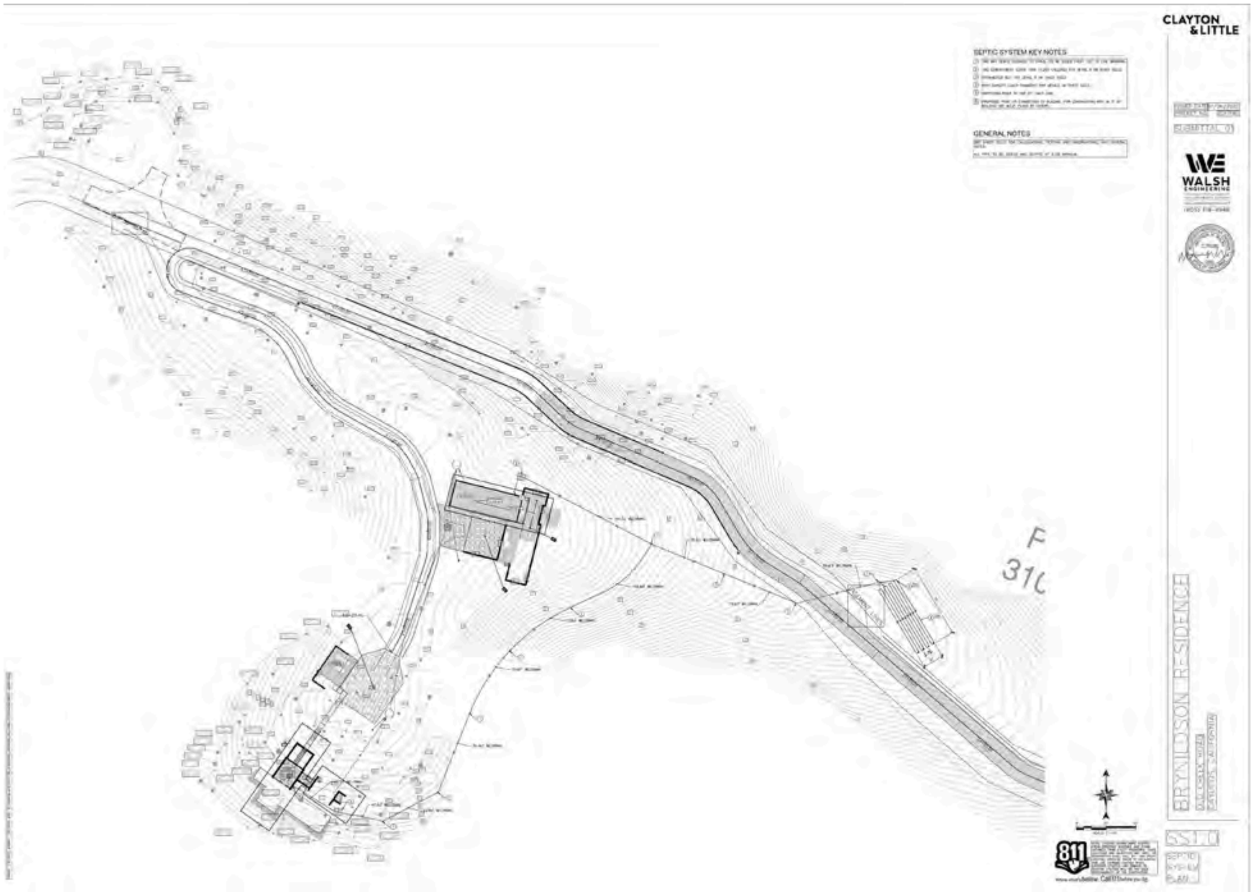

Figure 2: Site Map

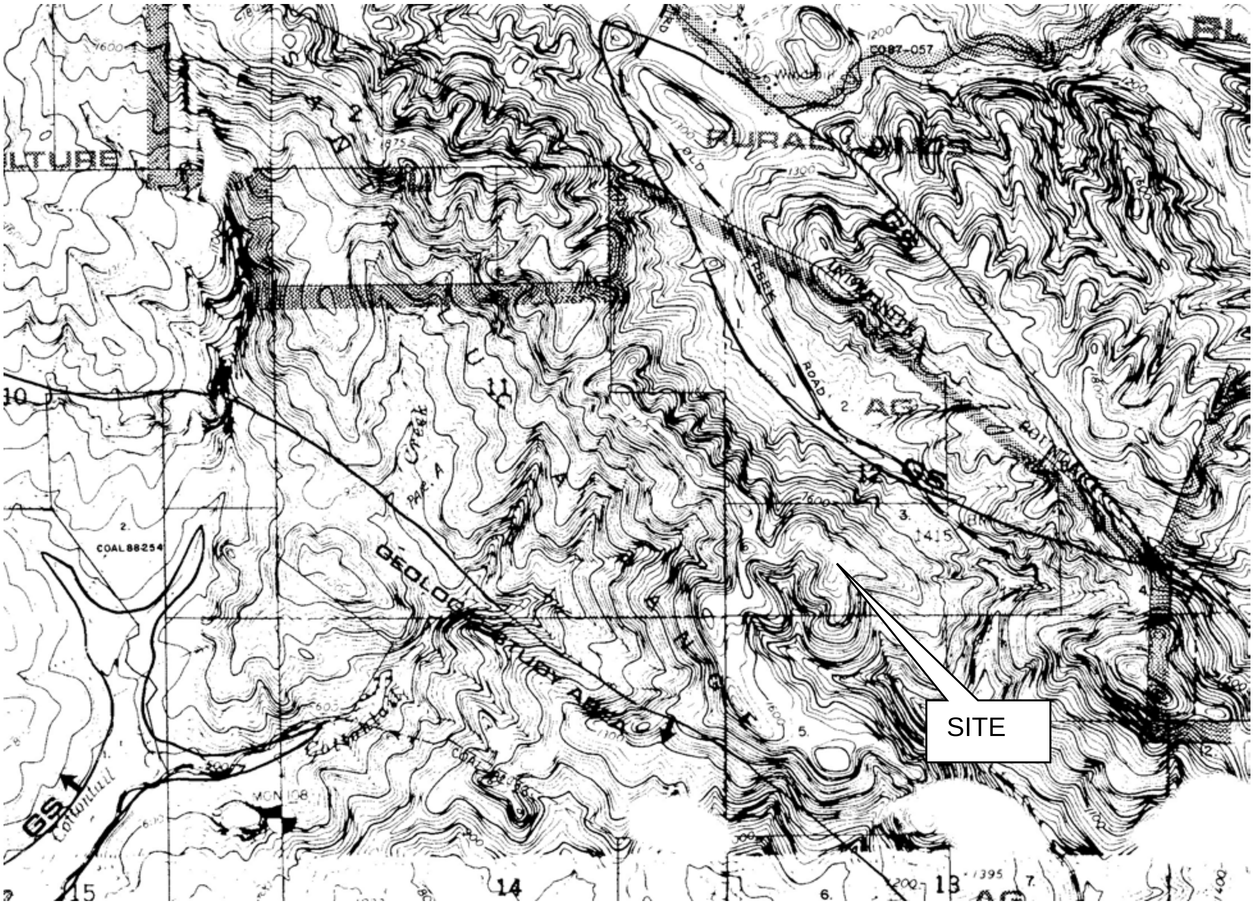

Figure 3: Geologic Study Area (GSA) Map

2.0 PURPOSE AND SCOPE

The purpose of this investigation was to evaluate engineering geologic hazards at the Site and to develop conclusions and recommendations regarding site development. The scope of this investigation consisted of:

1. Review of historical aerial photographs, pertinent published and unpublished geotechnical studies and literature, and geologic maps for the subject project area.

2. A field study consisting of site reconnaissance and subsurface exploration including exploratory trenches in order to formulate a description of the sub-surface conditions at the Site.

3. A review of regional faulting and seismicity hazards.

4. A review of landslide potential, surface and groundwater conditions, and liquefaction hazards.

5. Development of recommendations for site preparation.

6. Preparation of this report that summarizes our findings, conclusions, and recommendations regarding engineering geology aspects of the project.

3.0 GEOLOGIC RECOMMENDATIONS

The proposed development is geologically suitable provided that the recommendations provided herein are implemented. The following are recommended for implementation at the Site.

1. It is recommended that numerical slope stability analyses be conducted on fill and cut slopes constructed steeper than 2-to-1 (horizontal to vertical). Locally steeper slopes may be allowed depending on the results of a slope stability analysis.

2. It is anticipated that the foundations will be founded into competent formational material. Due to the presence of steep slopes in the immediate vicinity of the primary single-family residence and ADU/pool, deep foundation systems maybe required or structures should be setback from the slope. At the current configurations for the main house and ADU, footings should be a minimum of 5 feet below ground surface to achieve a daylight setback of 10 feet.

3. In addition, to minimize the landslide potential, surface drainage should be controlled and directed away from proposed and natural slopes. These surface drainage controls should be designed by the project civil engineer.

4. The foundation recommendations for expansive soils should be incorporated into the design.

5. It is recommended that guidelines for the mitigation of radon gas be incorporated into the design of the proposed development.

6. It is recommended that the septic system leach field not be located in the immediate vicinity of steep slopes to minimize the potential for effluent to negatively affect adjacent slopes. At the current configuration of the leach field (see Figure 2), trenches should be excavated to a total depth of 7 feet with the leach area limited to 5 feet below ground surface. As an alternative, the leach field should be realigned moving the northeast corner 5 feet to the south to provide a 10 foot to daylight of effluent.

7. Isolated seepage within formational units should be anticipated. Surface drainage facilities (graded swales, positive grades, etc.) are recommended at the base of cut slopes that allow surfacing water to be transferred away from the base of the slope. The project designer is recommended to offer specific design criteria for mitigation of water drainage behind walls and other areas of the site. Subsurface drainage systems should not be connected into conduit from surface drains.

8. Surface drainage should be controlled to prevent concentrated water-flow discharge onto either natural or constructed slopes. Surface drainage gradients should be planned to prevent ponding and promote drainage of surface water away from natural or man-made slopes. For soil areas we recommend that a minimum of two (2) percent gradient be maintained.

9. Excavation, fill, and construction activities should be in accordance with appropriate codes and ordinances of the County of San Luis Obispo. In addition, unusual subsurface conditions encountered during grading such as springs or fill material should be brought to the attention of the Engineering Geologist and Soils Engineer.

10. Rock rip-rap is recommended for concentrated drainage outfall locations that do not discharge onto paved or exposed rock surfaces. It is recommended that geotextile fabric (Enkamat 7010 or similar) be placed underneath the rip-rap and installed per the manufacturer’s recommendations.

4.0 ENGINEERING GEOLOGY

4.1 Regional Geology

The Site is located in the vicinity of the San Luis Range of the Coast Range Geomorphic Province of California. The Coast Ranges lie between the Pacific Ocean and the Sacramento-San Joaquin Valley and trend northwesterly along the California Coast for approximately 600 miles between Santa Maria and the Oregon border.

Regionally, the Site is located on the Cambrian Slab composed of a large, thick block of Cretaceous age sediments that are surrounded by Franciscan Complex rocks. The Cambrian Slab extends from the Los Osos fault south and northward to the Oceanic Fault.

4.2 Local Geology

Locally, the site is located within Monterey Formation as depicted on Plate 1A, Site Engineering Geology Map. Seiders, 1982 and Dibblee, 2006 mapped the Site as underlain by Miocene age Monterey Formation (Tmm, Tml) units. Information derived from subsurface exploration was used to classify subsurface soil and formational units and to supplement geologic mapping. Figure 4 depicts the geology map obtained from San Luis Obispo County Land Use View website.

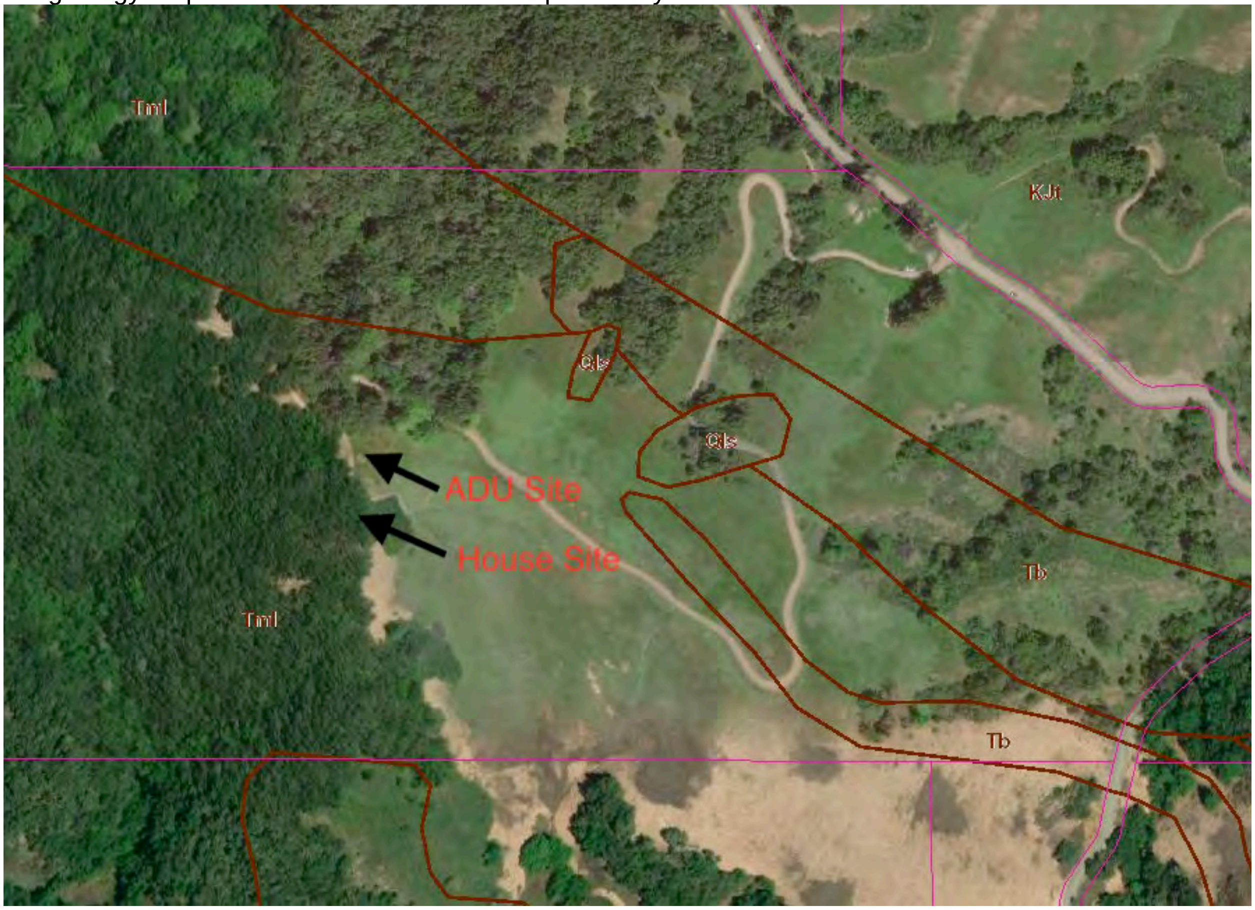

Figure 4: Geologic Map (provided by San Luis Obispo County Land Use View)

4.2.1 Monterey Formation

Seiders, 1982 maps the Site as within Monterey Formation (Tmm). Seiders, 1982 describes the Monterey Formation as “Calcareous and porcelaneous mudstone – Thin- to thick-bedded, chocolate-brown to buff, calcareous, foraminiferal mudstone, most abundant in lower part of section; locally phosphatic and glauconitic." The Monterey Formation was mapped throughout the site and was encountered within all trenches. The Monterey Formation at the site was encountered to consist of white siltstone (weathers orange along the fractures) observed to highly fractured, slightly to moderated weathered, and moderately soft to moderately hard. Plate 1A depicts the Monterey Formation (Tmm) throughout the property. Trench logs are presented in Appendix A. A syncline is mapped extending through the site between the primary and guest house locations. Unfavorable bedding was not observed to affect the proposed development.

4.3 Surface and Ground Water Conditions

Surface drainage follows the topography south in the vicinity of the proposed main house and southeast in the vicinity of the proposed ADU/pool. Surface drainage should be directed away from existing and proposed slopes. No springs or seeps were observed at the project, however they may be present in the wet winter months. Groundwater was not observed within any trenches.

4.4 Flooding and Severe Erosion

The site is not located within or near the 100-year or 500-year flood zone based on Federal Emergency Management Agency flood zone maps (FEMA, 2012).

The surficial and formational deposits are subject to erosion where not covered with vegetation or hardscape. The potential for severe erosion is considered low provided that vegetation and erosion control measures are implemented immediately after the completion of grading.

4.5 Hydrocollapse of Alluvial Fan Soils

The potential for hydrocollapse of subsurface materials is considered low due to the absence of alluvial fan material at the Site.

4.6 Active Faulting and Coseismic Deformation

The Alquist-Priolo Earthquake Fault Zoning Act passed in 1972 requires that the State Geologist establish Earthquake Fault Zones around the surface traces of active faults and to issue appropriate maps. The subject site is not located within an Earthquake Fault Zone (Jennings, 2010).

Table 1: Distance and Moment Magnitude of Closest Faults

Closest Active Faults to Site	Approximate Distance (miles)	Moment Magnitude (Mw)
Hosgri Fault	14.0	7.3
San Simeon Fault	20.0	7.3
San Andreas	36.0	6.9

The closest known active portion of a Holocene age fault is an active portion of the Hosgri Fault that is located approximately 14.0 miles southwest of the Site (Jennings, 2010). Plate 3 is a Regional Fault Map for the area. The San Andreas fault is the most likely active fault to produce ground shaking at the Site although it is not expected to generate the highest ground accelerations because of its distance from the Site.

4.7 Landslides

The San Luis Obispo County Siesmic Safety Element (County of San Luis Obispo, 1999) maps the site as within a high to very high landslide potential. Figure 5 presents of the landslide hazards map obtained from the San Luis Obispo Land Use View website. Seiders, 1982 and Dibblee, 2006 did not map landslides in the vicinity of the property. During site mapping, landslides were not observed in the immediate vicinity of the proposed structures, however landslides were observed on adjacent slopes along the roadway alignment (including in the area of the proposed leach field). Historical photographs were analyzed from 1949. Large scale landslides were not observed in the photographs at the building site, however due to the large scale of the photographs available it was difficult to identify smaller landslides. Figure 6 is a crop of the 1949 aerial photograph (original copies of the photographs can be provided). Plate 4 presents a current aerial photograph of the site. Due to the steep slopes, there appears to be a moderate potential for landslides to affect the proposed development. The 2019 California Building Code (CBC) required a footing setback for descending slopes as H/3 not to exceed 40 feet (H is the height of the descending slope). A slope stability analysis was performed to determine the stability of the natural slopes to reduce the footing setback distance to 10 feet to daylight. Section 5 provides the results and conclusions of the slope stability analysis.

There is a low rockfall potential to affect the proposed residence based on the lack of boulders upslope of the proposed development.

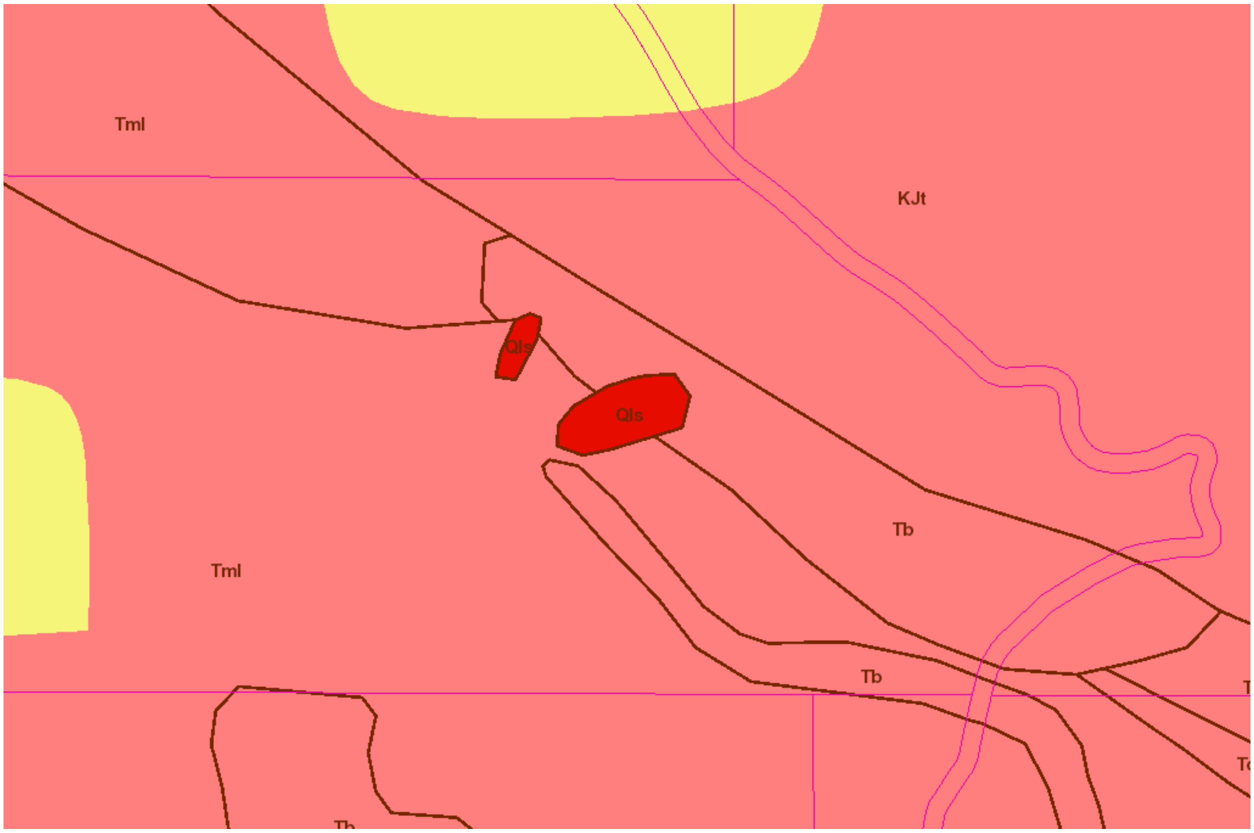

Figure 5: Landslide Potential Map (obtained from San Luis Obispo County Land Use View) (yellow-moderate potential, pink-high potential, red-very high potential)

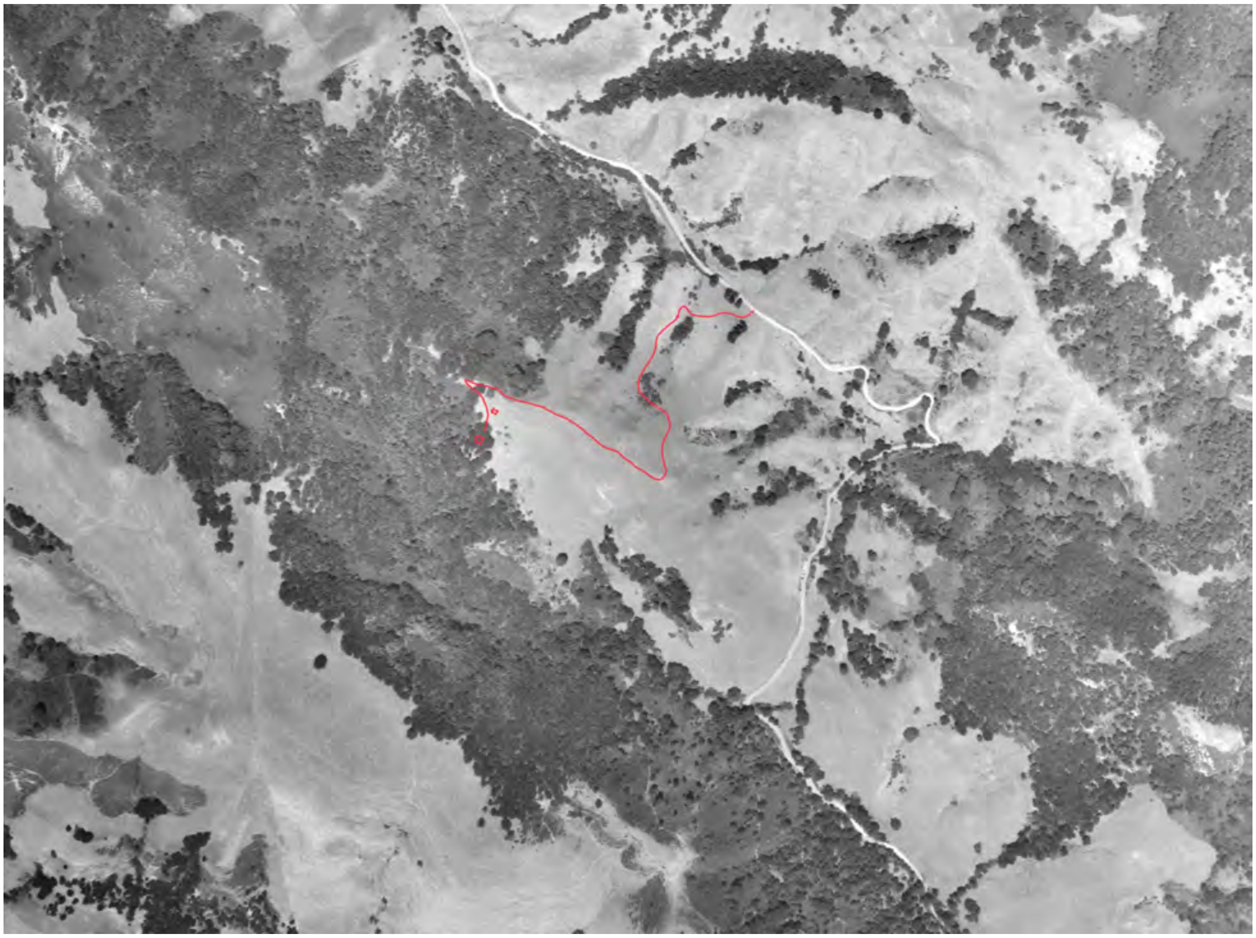

Figure 6: Aerial Photograph (1949)

5.0 NUMERICAL SLOPE STABILITY

A numerical slope stability analysis was performed on the existing slopes at the main house, ADU and septic area. Utilizing the results of laboratory testing performed on representative samples of soil and rock material from the area, the numerical slope stability analysis was performed in SLOPE/W, a computer-modeling program by Geo-Slope International, Limited (Geo-Slope, 2012). SLOPE/W uses limit equilibrium theory to compute the factor of safety of earth slopes. The engineering standard for permanent slopes is a factor of safety of 1.5 for static and 1.1 for pseudo-static (seismic) conditions. A factor of safety less than unity (1.0) is considered unstable.

5.1 Slope/W Discussion

SLOPE/W was utilized to determine the critical factor of safety along profile A-A (main house), profile B-B (ADU) and profile C-C (septic). SLOPE/W performs the stability analysis by passing a slip surface through the earth mass and dividing it into vertical slices. To compute the factor of safety, SLOPE/W utilizes the theory of limit equilibrium of forces and moments. The limit equilibrium method may be utilized to analyze circular and noncircular failure surfaces and assumes that:

1. The soil behaves as a Mohr-Coulomb material.
2. The factor of safety of the cohesive component of strength and the frictional component of strength are equal for all soils involved.
3. The factor of safety is the same for all slices.

The General Limit Equilibrium formulation and solution may be used to simulate most of the commonly used methods of slices. The characteristics of Spencer's method are identified as an "satisfies all conditions of equilibrium; applicable to any shape of slip surface; assumes that inclinations of side forces are the same for every slice; side force inclination is calculated in the process of solution so that all conditions of equilibrium are satisfied; accurate method; 3N equations and unknowns" (Duncan, 1996).

Each potential slip surface results in a different value for factor of safety. The smaller the factor of safety (the smaller the ratio of shear strength to shear stress required for equilibrium), the greater the potential for failure to occur by movement on that surface. Movement is most likely to occur on the slip surface with the minimum factor of safety. This is referred to as the critical slip surface. However, for movement to occur the ratio must be below 1.0.

5.2 Modeling Conditions

Three numerical slope stability analyses were modelled to analyze existing slopes. Profile A-A (see Plate 1A) modelled the natural slope at the main house location, Profile B-B modelled the natural slope at the ADU location, and Profile C-C modelled the natural slope at the proposed leach field location. The profiles were determined by the topography provided in the referenced project plans. All slopes consist of 3 to 4 feet of colluvium overlying Monterey Formation. Groundwater was not modelled, with the exception of the septic area.

A remolded shear test was performed on a representative soil and rock sample. The purpose of this data was to determine the soil resistance to deformation (shear strength), interparticle attraction (cohesion), and resistance to inter-particle slip (angle of internal friction). Angle of internal friction and cohesion values were utilized from laboratory test results.

A moisture density relation curve, developed in accordance with ASTM D1557, five-layer method, was performed on a representative sample obtained from the excavation area. The purpose of the relation curve is to determine the maximum density and optimum moisture contents, as well as evaluate the stability of the soils. The laboratory sheets depict the dry unit weight of soil and have been converted to the unit weight (γ) for use in the stability analysis.

Table 2: Laboratory Test Results

Description	Unit Weight (pcf)	Angle of Internal Friction (degrees)	Cohesion (psf)
Colluvium	130.1	28	311
Monterey Formation	118.2	17	646

5.3 Results

Our analysis resulted in a range of values for factor of safety and their respective slip surfaces. The lowest factor of safety value corresponds to the critical slip surface. This critical slip surface does not necessarily result in the largest slip surface. The critical static factor of safety value is presented in Table 3. The potential critical slip surface for static conditions is presented on Figure 7, 9 and 11.

As the slope may be affected by seismic events, a dynamic loading condition was applied to the slope model (pseudo-static conditions). As stated in *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (CDMG, 1997), "In California, many state and local agencies, on the basis of local experience, require the use of a seismic coefficient of 0.15, and a minimum computed pseudo-static factor of safety of 1.0 to 1.2 for analysis of natural, cut, and fill slopes. Basic guidelines for making preliminary evaluations of embankments to ensure acceptable performance were: using a pseudo-static coefficient of 0.10 for magnitude 6.5 earthquakes and 0.15 for magnitude 8.25 earthquakes, with an acceptable factor of safety of the order of 1.15." Calculations for pseudo-static numerical analysis within these iterations utilized a seismic coefficient of 0.15 g.

The critical seismic factor of safety value is presented in Table 3. The potential critical slip surface for pseudo-static conditions is presented on Figure 8, 10 and 12.

Table 3: Factors of Safety Results

Profile	Static Factor of Safety	Seismic Factor of Safety
A-A (Main House)	2.60	1.68
B-B (ADU)	1.94	1.36
C-C (Septic)	1.58	1.11

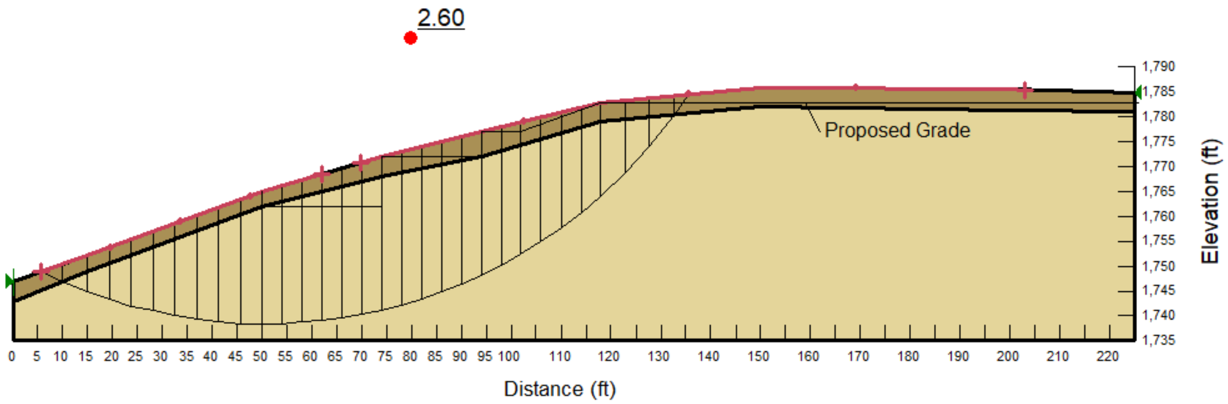

Figure 7: Profile A-A – Main House Natural Slope (static)

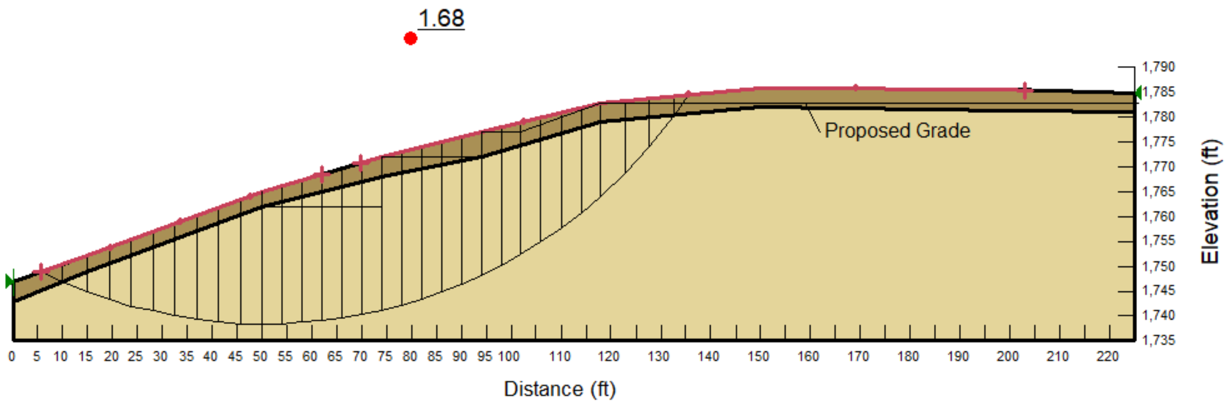

Figure 8: Profile A-A - Main House Natural Slope (seismic)

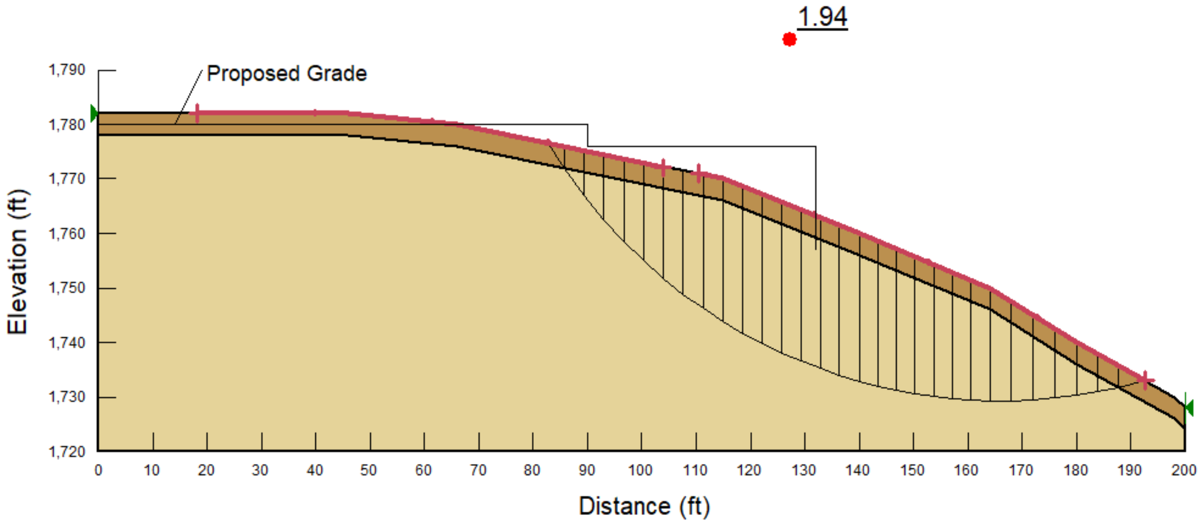

Figure 9: Profile B-B – ADU Natural Slope (static)

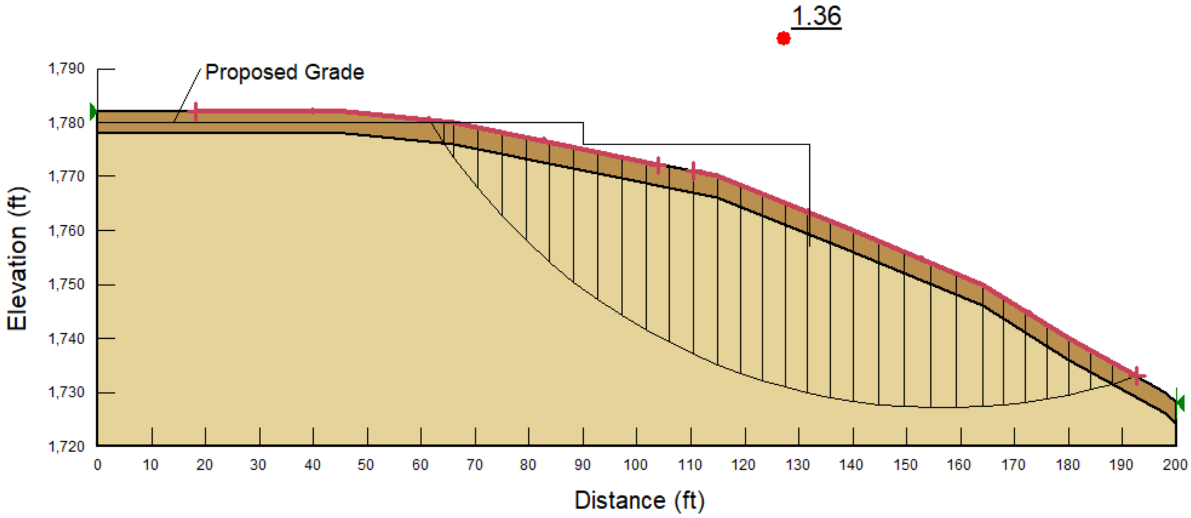

Figure 10: Profile B-B - ADU Natural Slope (seismic)

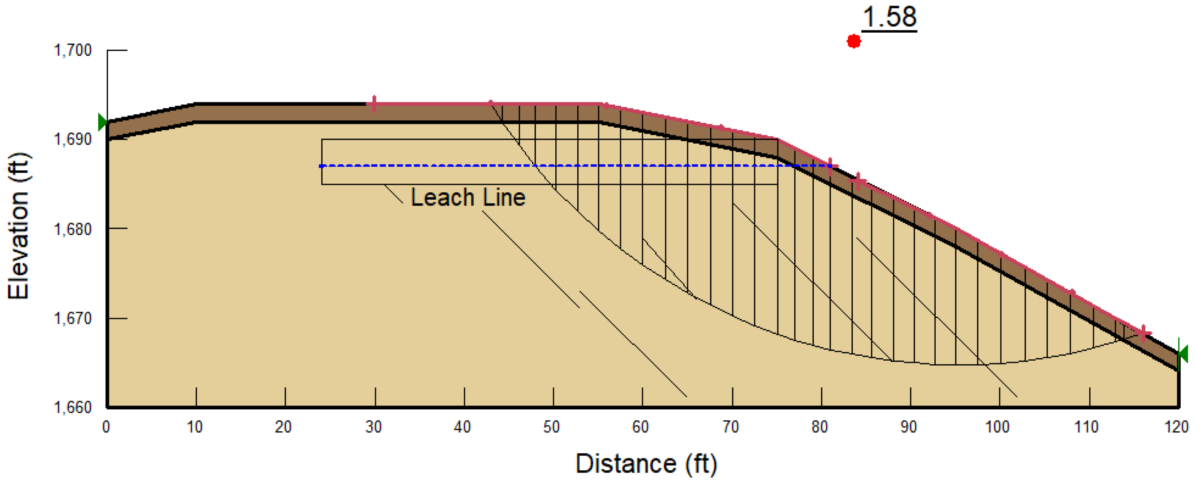

Figure 11: Profile C-C – Septic Natural Slope (static)

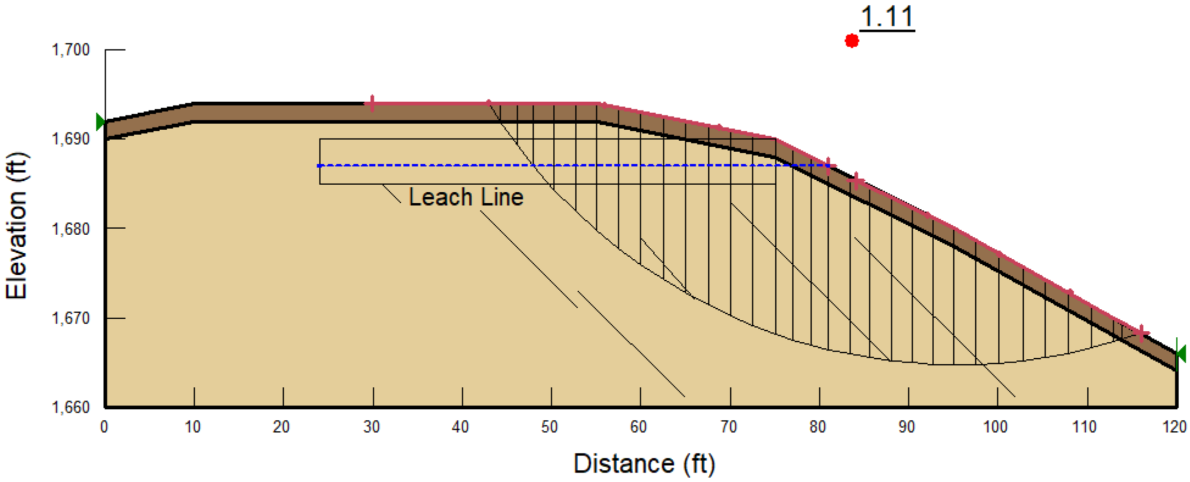

Figure 12: Profile C-C - Septic Natural Slope (seismic)

The slope conditions modeled in profile A-A, B-B and C-C resulted in a critical static and seismic factor of safety value above the minimum standard, indicating stable conditions. However, due to the presence of steep slopes in the immediate vicinity of the primary single-family residence and ADU/pool, deep foundation systems maybe required or structures should be setback from the slope. At the current configurations for the main house and ADU, footings should be a minimum of 5 feet below ground surface to achieve a daylight setback of 10 feet. In addition, to minimize the landslide potential, surface drainage should be controlled and directed away from proposed and natural slopes. These surface drainage controls should be designed by the project civil engineer.

6.0 ON-SITE SEPTIC SYSTEMS

A Percolation Testing Report was performed by this firm (GeoSolutions, Inc., May 14, 2019). Percolation rates varied from 11 to 13 minutes per inch. Per the project plans, the proposed leach field is located on a ridgetop east of the proposed ADU adjacent to the roadway (see Figure 2). Per the slope survey performed by the project civil engineer the leach field is located on slopes less than 30 percent however they are surrounded by slopes above 30 percent. A landslide was mapped immediately north of the leach field. At the current configuration, the northeast corner of the leach field is located at the top of the steep portion of the slope. The numerical slope stability analysis described in Section 5, resulted in stable conditions, however factor of safety values are right at the minimum standards. Due to this, it is recommended that trenches should be excavated to a total depth of 7 feet with the leach area limited to 5 feet below ground surface. As an alternative, the leach field should be realigned moving the northeast corner 5 feet to the south to provide a 10 foot to daylight of effluent.

7.0 SISMOLOGY AND CALCULATION OF EARTHQUAKE GROUND MOTION

7.1 Seismic Hazard Analysis and Structural Building Design Parameters

Estimating the design ground motions at the Site depends on many factors including the distance from the Site to known active faults; the expected magnitude and rate of recurrence of seismic events produced on such faults; the source-to-site ground motion attenuation characteristics; and the Site soil profile characteristics. According to section 1613 of the 2016 CBC (CBSC, 2016), all structures and portions of structures should be designed to resist the effects of seismic loadings caused by earthquake ground motions in accordance with the *ASCE 7: Minimum Design Loads for Buildings and Other Structures*, hereafter referred to as ASCE7-10 (ASCE, 2013). The Site soil profile classification (Site Class) can be determined by the average soil properties in the upper 100 feet of the Site profile and the criteria provided in Table 20.3-1 of ASCE7-10.

Spectral response accelerations, peak ground accelerations, and site coefficients provided in this report were obtained using the computer-based Seismic Design Maps tool available from the Structural Engineers Association of California (SEAOC, 2018). This program utilizes the methods developed in the ASCE7-10 in conjunction with user-inputted Site location to calculate seismic design parameters and response spectra (both for period and displacement) for soil profile Site Classes A through E.

Site coordinates of **35.5089** degrees north latitude and **-120.8507** degrees east longitude were used in the web-based probabilistic seismic hazard analysis (SEAOC, 2018). Based on the results from the in-situ tests performed during the field investigation, the Site was defined as **Site Class C**, “Very Dense Soil and Soft Rock” profile per ASCE7-10, Chapter 20. Relevant seismic design parameters obtained from the program area summarized in Table 4.

Table 4: Seismic Design Parameters

Site Class	**C**
Seismic Design Category	**D**
1-Second Period Design Spectral Response Acceleration, S_{D1}	**0.378g**
Short-Period Design Spectral Response Acceleration, S_{DS}	**0.742g**
Site Specific MCE Peak Ground Acceleration, PGA_M	**0.424g**

8.0 LIQUEFACTION

Due to the densities within the sub-surface material and the presence of clays in the subsurface, the liquefaction potential at the Site is considered low.

9.0 TSUNAMIS AND SEICHES

Tsunamis and seiches are two types of water waves that are generated by earthquake events. Tsunamis are broad-wavelength ocean waves and seiches are standing waves within confined bodies of water, typically reservoirs. As the property is at an elevation over 1700 feet and distance to the Pacific Ocean, the potential for a tsunami to affect the Site is low.

Flooding associated with a seismic event (seiche) is considered low due to the absence of a body of water upslope of the property.

10.0 HAZARDS FROM GEOLOGIC MATERIALS

10.1 Expansive Soils

The potential for expansive soil at the Site is low to medium based on laboratory testing performed for the concurrent Soils Engineering Report, expansion index of 94. The foundation recommendations for expansive soils should be incorporated into the design.

10.2 Naturally Occurring Asbestos

Naturally occurring asbestos is associated with serpentinite rock units within the Franciscan Complex. Due to the lack of Franciscan Complex units, there is a low potential for natural occurring asbestos at the Site.

10.3 Radon and Other Hazardous Gases

The Monterey Formation shale is a radon prone geologic unit located at the property. Radon gas is a naturally occurring radioactive gas that is invisible and odorless. It forms from the radioactive decay of small amounts of uranium and thorium naturally present in rocks and soils. Radon gas moves readily through rock and soil along micro-fractures and through pre-spaces between mineral grains. Many conditions affect how far radon can move in the subsurface but the ultimate limitation is the relatively short half-lives of radon's different isotopes (Churchill, 1997).

Radon moves from the soil into buildings in various ways. It can move though cracks in slabs or basement walls, pores and cracks in concrete blocks, through-going floor—wall joints, and openings around pipes. Radon moves into buildings from the soil when air pressure inside the buildings is lower that the air pressure outside. Because radon enters buildings from the adjacent soil, radon levels are typically highest in basements and ground floor rooms.

Radon levels in buildings can vary hour by hour, and season by season as a function of weather, climate, closed or opened windows, heating, and air conditioning. Radon gas may be present within Monterey Formation shale units underlying the property. Recommendations for mitigation of radon gas are presented in Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings (ASTM, July 15, 2007). This document is available from the publications page of EPA's website, identified as EPA document number 402-K-07-010. It is recommended that guidelines for the mitigation of radon gas be incorporated into the design of the proposed development.

11.0 GRADING OPERATIONS, CUT AND FULL, SUBDRAINS

Based on the depth of Monterey Formation units encountered at the site, it is anticipated that the grading will be excavated into formational material. Due to the presence of steep slopes in the immediate vicinity of the main house and ADU/pool, deepened footings or a deep foundation system maybe required. Conventional grading equipment may be used for excavations. The Soils Engineering Report provides additional foundation and construction recommendations. Based on the field investigation, subdrains will be evaluated at the time of construction if fill slopes are proposed.

Construction inspections and testing during all grading and excavating operations should be performed by the project Soils Engineer/Engineering Geologist. Section 1705.6A of the 2016 CBC (CBSC, 2016) requires the following inspections by the Soils Engineer/Engineering Geologist as shown in Table 5: Required Verification and Inspections of Soils:

Table 5: Required Verification and Inspections of Soils

Verification and Inspection Task	Continuous During Task Listed	Periodically During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.	-	X
2. Verify excavations are extended to proper depth and have reached proper material.	-	X
3. Perform classification and testing of controlled fill materials.	-	X
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of controlled fill.	X	-
5. Prior to placement of controlled fill, observe sub-grade and verify that site has been prepared properly.	-	X

12.0 ADDITIONAL SERVICES

The recommendations contained in this report are based on exploratory trenches and on the continuity of the sub-surface conditions encountered. It is assumed that GeoSolutions, Inc. will be retained to perform the following services:

1. Consultation during plan development.
2. Final plan review of final grading and drainage documents prior to construction.
3. Additionally, construction observation by the Engineering Geologist and/or Soils Engineer may be necessary to verify sub-surface conditions during excavation activities.
4. Final grading report and as-built map in accordance with County Guidelines for Engineering Geology Reports, Item 29 (San Luis Obispo County Department of Planning and Building, 2016).

13.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed during our study. Should any variations or undesirable conditions be encountered during the development of the Site, GeoSolutions, Inc. should be notified immediately and GeoSolutions, Inc. will provide supplemental recommendations as dictated by the field conditions.

This report is issued with the understanding that it is the responsibility of the owner or his/her representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project, and incorporated into the project plans and specifications. The owner or his/her representative is responsible to ensure that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they are due to natural processes or to the works of man on this or adjacent properties. Therefore, this report should not be relied upon after a period of 3 years without our review nor should it be used or is it applicable for any properties other than those studied. However, many events such as floods, earthquakes, grading of the adjacent properties and building and municipal code changes could render sections of this report invalid in less than 3 years.

Thank you for the opportunity to have been of service in preparing this report. If you have any questions or require additional assistance, please feel free to contact the undersigned at (805)543-8539.

Sincerely,
GeoSolutions, Inc.

Jeffrey Pfost, CEG 2493
Principal Engineering Geologist

PROFESSIONAL GEOLOGIST
JEFFREY PFOST
NO. 2493
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

\\192.168.0.5\s\SL10500-SL10999\SL10982-3 - Old Creek Road\Geology\SL10982-3 Old Creek Road Engineering Geology Investigation.doc

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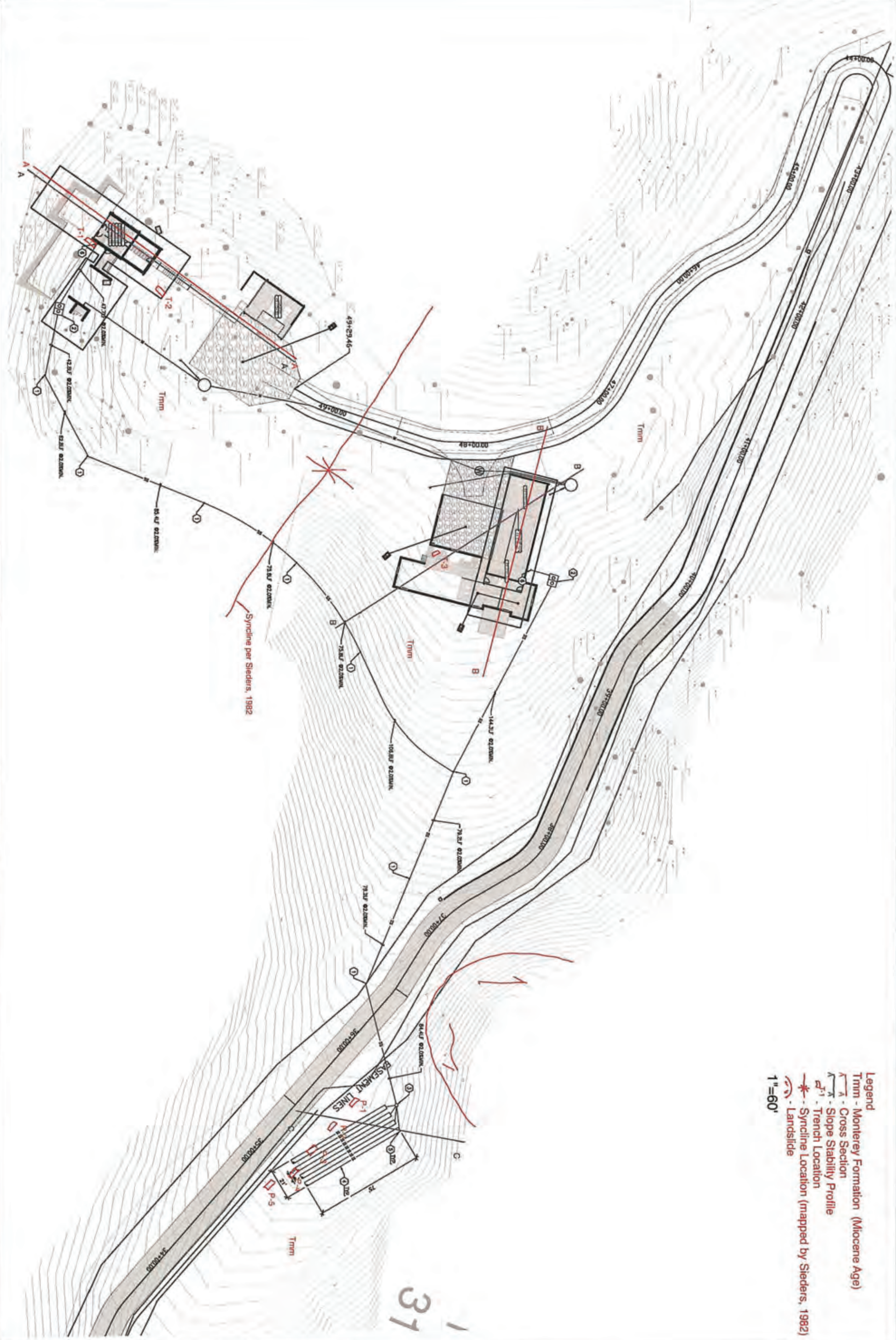
PLATES



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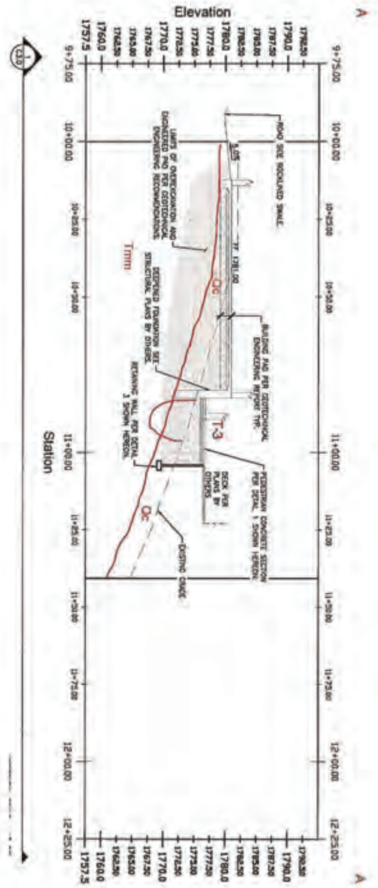
SITE ENGINEERING GEOLOGY MAP

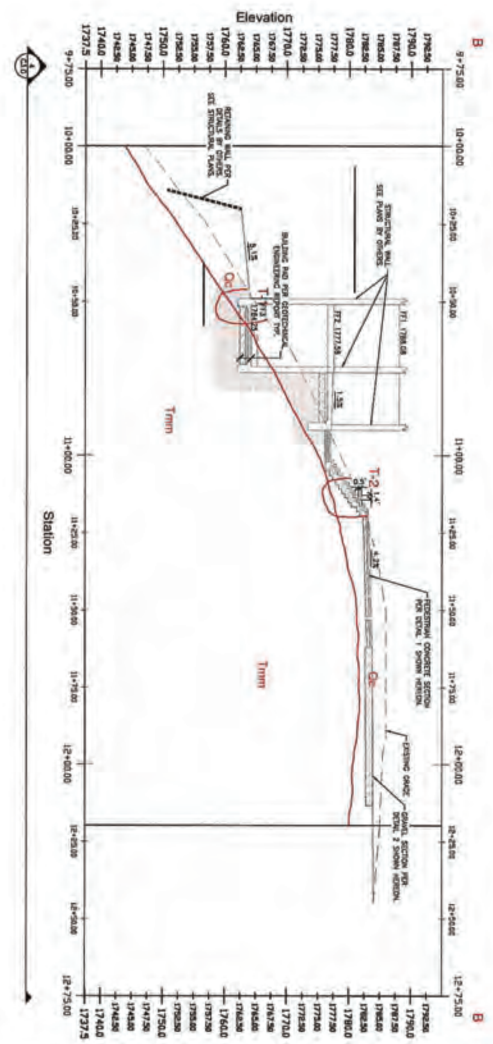
OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
1A

PROJECT
SL10982-3

HORIZONTAL SCALE 1"=40'





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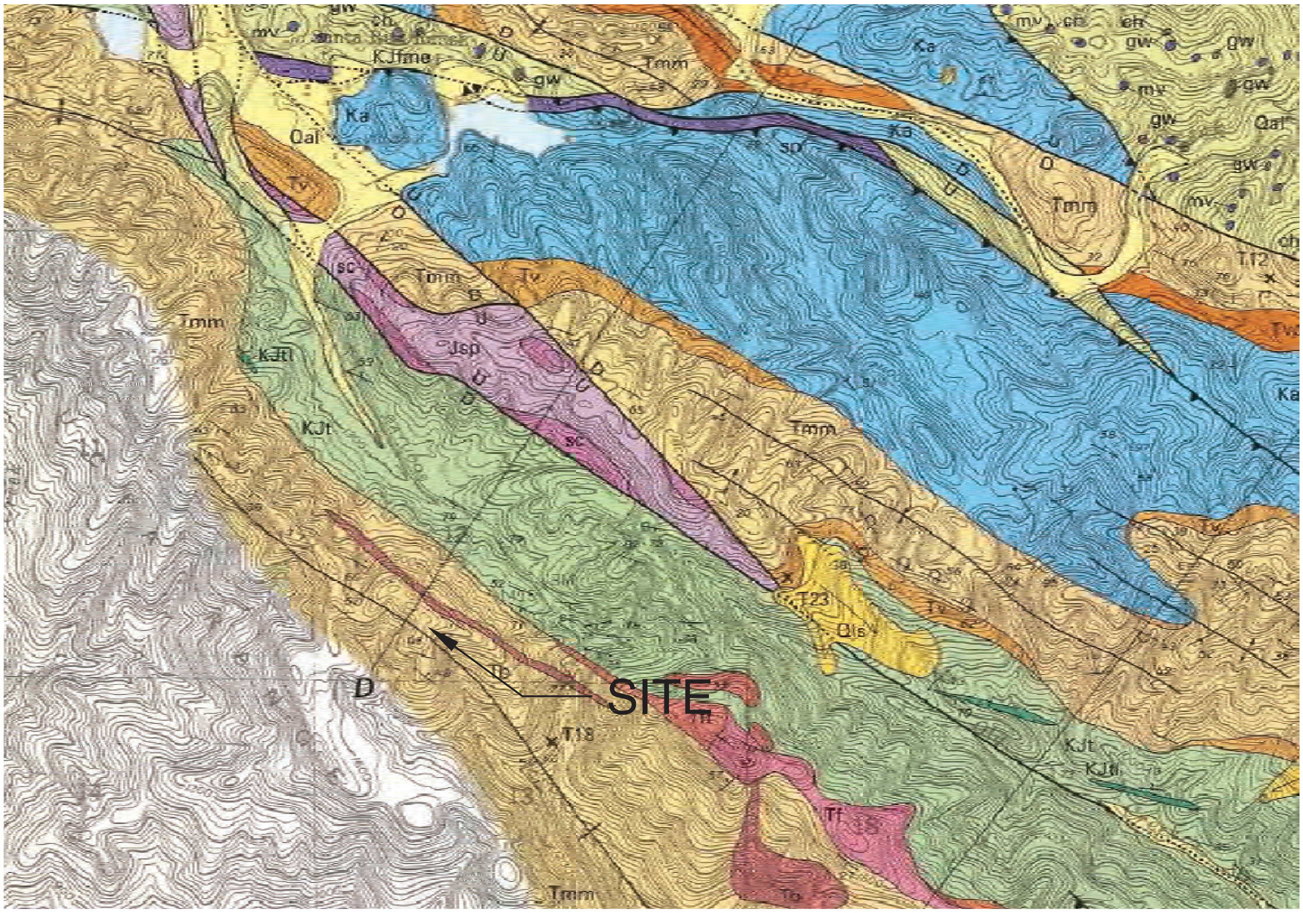
SITE CROSS SECTION

OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
1B

PROJECT
SL10982-3



DESCRIPTION OF MAP UNITS

mw MINE WASTE

Qal ALLUVIUM (Holocene)—Sand, gravel, silt, and mud in flood plains and low terraces along streams

Qls LANDSLIDE DEPOSITS (Holocene)—Unsorted rock and mud debris with characteristic hummocky surface expression. Especially abundant on serpentinite and the Franciscan assemblage. Not all landslide deposits are shown. Arrow indicates direction of movement

Tb DIABASE AND BASALT (Miocene)—Dark-gray, locally amygdaloidal rocks, chiefly sheets and dikes that intrude Tertiary rocks; rare small bodies intrude Cretaceous rocks

SANDHOLDT MEMBER OF MONTEREY FORMATION (Miocene)—Includes

Tmm Calcareous and porcelaneous mudstone—Thin- to thick-bedded, chocolate-brown to buff, calcareous, foraminiferal mudstone, most abundant in lower part of section; locally phosphatic and glauconitic. Thin- to medium-bedded, porcelaneous mudstone most abundant in upper part of exposed section, weathers to light-gray rock of low density locally known as "chalk rock". Locally abundant concretions, lenses, and rare beds of buff to grayish-orange limestone and dolomite. Rare dark-gray cherty mudstone and thick lenses of laminated dark-gray chert. Local graded sandstone beds. About 400 m thickness exposed

Tmt Tuffaceous mudstone and tuff—Light-gray, thin- to thick-bedded, includes some buff to dark-gray calcareous mudstone. About 200 m thickness exposed

Tms Sandstone—Light-gray to buff, fine- to coarse-grained, calcareous; locally contains fossil shells of small pectens. Maximum thickness about 30 m

Tv VAQUEROS FORMATION (early Miocene and late Oligocene)—Sandstone, yellowish-gray to light-gray, very thick to thick-bedded, fine- to coarse-grained, arkosic, calcareous. Locally pebbly and includes some conglomerate beds in the lower part. Fossil shells of giant pectens, some as large as 17 cm, are common in some places. Rare oyster beds. Thickness ranges from 0 to about 120 m

Tvc Conglomerate member—Pebble, cobble, and boulder conglomerate with subordinate gray sandstone and pebbly to cobbly sandstone. Clasts are chiefly of sandstone and felsic volcanic rocks, but a wide variety of rock types are present. Locally contains boulders of granitic gneiss and marble derived from the basement of the Salinian block. Thickness ranges from 0 to 100 m

FELSIC VOLCANIC ROCKS (Oligocene)—Includes

Tf Felsite—Light-gray to grayish-orange, commonly flow-layered, with phenocrysts of quartz and plagioclase. Locally consists of dark-gray perlitic glass. Forms bulbous masses probably representing lava domes and volcanic necks

Tfv Felsic volcaniclastic rocks—Light-gray, grayish-orange, and pale-green felsic tuff, lapilli tuff, tuff breccia, and breccia. In part rich in pumice, in part contains abundant clasts of flow-layered felsite like unit Tf. Thickness ranges from 0 to about 200 m

Tl LOSPE FORMATION (Oligocene)—Grayish-red, locally grayish-green, thick-bedded pebbly sandstone, sandstone, conglomerate, and mudstone. Largely nonmarine but local medium-gray, calcareous, pebbly sandstone along southern limit of exposure may be marine. Thickness ranges from 0 to about 30 m

ATASCADERO FORMATION (Late Cretaceous)—Includes

Kaps Pebbly sandstone—Light-gray to light-olive-gray, very thick to thick-bedded sandstone and pebbly to cobbly sandstone. In part shows large-scale crossbedding. Clasts occur both scattered in sandstone matrix and in thin discontinuous beds commonly only one pebble or cobble thick. Subordinate thin- to medium-bedded sandstone with interbedded mudstone. Local conglomerate and rare pebbly mudstone. Fossils of shallow-water origin are common. Exposed thickness about 1800 m

Kan Thin-bedded sandstone and mudstone—Greenish-gray, thin- to medium-bedded, fine- to medium-grained, commonly calcareous, arkosic sandstone and interbedded olive-gray mudstone. Sandstone commonly displays graded bedding, small-scale crossbedding, and convolute bedding. Locally about 550 m exposed but occurs in several fault blocks with uncertain correlation; aggregate thickness may be greater

Kah Very thick-bedded sandstone—Light-gray, coarse-grained arkosic sandstone. Forms conspicuous outcrops on hillsides and ridge crests. Includes less well exposed thin- to thick-bedded, in part graded, sandstone and mudstone. About 1100 m thick

About 1100 m thick

Kapm Pebbly mudstone—Several thin and one thick lens of very thick to medium-bedded, pebbly to cobbly mudstone and local conglomerate interbedded with subordinate thin- to thick-bedded sandstone and mudstone. Pebbles typically have well-polished surfaces. At one locality on Jack Creek the pebbles are felsic volcanic rocks (80 percent), quartzite, sandstone, and mudstone (8 percent), chert (7 percent), and granitic rocks (5 percent). Locally about 450 m thick

Ka Thick-bedded sandstone—Light-gray to greenish-gray, fine- to coarse-grained, commonly calcareous, arkosic sandstone. Chiefly thick-bedded, but includes considerable volumes of thin- to medium bedded and very thick bedded sandstone. Locally pebbly; includes some pebble conglomerate. Graded bedding very common. Subordinate interbedded olive-gray mudstone. Locally about 1200 m thick but occurs in several fault blocks with uncertain correlation; aggregate thickness probably greater

Kac Conglomerate—Very thick bedded pebble, cobble, and boulder conglomerate. Thick lens of conglomerate on Cayucos-Templeton Road is composed chiefly of clasts of felsic volcanic rocks (63 percent), granitic rocks (27 percent), and quartzite and sandstone (10 percent). Thick lenses of conglomerate at east edge of map area are rich in boulders of sandstone and felsic volcanic rocks. Locally at least 300 m thick

Kasc Sandy conglomerate—Two stratigraphically equivalent lenses of pebbly to cobbly sandstone, sandy conglomerate and conglomerate. Maximum thickness about 130 m

FRANCISCAN ASSEMBLAGE (Late and Early Cretaceous and Jurassic)—Includes

KJfcg Conglomerate—Poorly sorted pebble, cobble, and boulder conglomerate rich in clasts of graywacke and containing a variety of clasts apparently derived from older parts of the Franciscan assemblage (Cowan and Page, 1975)

KJfgw Graywacke—Grayish-yellow-green to greenish-gray, thick-bedded, medium- to coarse-grained lithic sandstone and subordinate thin- to medium-bedded sandstone and interbedded olive-gray mudstone. Mapped in larger tectonic inclusions in mélange

KJfmv Mafic volcanic rocks—Mafic lava, volcaniclastic rocks and dikes. Indistinguishable from unit Jmv. Occurs as tectonic inclusions within mélange

KJfme Mélange—Pervasively sheared dark-gray shale matrix containing various types of tectonic inclusions, commonly highly fractured, ranging from pebble size to mappable units. Not all mappable units are shown. Inclusions include: graywacke (gw); poorly sorted conglomerate rich in clasts of graywacke (cg); moderately sorted conglomerate rich in clasts of chert (cg-c); mafic volcanic rocks (mv); green or red, thin- to medium-bedded radiolarian chert (ch); serpentinite (sp); silica-carbonate rocks (sc); gabbro (gb); diabase (db); greenschist (gs); amphibolite (am); gneiss (gn); blueschist (bs); phyllite (ph); intermediate volcanic rocks (iv); felsic volcanic rocks (fv); vein quartz (qz); and plagiogranite (pg)

KJt TORO FORMATION (Early Cretaceous and Late Jurassic)—Thin-bedded sandstone and mudstone—Medium-gray to greenish-gray, thin-bedded, locally medium-bedded, fine- to medium-grained, graded lithic sandstone interbedded with olive-gray mudstone, in part laminated with fine-grained sandstone. Sandstone commonly calcareous; mudstone locally contains limestone concretions. Exposed thickness about 1200 m. Locally includes:

KJtl Limestone—Lenses of light- to medium-gray, thick-bedded, microcrystalline limestone, locally with scattered shell fragments. Lenses to about 10 m thick

KJtc Chert-pebble conglomerate—Lenses of moderately sorted pebble to cobble conglomerate interbedded with subordinate thin- to thick-bedded sandstone, in part pebbly, rare pebbly mudstone. Pebbles are well rounded; clasts are moderately well imbricated. Clasts consist chiefly of chert (60–70 percent), quartzite (10–30 percent), mudstone (2–12 percent), and sandstone (1–7 percent). Lenses to about 30 m thick

Jch BEDDED CHERT (Late Jurassic)—Olive-gray, yellowish-gray, and grayish-yellow-green, thin- to medium-bedded, very impure, tuffaceous, radiolarian chert. Thickness 0 to about 100 m; generally less than 10 m thick

Jmv MAFIC VOLCANIC ROCKS (Jurassic)—Grayish-green basaltic lava, in part pillowed, basaltic volcanic breccia, and abundant diabase dikes; local gabbro. Pervasively altered to low-grade metamorphic mineral assemblages

Jsp SERPENTINITE (Jurassic)—Serpentinized ultramafic rocks, massive to intensely sheared, with dikes, commonly fragmented, of gabbro, diabase, and diorite, in part altered to rodingite. Locally includes silica carbonate rocks (sc)

Contact

Fault—Dotted where concealed. U, upthrown side; D, downthrown side. Arrows show relative horizontal movement. In cross sections, dashed where approximately located

Thrust fault—Dotted where concealed. Sawteeth on upper plate. Indicates fault interpreted to have had low original angle of dip; most thrust faults now have steep dips as a result of later folding; some thrust faults have later reverse or normal movement. In cross section, T indicates movement toward observer; A, movement away from observer

Anticline—Showing trace of axial plane; dotted where concealed

Syncline—Showing trace of axial plane; dotted where concealed

Strike and dip of beds—Ball indicates tops of beds are known from sedimentary structures; ball shown on top side of vertical beds
- Inclined
- Vertical
- Horizontal
- Overturned

Strike and dip of flow layering in felsite
- Inclined
- Vertical

Approximate strike and dip of shear planes

Area of rock alteration—Rocks are bleached and show thin reddish-brown vat veins; occurs around some quicksilver deposits

fl Quarry—fl, flagstone

Hg Abandoned mine or quarry—Hg, quicksilver

Adit

Cr Prospect pit—Cr, chromite

M13 Fossil locality—See table 1

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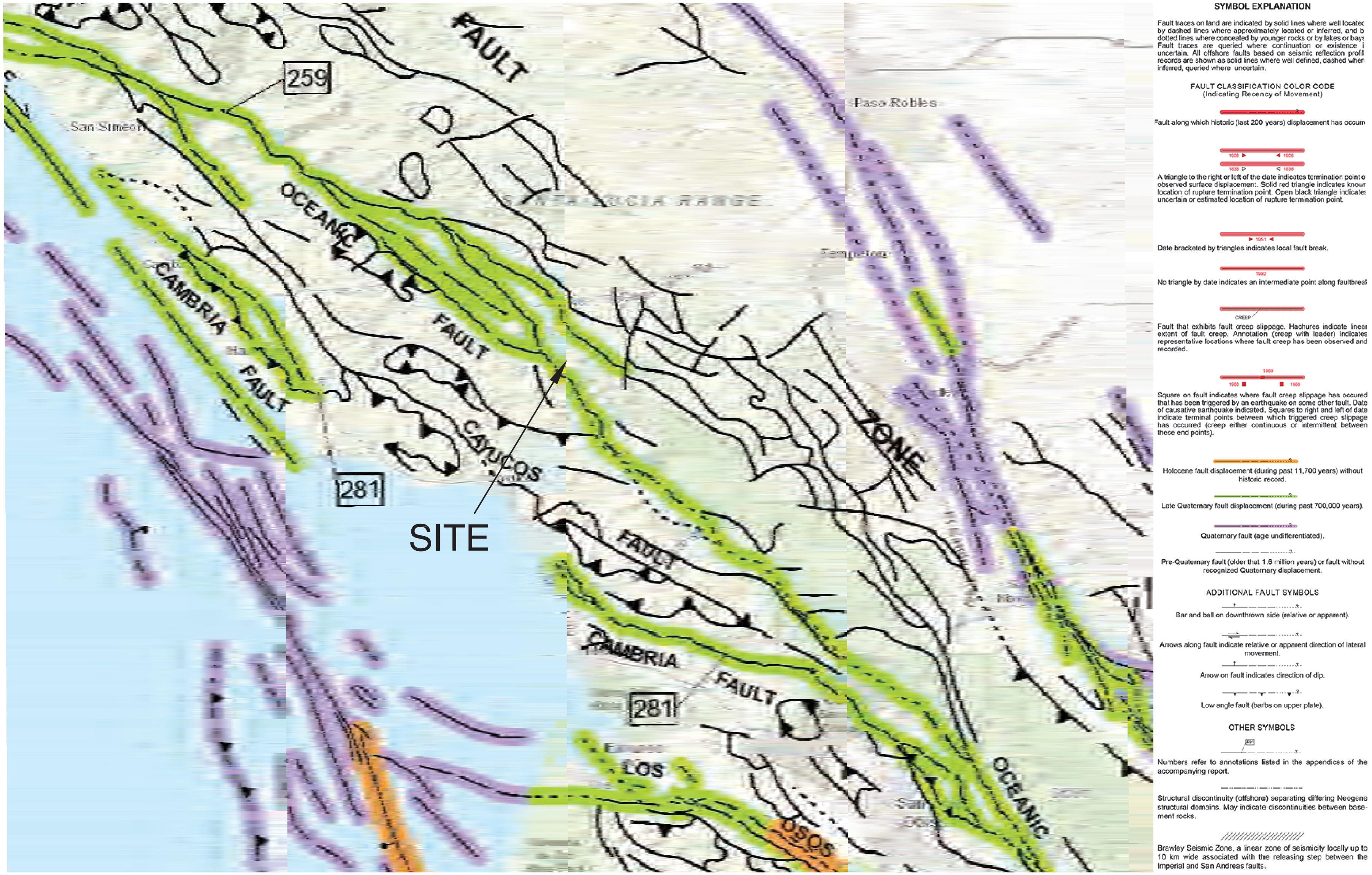
REGIONAL GEOLOGY MAP

(SEIDERS, 1982)
OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
2

PROJECT
SL10982-3



SYMBOL EXPLANATION

Fault traces on land are indicated by solid lines where well locatec by dashed lines where approximately located or inferred, and b dotted lines where concealed by younger rocks or by lakes or bays Fault traces are queried where continuation or existence i uncertain. All offshore faults based on seismic reflection profil records are shown as solid lines where well defined, dashed when inferred, queried where uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurr

A triangle to the right or left of the date indicates termination point o observed surface displacement. Solid red triangle indicates knowr location of rupture termination point. Open black triangle indicate: uncertain or estimated location of rupture termination point.

Date bracketed by triangles indicates local fault break.

No triangle by date indicates an intermediate point along faultbreal

Fault that exhibits fault creep slippage. Hachures indicate linear extent of fault creep. Annotation (creep with leader) indicates representative locations where fault creep has been observed and recorded.

Square on fault indicates where fault creep slippage has occured that has been triggered by an earthquake on some other fault. Date of causative earthquake indicated. Squares to right and left of date indicate terminal points between which triggered creep slippage has occurred (creep either continuous or intermittent between these end points).

Holocene fault displacement (during past 11,700 years) without historic record.

Late Quaternary fault displacement (during past 700,000 years).

Quaternary fault (age undifferentiated).

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement.

ADDITIONAL FAULT SYMBOLS

Bar and ball on downthrown side (relative or apparent).

Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate).

OTHER SYMBOLS

Numbers refer to annotations listed in the appendices of the accompanying report.

Structural discontinuity (offshore) separating differing Neogene structural domains. May indicate discontinuities between basement rocks.

Brawley Seismic Zone, a linear zone of seismicity locally up to 10 km wide associated with the releasing step between the Imperial and San Andreas faults.

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REGIONAL FAULT MAP

(JENNINGS, 2010)
OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
3

PROJECT
SL10982-3

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AERIAL PHOTOGRAPH

(GOOGLE)
OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
4

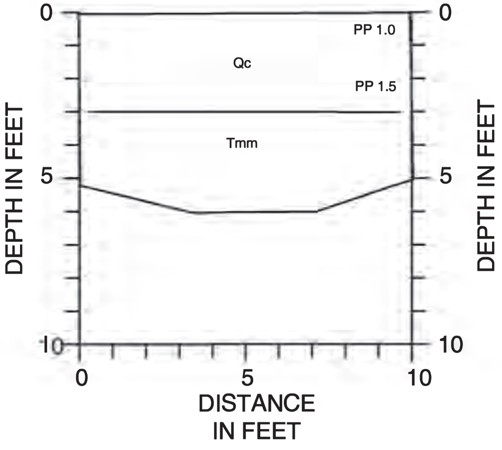
PROJECT
SL10982-3

APPENDIX A

Trench Logs

Percolation Logs

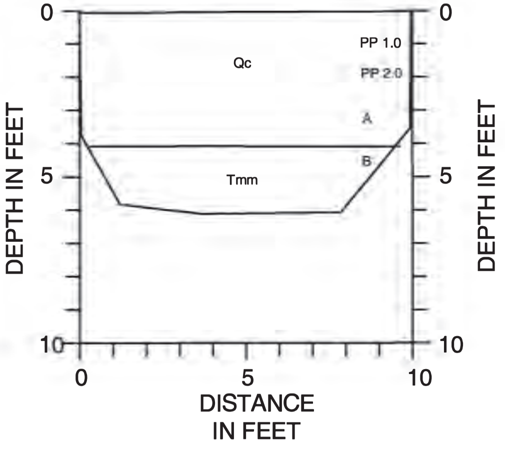
T-1 (MAIN HOUSE LOWER)
TD@6.0 FT.



Qc- dark brown sandy SILT (MH), dry, roots throughout, cobbles of Sandstone

Tmm- white SILTSTONE, highly fractured, weathered orange, slightly to moderately weathered Monterey Formation

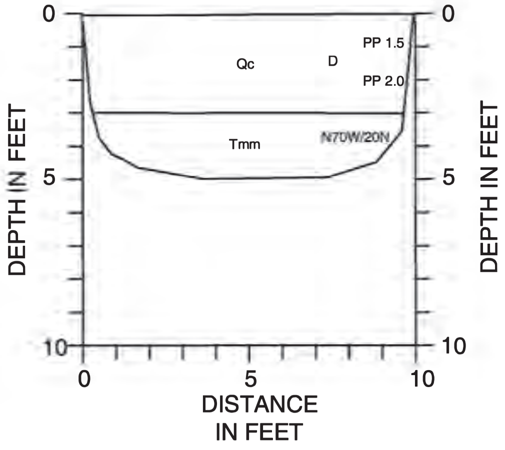
T-2 (MAIN HOUSE UPPER)
TD@6.0 FT.



Qc- dark brown sandy SILT (MH), dry, roots , cobbles of Sandstone

Tmm- white SILTSTONE, highly fractured, moderately weathered Monterey Formation

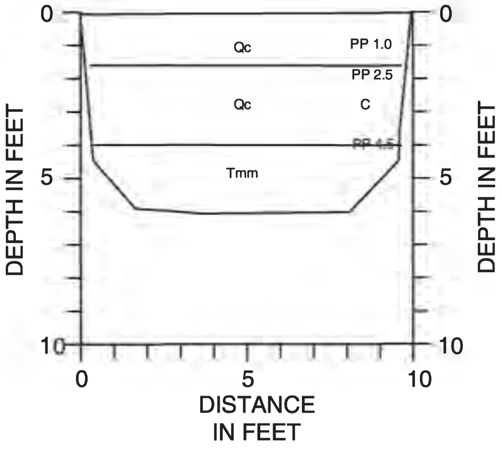
T-4 (EQUIPMENT BUILDING)
TD@5.0 FT.



Qc- dark brown sandy SILT (MH), dry to slightly moist

Tmm- white SILTSTONE, severely weathered to moderately weathered, highly fractured Monterey Formation

T-3 (GUEST HOUSE)
TD@6.0 FT.



Qc- dark brown sandy SILT (MH), slightly moist

Qc- dark yellow CLAY (CL), severely weathered, some rock fabric

Tmm- white CLAYSTONE, severely weathered moderately weathered Monterey Formation

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TRENCH LOGS

OLD CREEK ROAD, APN'S: 046-031-033 & -043, CAYUCOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

LOG
1

PROJECT
SL10982-3

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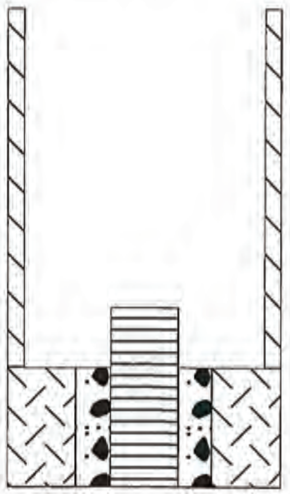
201 S. Milpas St, Ste 103, Santa Barbara, CA 93103
Phone: 805-966-2200

PERCOLATION LOG

TRENCH NO. **P-1-P-4**
JOB NO. **SL10982-1**

PROJECT INFORMATION		TRENCHING INFORMATION	
PROJECT:	**Old Creek Road**	EQUIPMENT:	**Mini Excavator**
TRENCHING LOCATION:	**See Plate 1**	BUCKET SIZE:	**18 inches**
DATE TRENCHED:	**December 3, 2018**	SAMPLING METHOD:	**Bag**
LOGGED BY:	**JP**	APPROX. ELEVATION:	**Not Recorded**

Depth of Groundwater: **Not Encountered** Trench Terminated At: **4 feet** Page 1 of 2

DEPTH	LITHOLOGY	USCS	SOIL DESCRIPTION	ANNULAR MATERIAL DESCRIPTION	WELL CASING MATERIAL DESCRIPTION	WELL CROSS-SECTION
0	🟨	ML	SANDY SILT: dark brown			
1	🟨					
2	🟨		SILTSTONE: white, highly fractured, Monterey Formation		PVC SCREEN	
3	🟨			PEA GRAVEL		
4						
5						
6						
7						
8						
9						
10						

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Phone: 805-966-2200

PERCOLATION LOG

TRENCH NO. **P-5**
JOB NO. **SL10982-1**

PROJECT INFORMATION

PROJECT: **Old Creek Road**
TRENCHING LOCATION: **See Plate 1**
DATE TRENCHED: **December 3, 2018**
LOGGED BY: **JP**

TRENCHING INFORMATION

EQUIPMENT: **Mini Excavator**
BUCKET SIZE: **18 inches**
SAMPLING METHOD: **Bag**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Trench Terminated At: **15 Feet** Page 2 of 2

DEPTH	LITHOLOGY	USCS	SOIL DESCRIPTION	ANNULAR MATERIAL DESCRIPTION	WELL CASING MATERIAL DESCRIPTION	WELL CROSS-SECTION
0–2		MH	SANDY SILT: dark brown			
2–15			SILTSTONE: white, highly fractured, Monterey Formation